

# CONGRESSO NAZIONALE SIFE

Rigenerazione ossea con tecniche di fissazione interna ed esterna.  
Prevenzione e trattamento delle infezioni ossee in traumatologia

Presidente del Congresso  
Dott. Alexander Kirienko  
Istituto Clinico Humanitas - Rozzano

**SIFE**  
SOCIETÀ ITALIANA  
FISSAZIONE ESTERNA

**2023**  
**27-28 Ottobre**  
**MILANO**

Sessione 5

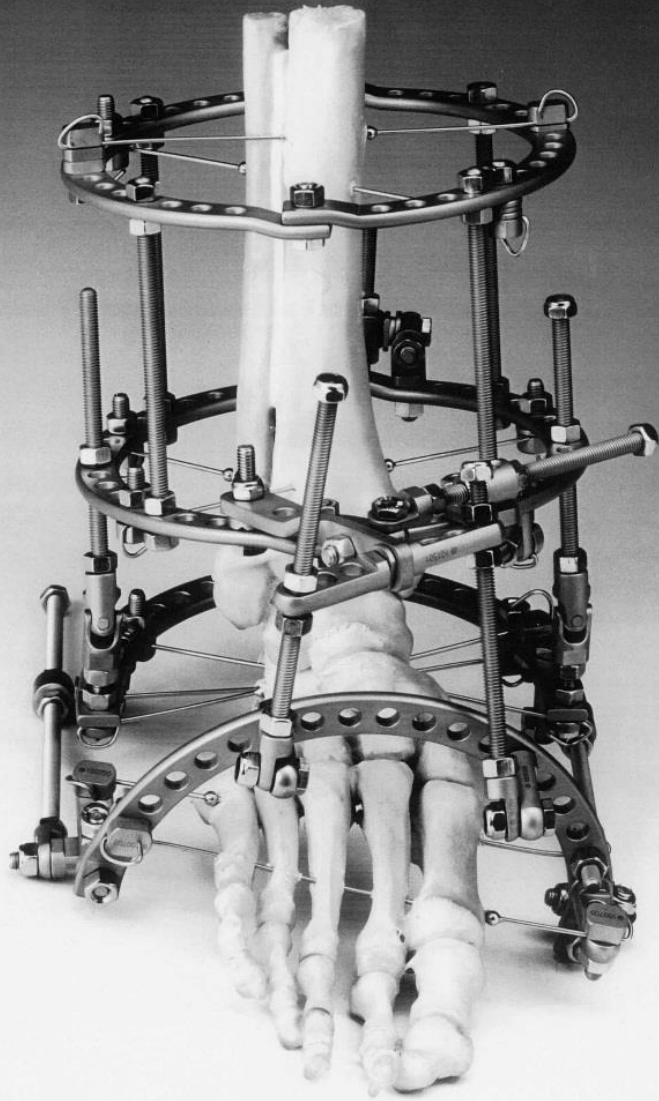
## DEFORMITÀ DEL PIEDE E PIEDE DI CHARCOT

*Foot deformity and Charcot foot*

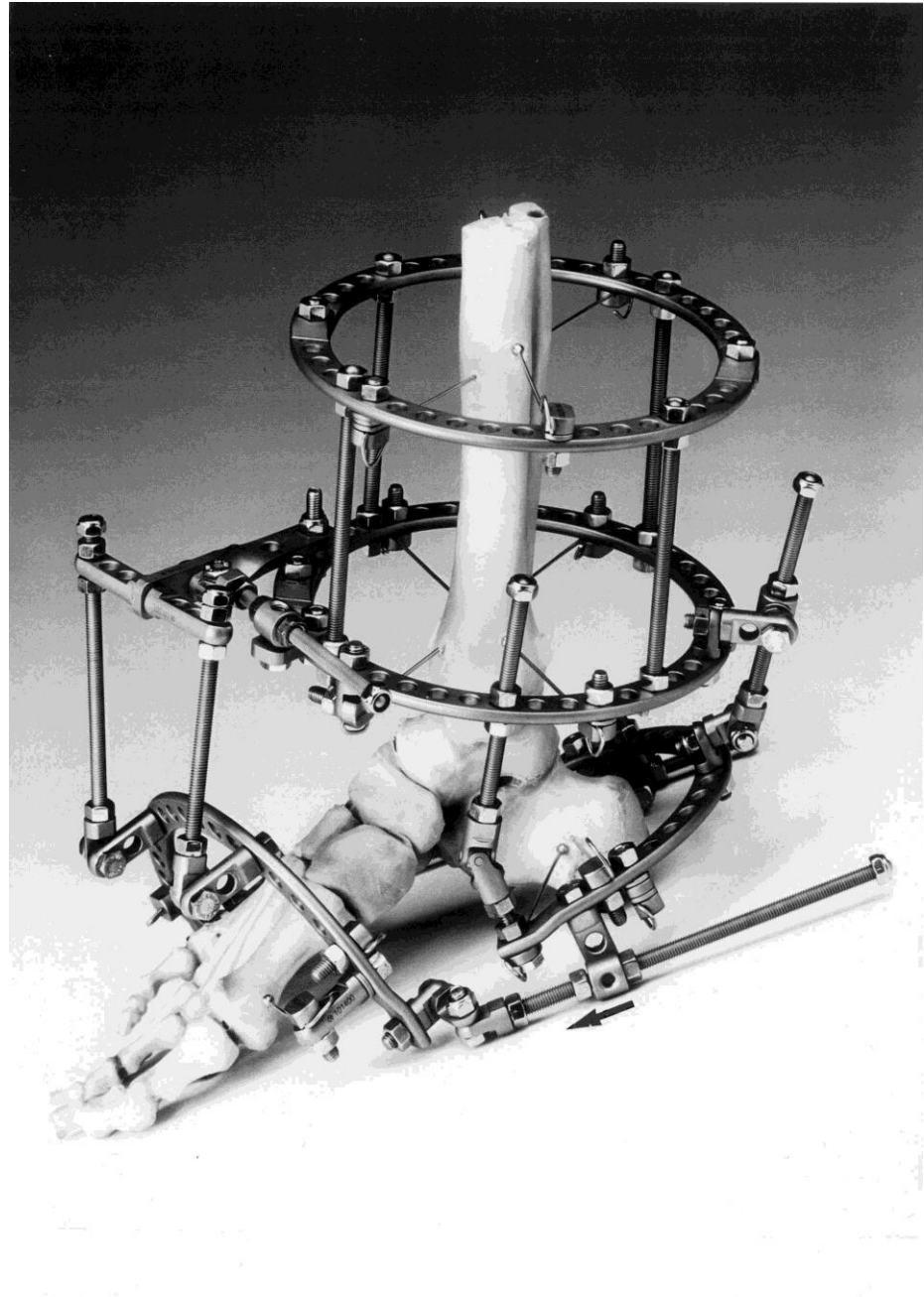
### CORREZIONE CON TECNICA CLASSICA

***E. Malagoli, A. Kirienko, F. Vandenbulcke***

*Istituto Clinico Humanitas. Traumatologia - Sezione Fissazione Circolare*



75



DROR PALEY

# Principles of Deformity Correction

EXTRA  
MATERIALS  
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With Editorial Assistance  
from J. E. Herzenberg



Springer

Exercise Workbook



## New Sagittal Plane Reference Parameters for Foot Deformity Correction Planning: The Vitruvian Foot

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### ARTICLE INFO

Level of Clinical Evidence: 3

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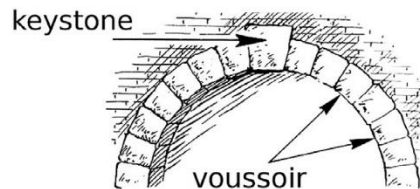
deformity correction planning  
hindfoot deformity  
midfoot deformity  
reference lines and angles

### ABSTRACT

Currently available methods for analysis and planning of post-traumatic or congenital deformity correction of the foot have some limitations. The aim of this retrospective study was to establish reference lines and angles (RLAs), and the resulting ratios, based on reproducible anatomic points on sagittal feet radiographs. The key starting point of our evaluation was the previously undescribed length and position of the talus joint line (TJL), from the border of the articular surface of the talus and the posterior process of talus. First, we calculated the relationships between the TJL and the axes of the foot, particularly the anatomic and mechanical lateral talometatarsal angle axes of the  $\gamma$  the lateral heel angle. Finally,

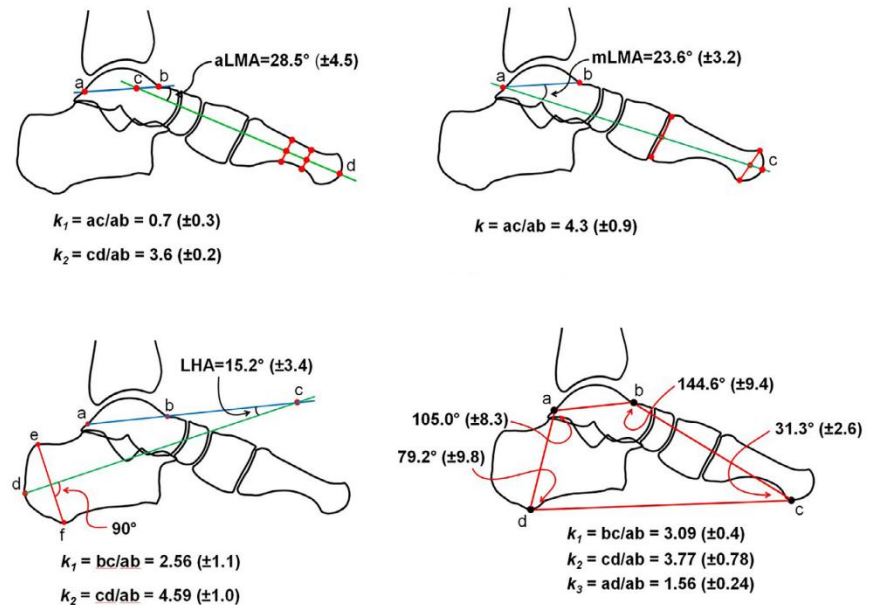


**Fig. 1.** The talus joint line connecting the posterior border of the articular surface and anterior border of the articular surface of the neck of the talus.



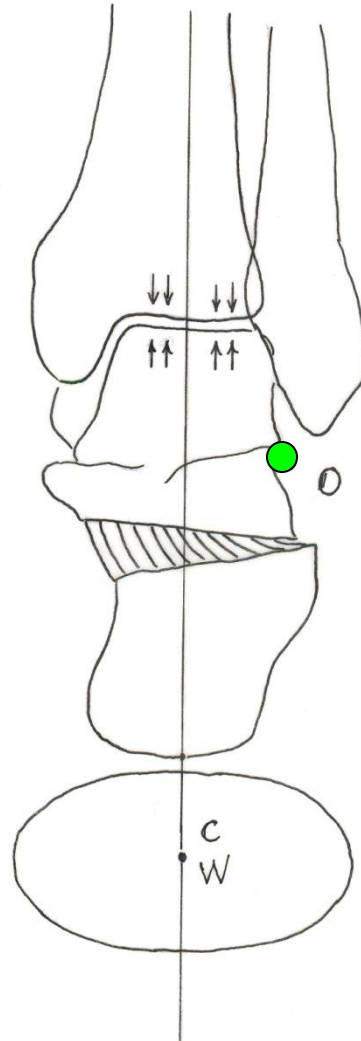
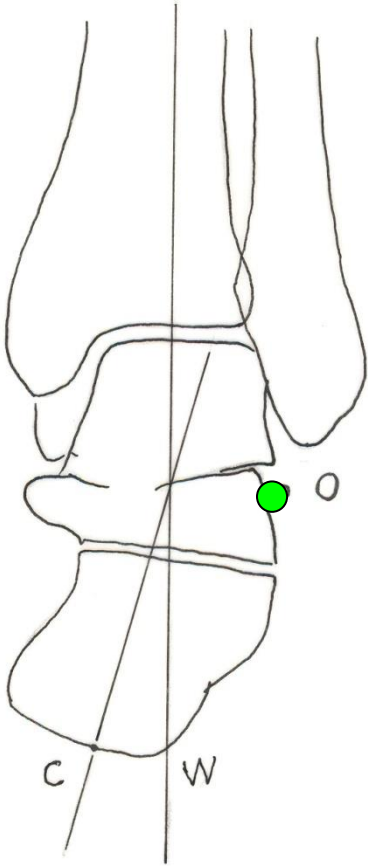
**Fig. 2.** The keystone of an arch is analogous to the talus in the foot. The other bones of the arch are analogous to the wedge-shaped “voussoirs” of the architectural arch.

*LN. Solomin et al. / The Journal of Foot & Ankle Surgery 58 (2019) 865–869*





# The varus heel



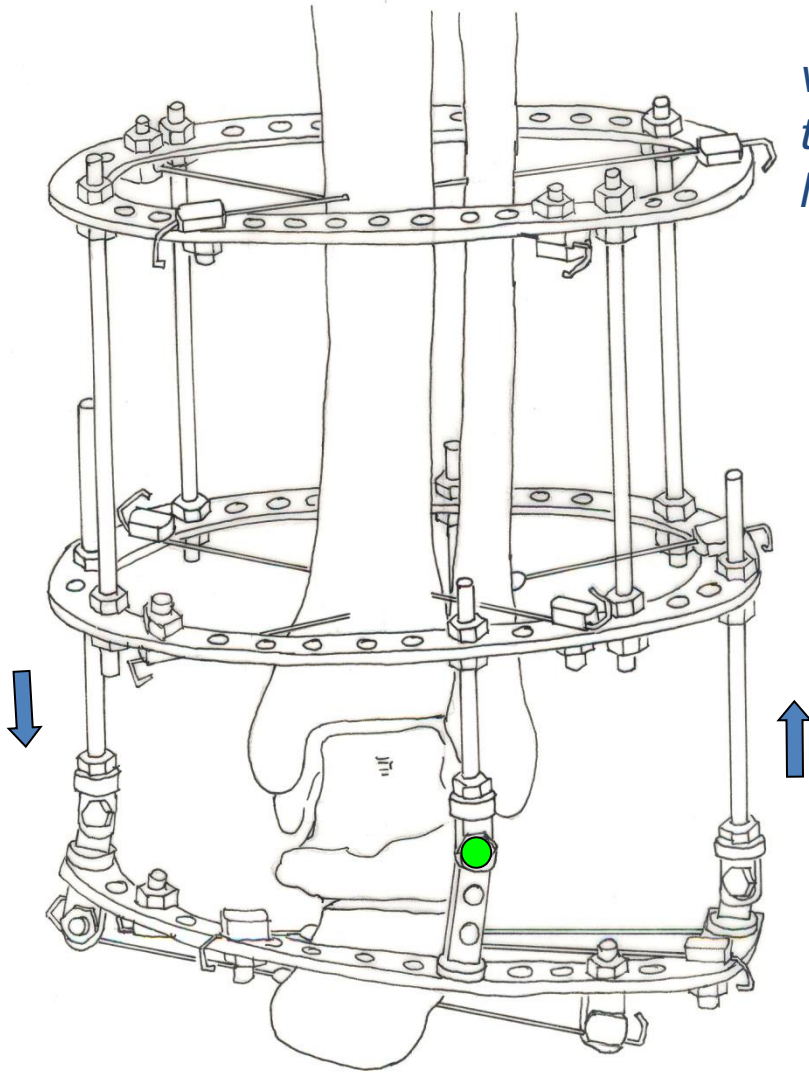
*Hinge axis (O) is proximal to the osteotomy (RULE 2°)*

*Lateral translation is added to the corrective procedure.*

*Weight-bearing area (W) and calcaneal axis (C) are overlapping*

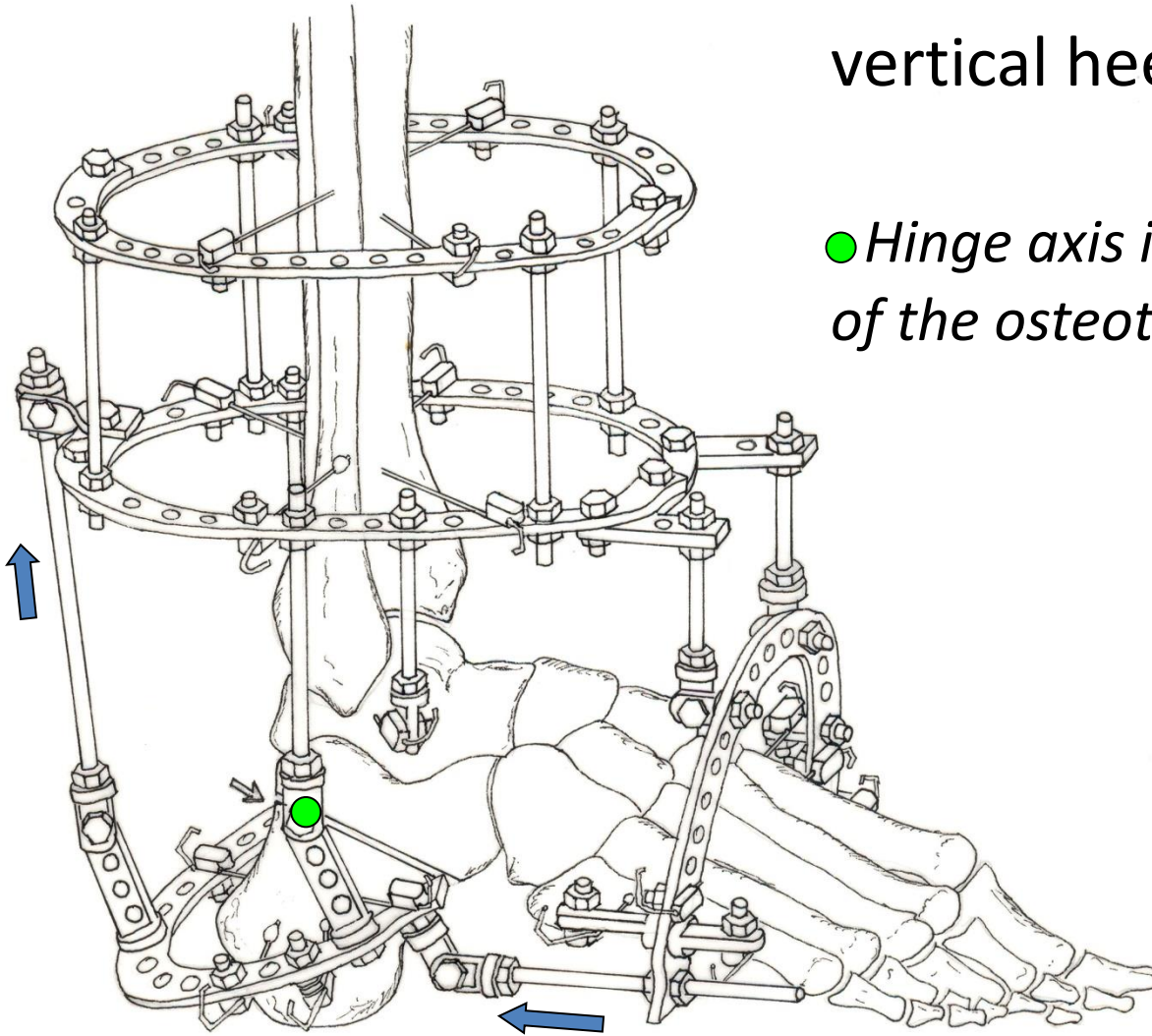
*Frame for correction :*

*varus,  
translation  
lengthening*

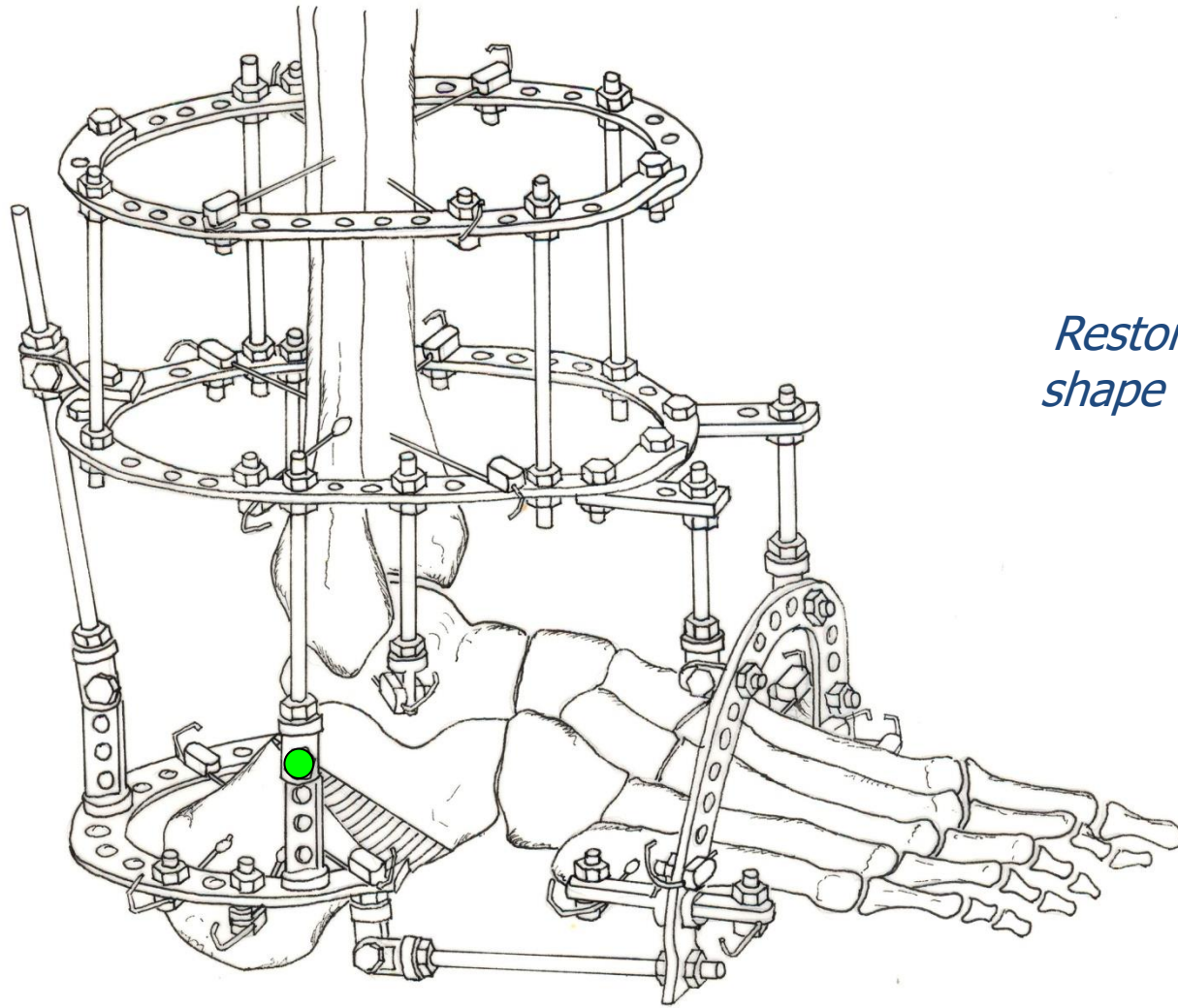


Frame for correction of vertical heel.

- Hinge axis is at the cranial end of the osteotomy ( *RULE 1°* )







*Restoration of the  
shape of calcaneus*

# Classification

## *Ethyological*

### Congenital

- congenital club foot
- fibular or tibial hemimelia
- congenital malformation -Brachimetatarsia
- vascular malformation -Haglund's deformity (Calcaneus deformity)
- Trevor's syndrome (dysplasia epifisaria hemimelica)

### Neurological

- Spina Bifida
- Charcot Marie Tooth
- Polio

### Postraumatic

## *Anatomical*

Hindfoot (Calcagno –talus coalition)

Midfoot (Cavus foot),

Forefoot (Apert syndrom, polidattilia, brachidattilia)





# Correction of foot deformity

## Closed surgery

(without osteotomy)

2-12 years

- *The skeleton is in the active growth phase*

## Open surgery

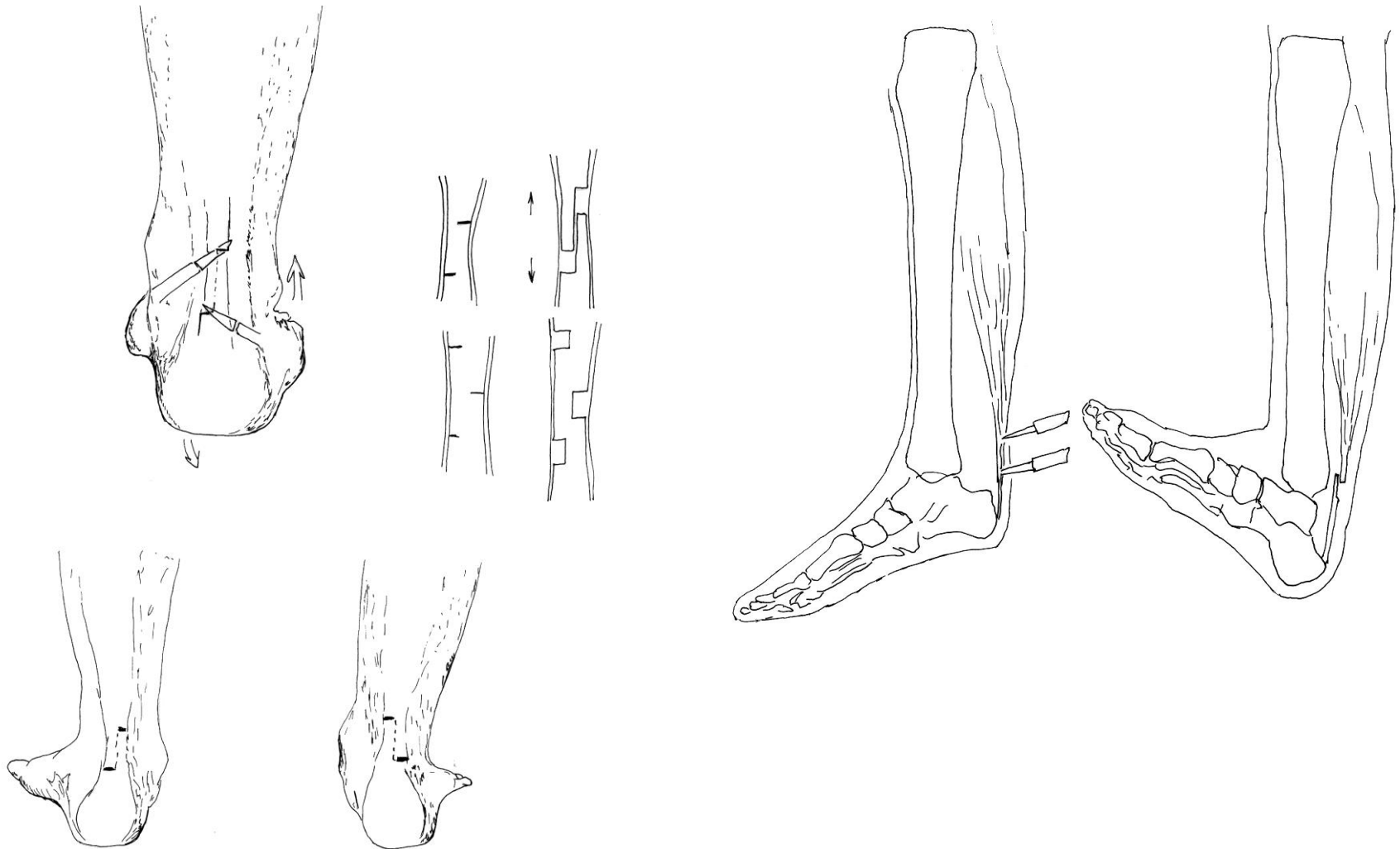
(Ilizarov's osteotomies)

- Children after 12 years
- and adults

Ilizarov's  
osteotomies

Arthrodesis

# Percutaneous achilles tendon lengthening technique

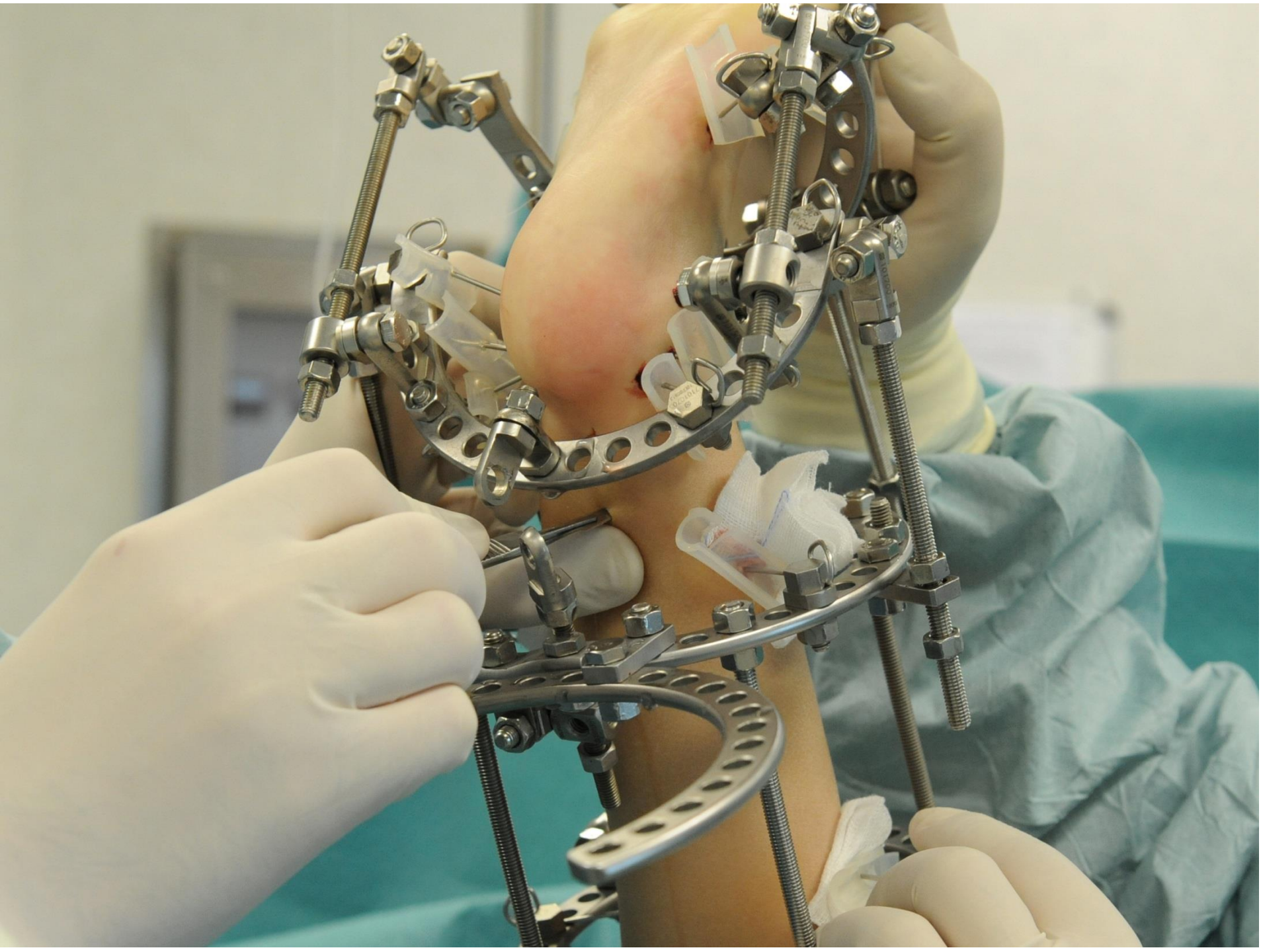








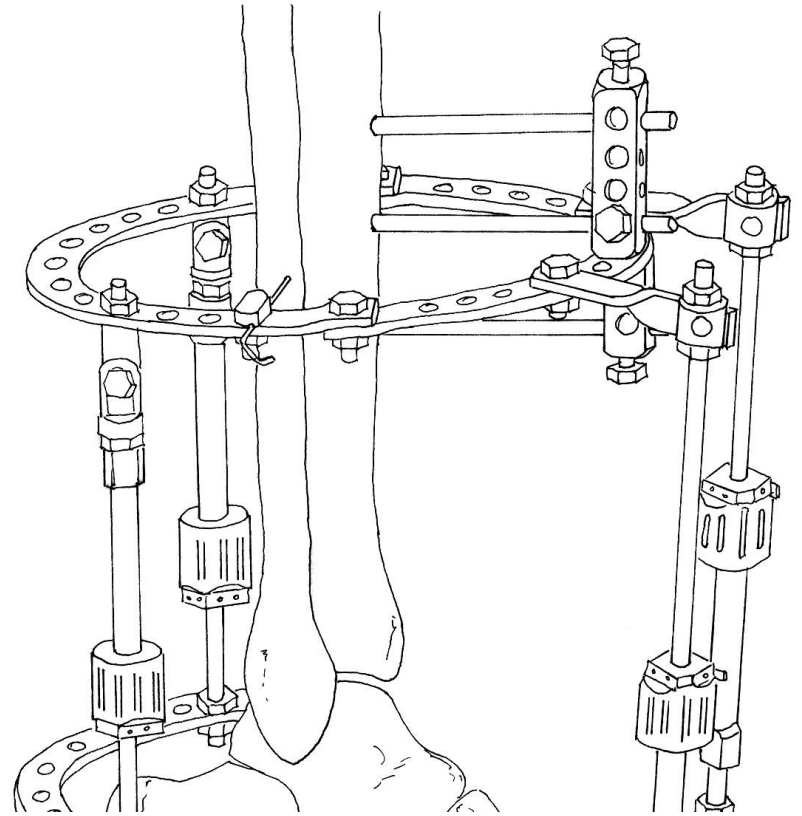
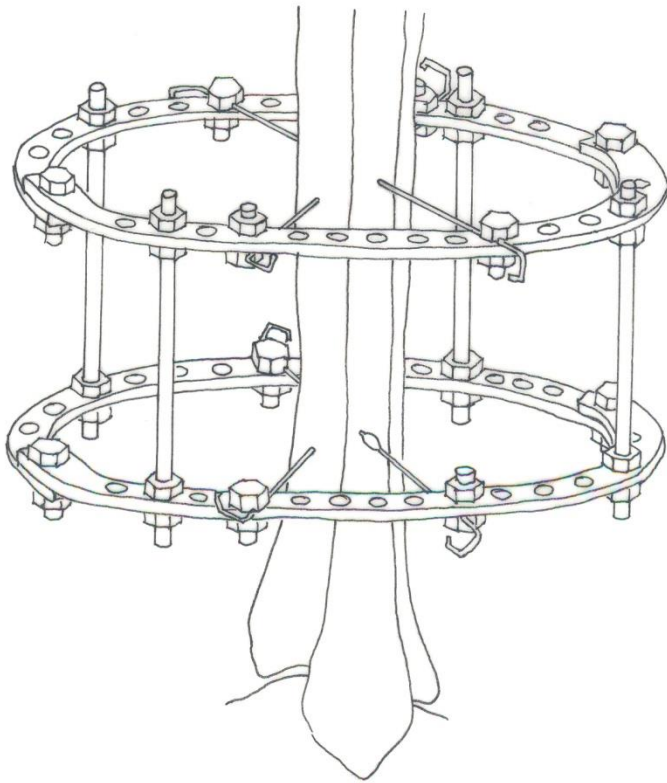






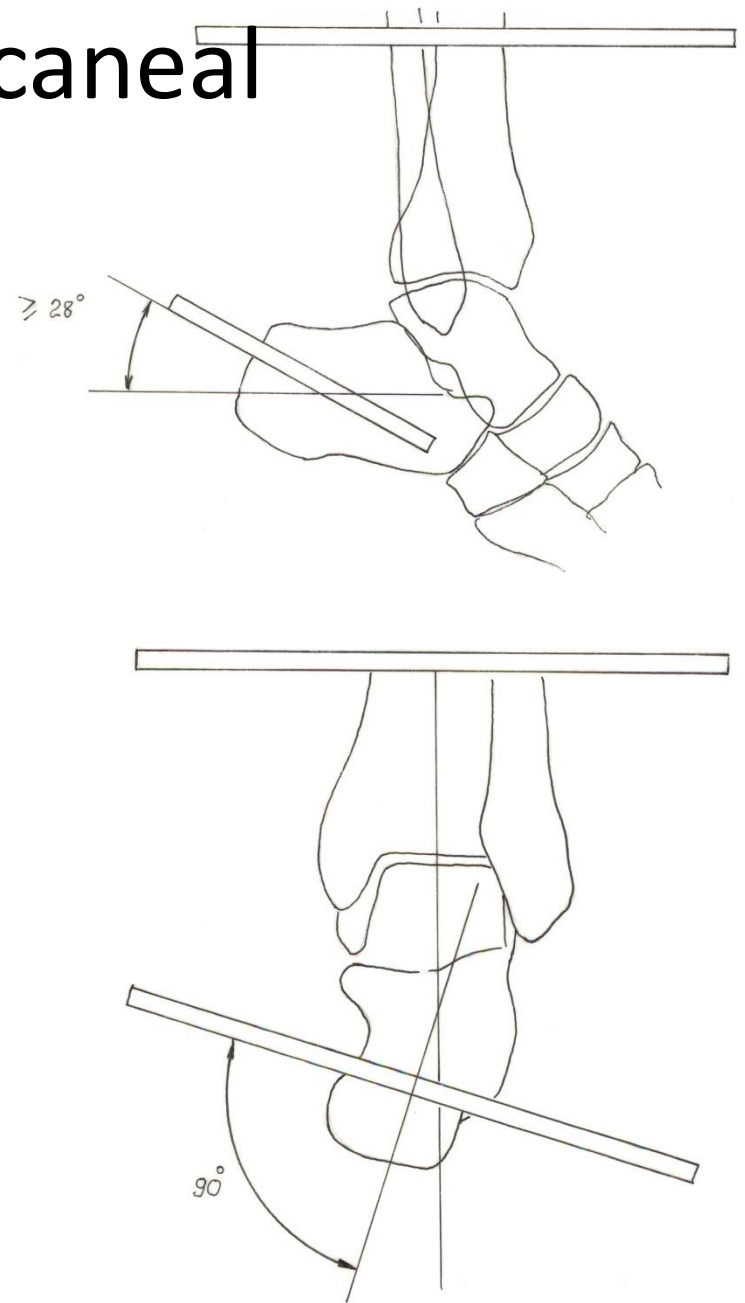
# Technique

## Tibial block application

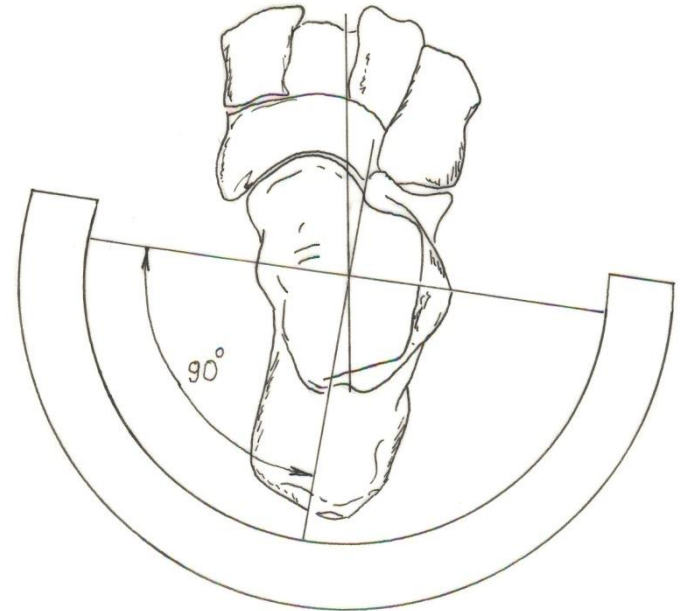


# The position of the calcaneal half-ring

- In the sagittal plane - 28 degrees to the longitudinal axis of the calcaneus
- In the coronal plane - perpendicular to the vertical axis of the calcaneus

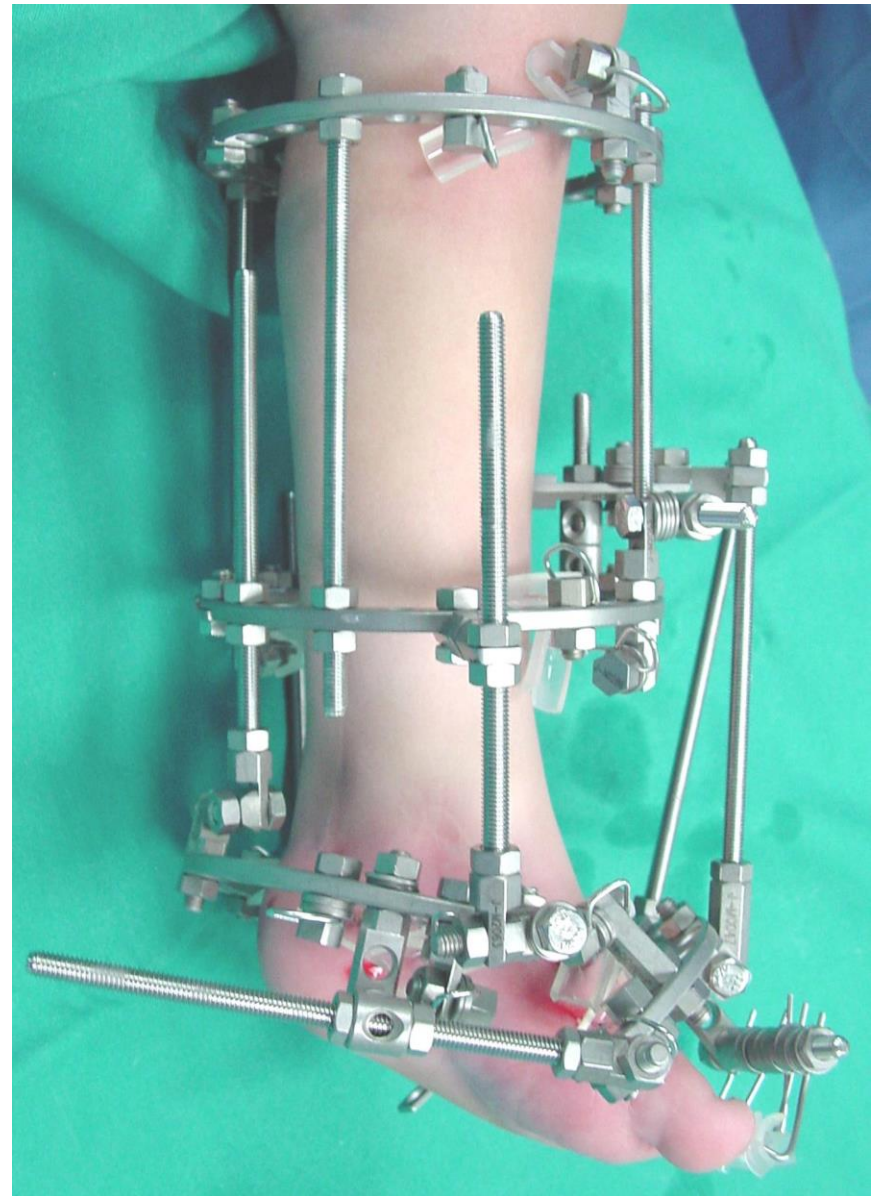
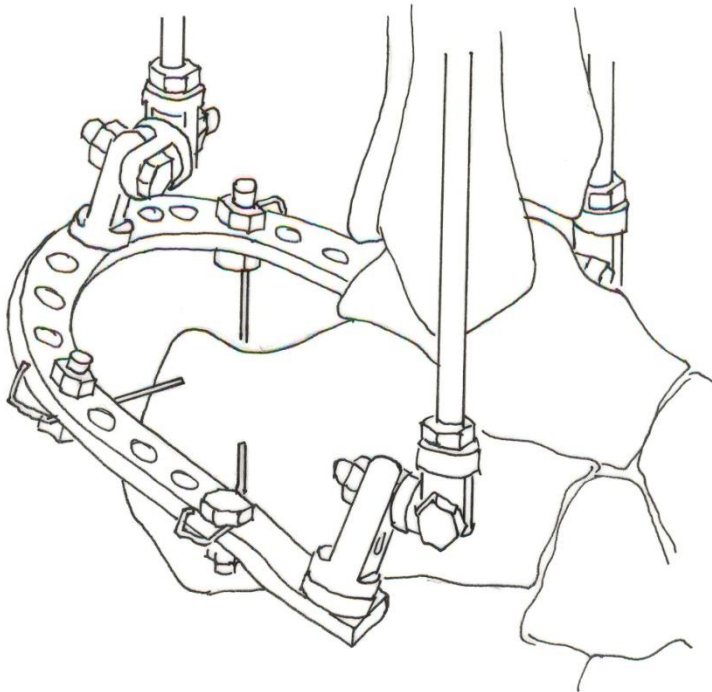


The position of the calcaneal half-ring in the horizontal plane for the correction of calcaneal adduction



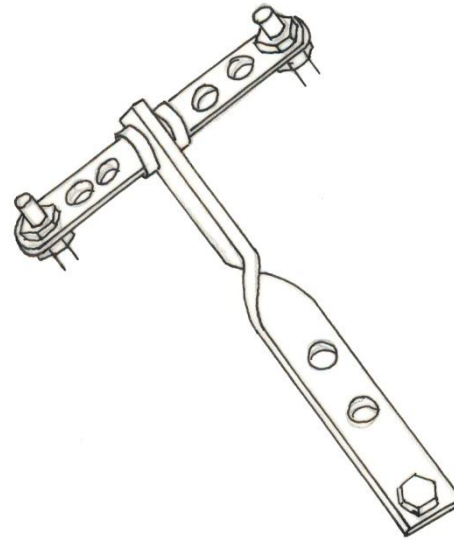
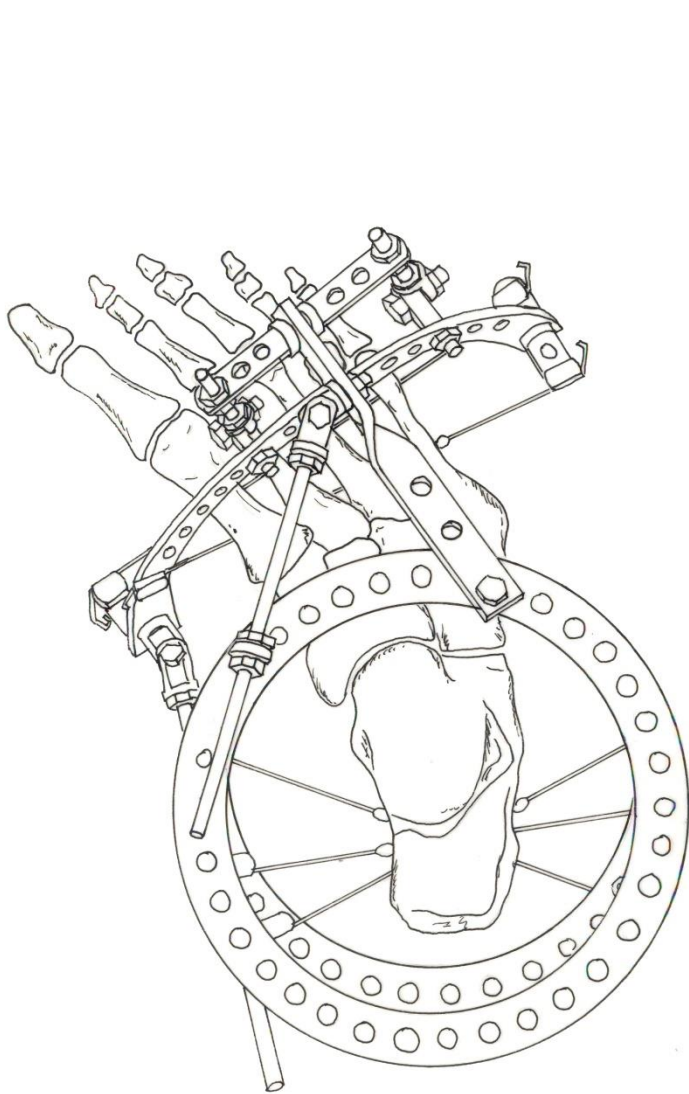
The extreme medial portion of the half-ring lies in a more anterior position

Connection of the calcaneal half-ring to the tibial block with three rods and bi-planar hinges

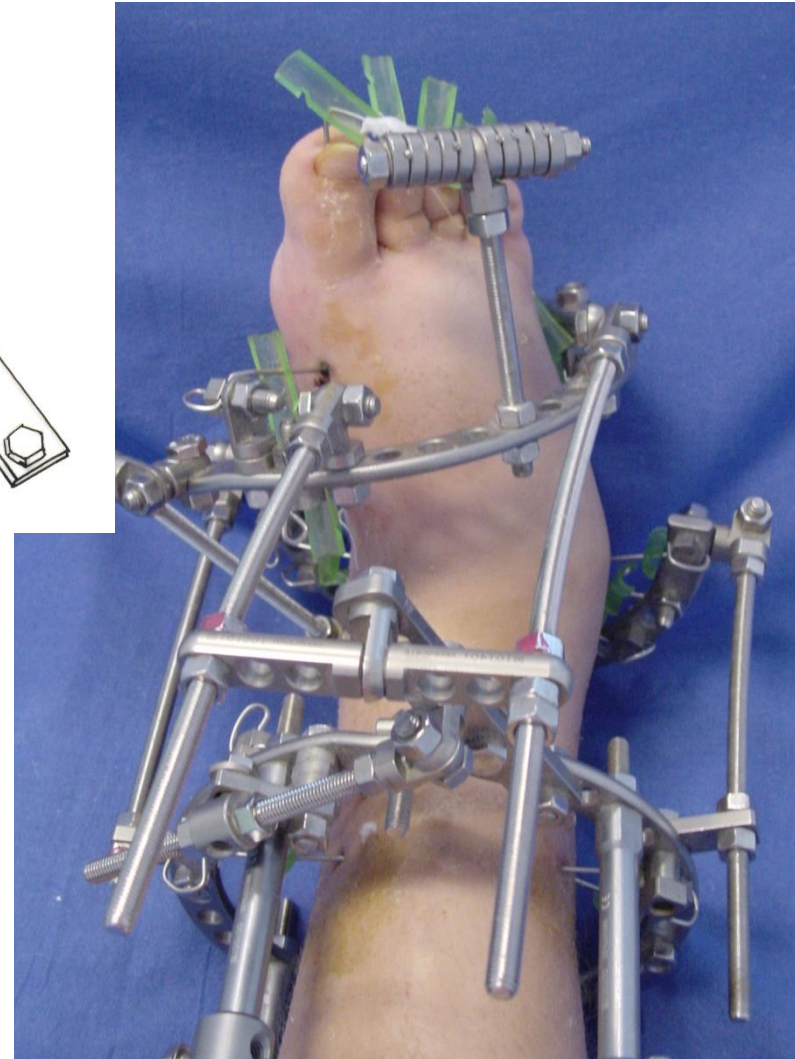




# Correction forefoot

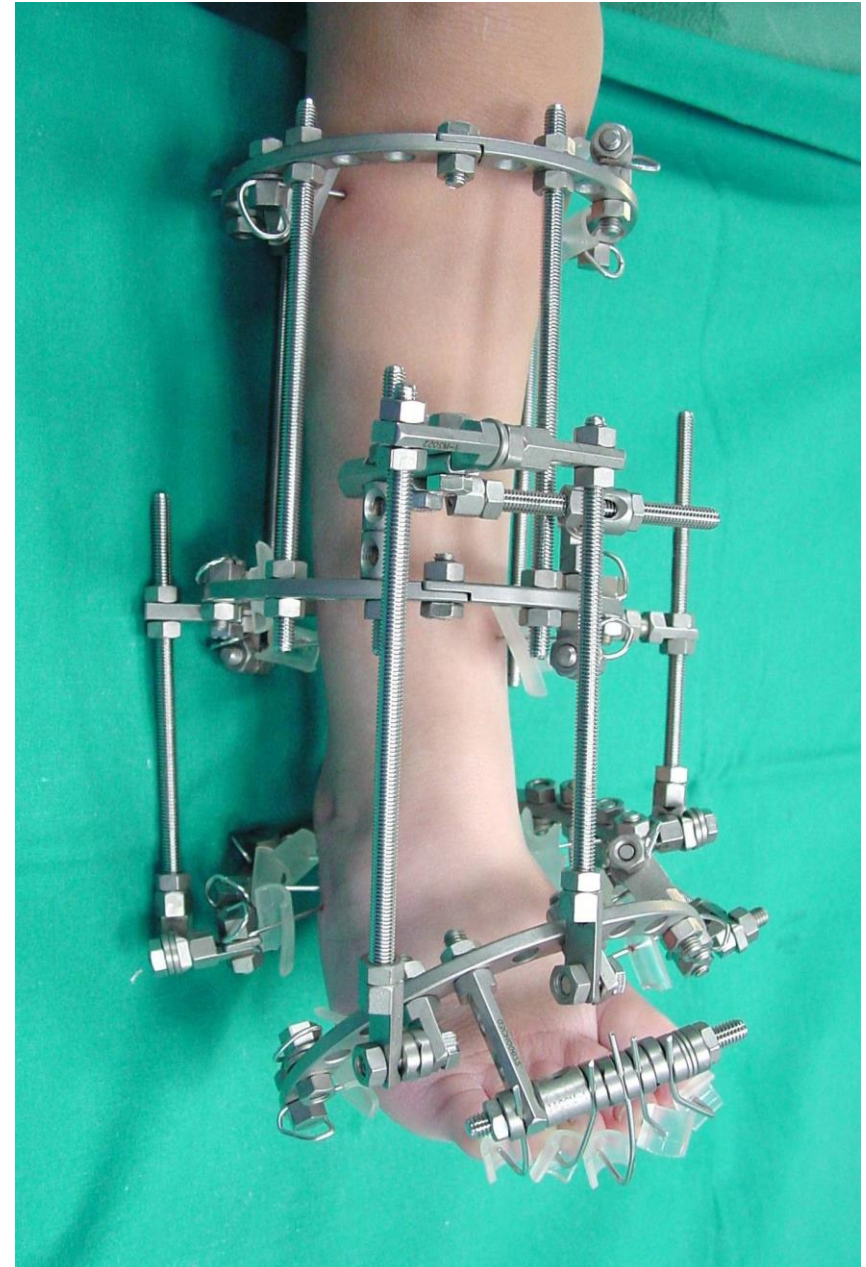
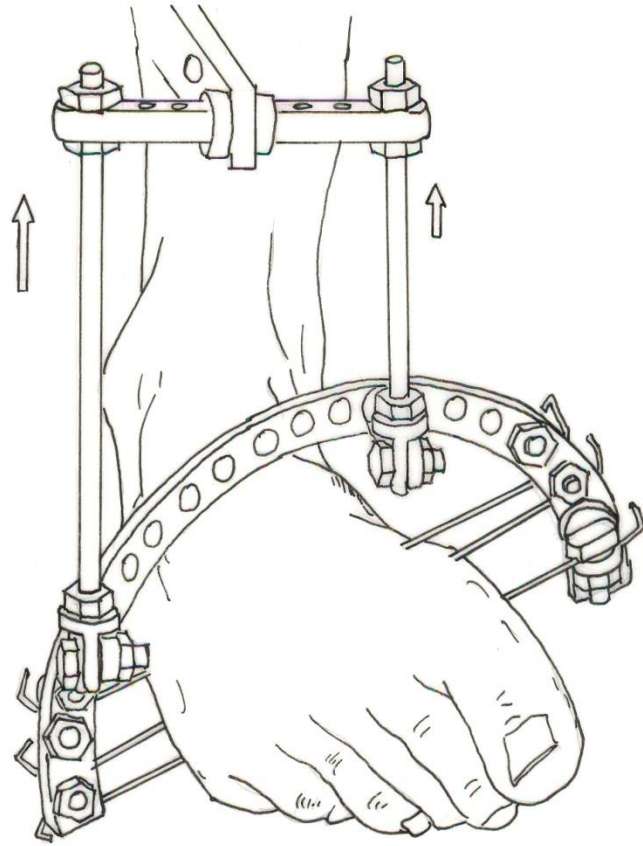


"T"-module

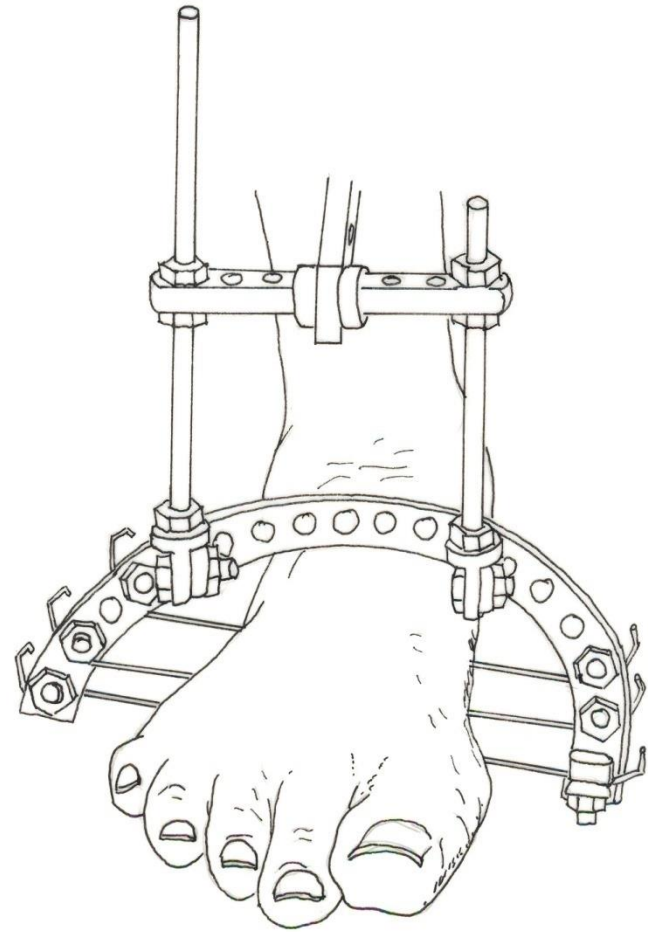
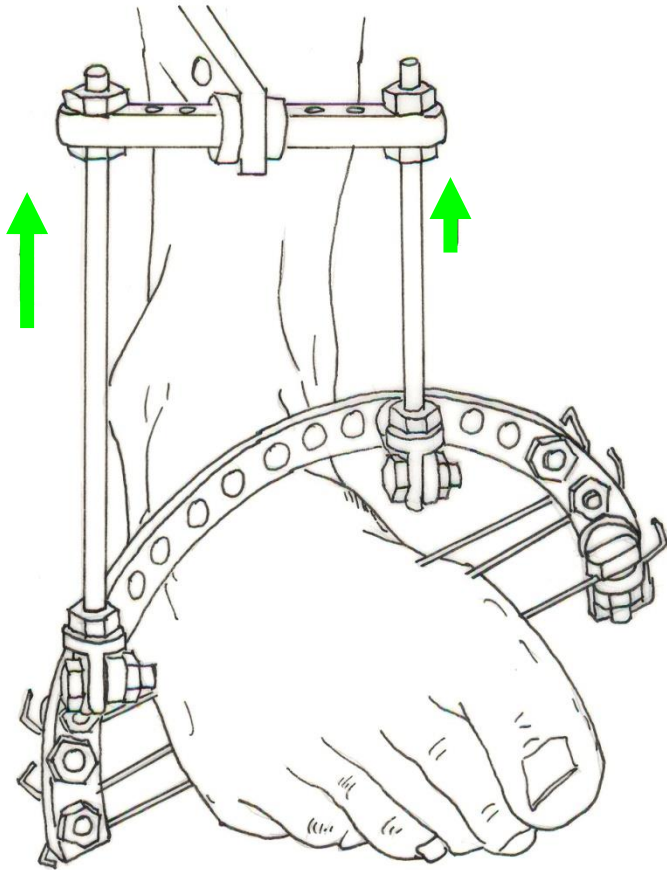




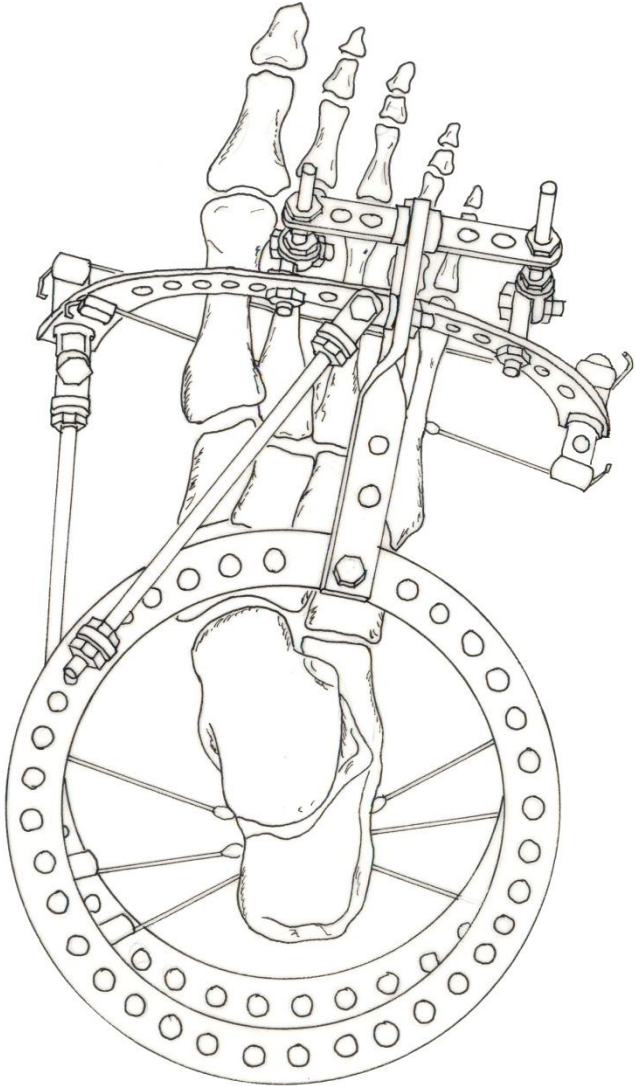
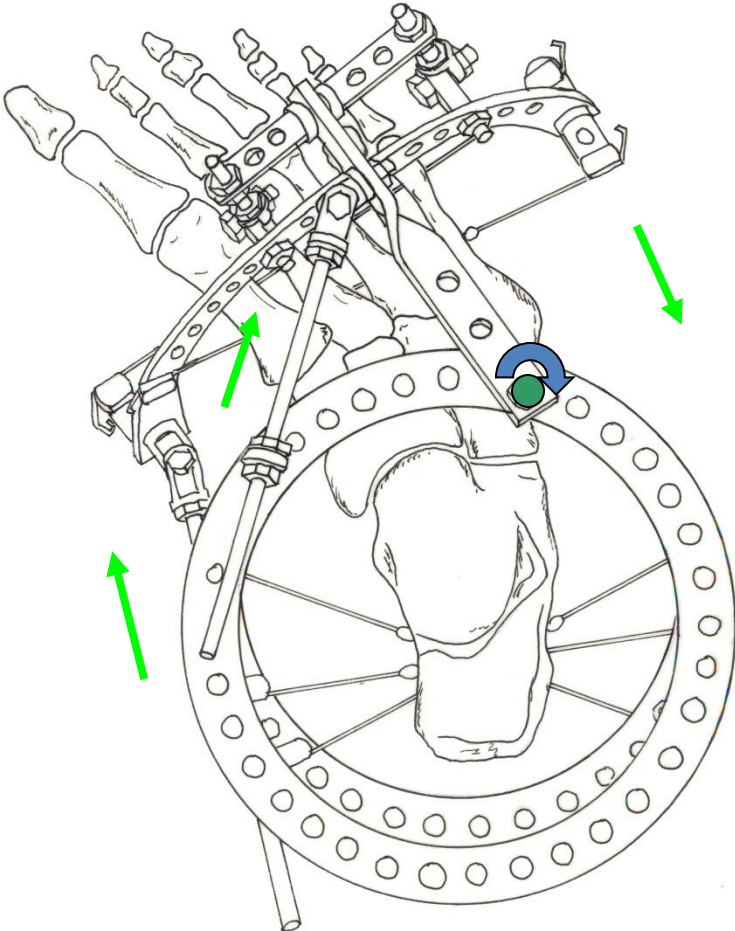
# Forefoot fixation



# Correction of supination

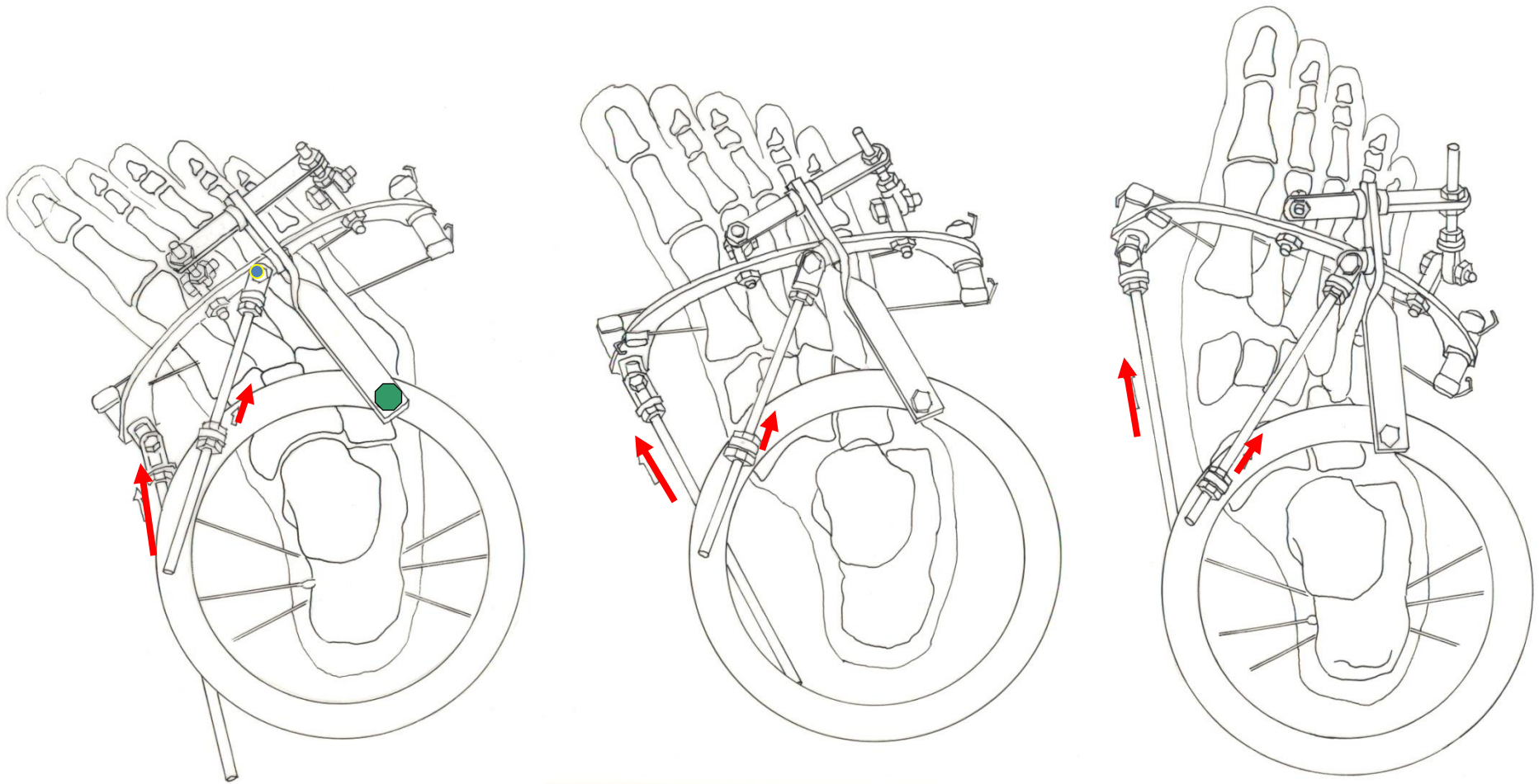


# Adduction correction with "T" module

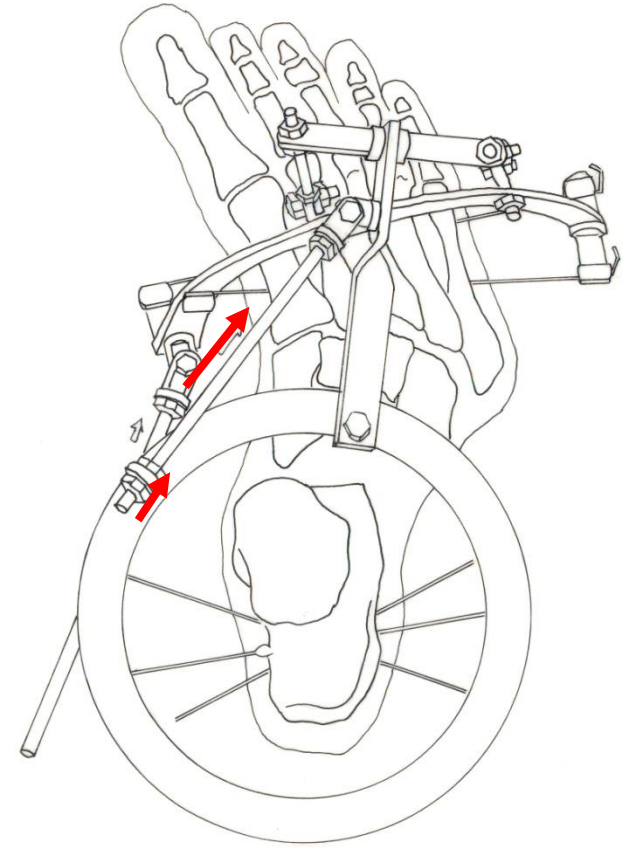
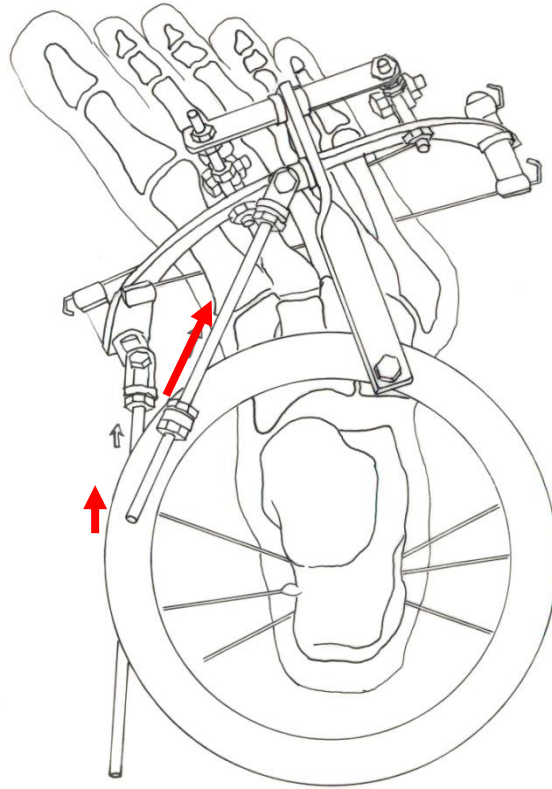
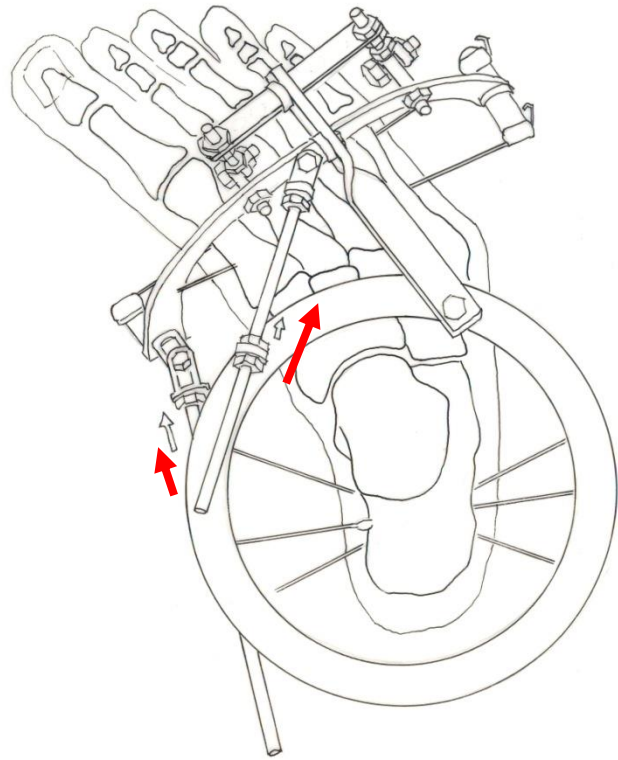




## Complications of adduction correction – medial subluxation of the forefoot



# Complications of adduction correction- lateral subluxation of the forefoot





- **Correzione progressiva a cielo chiuso**

10 y. O. boy with reccurent club foot





Adduction of forefoot





# Closed method

## TREATMENT PROTOCOL

- Correction period for 1-2 months (depends on severity)
- Overcorrection of each component of deformity
- Fixation period 1.5 months
- Plaster cast immobilization for 1.5 - 2 months
- Corrective shoes and soles for maintain overcorrection for few month

# True/Lok application for closed treatment

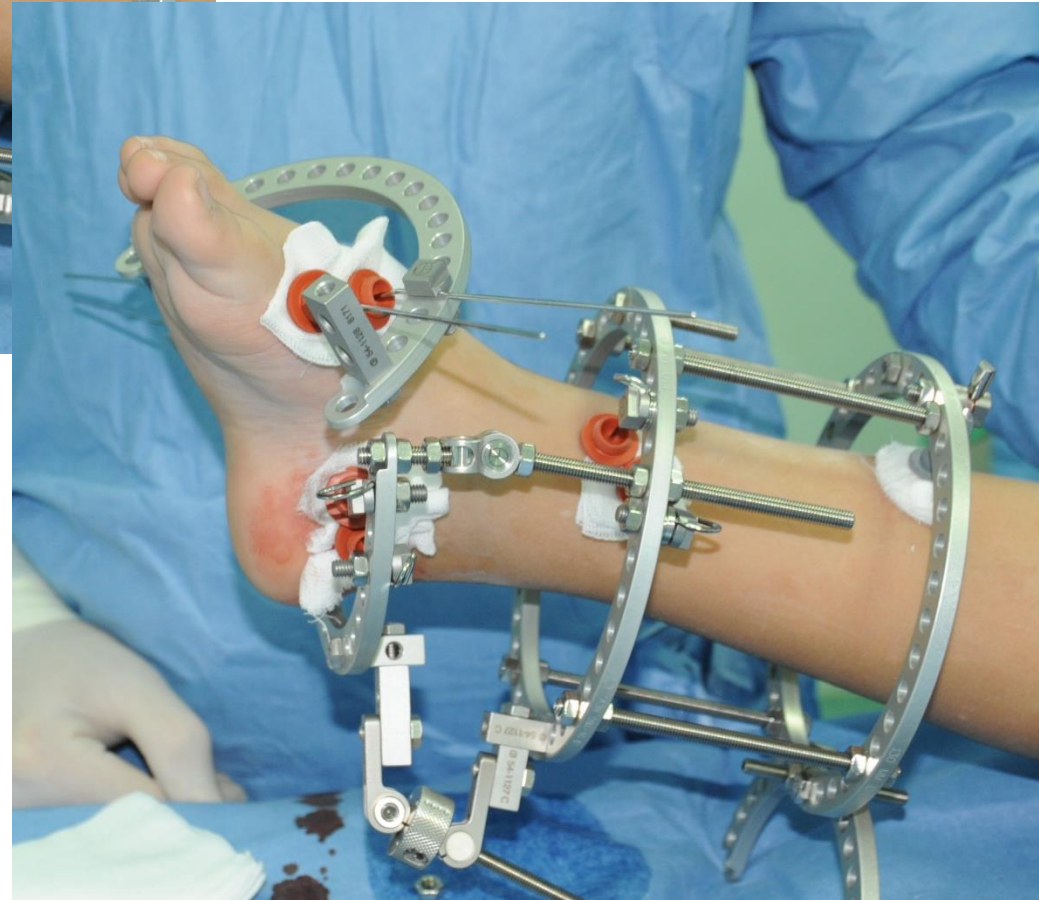
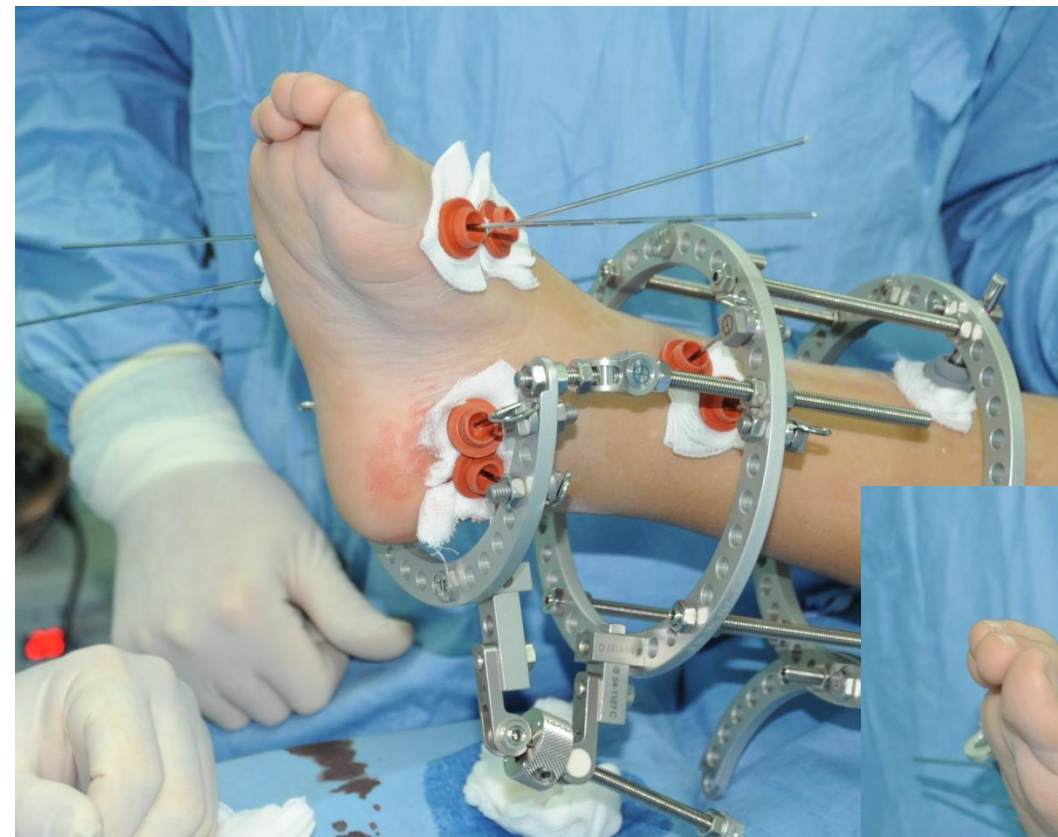


# Calcaneal half ring

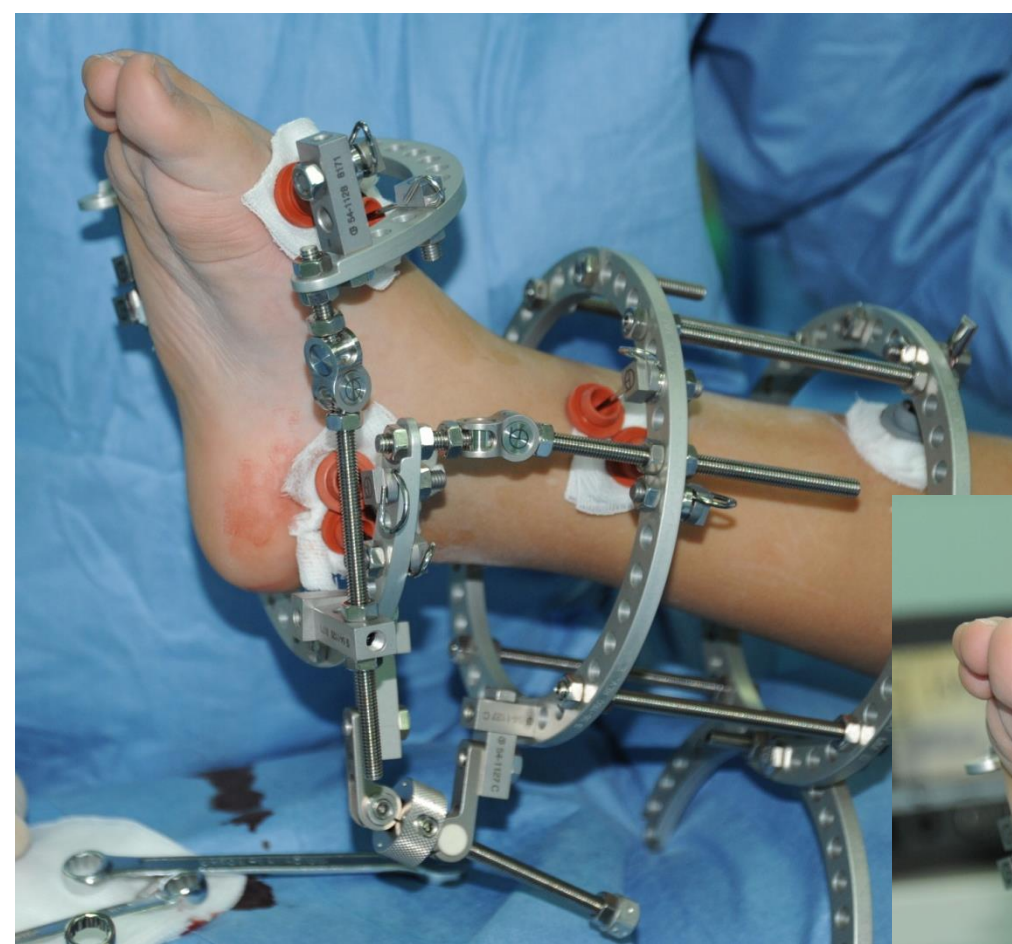




# Forefoot application

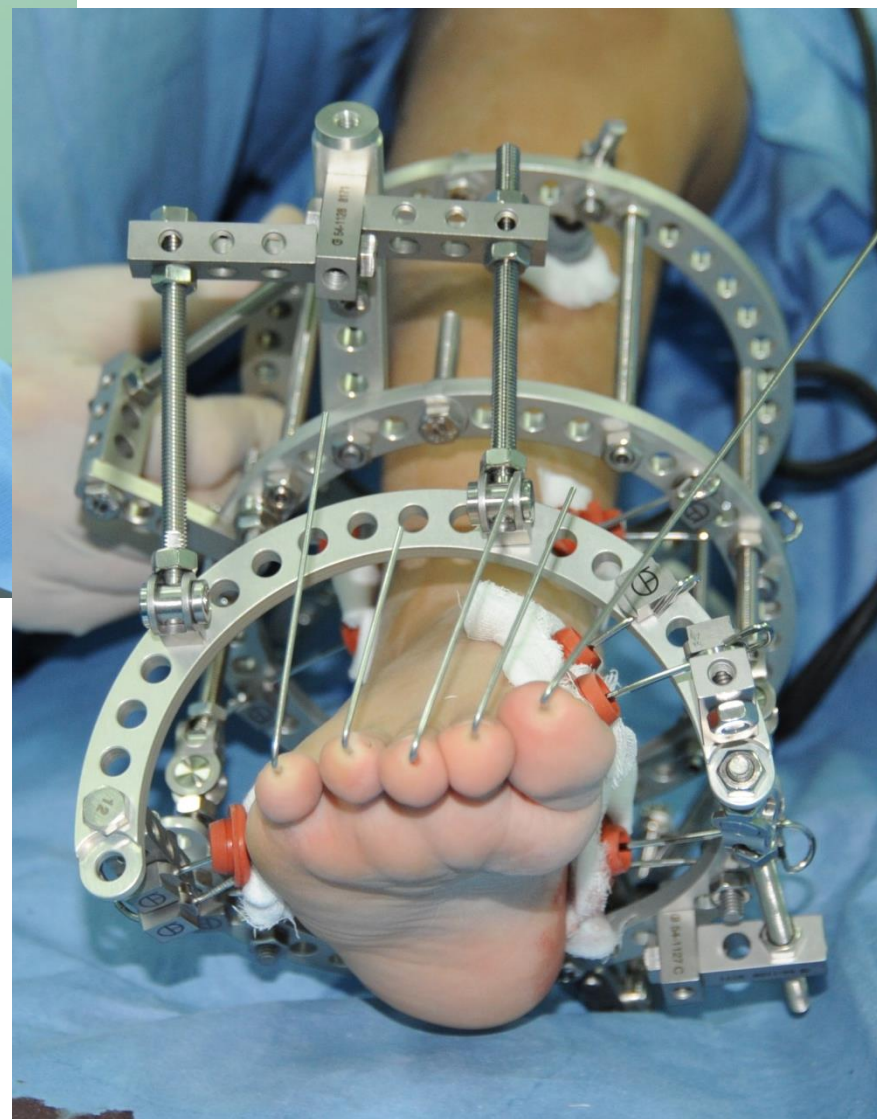


# Connection of anterior half ring





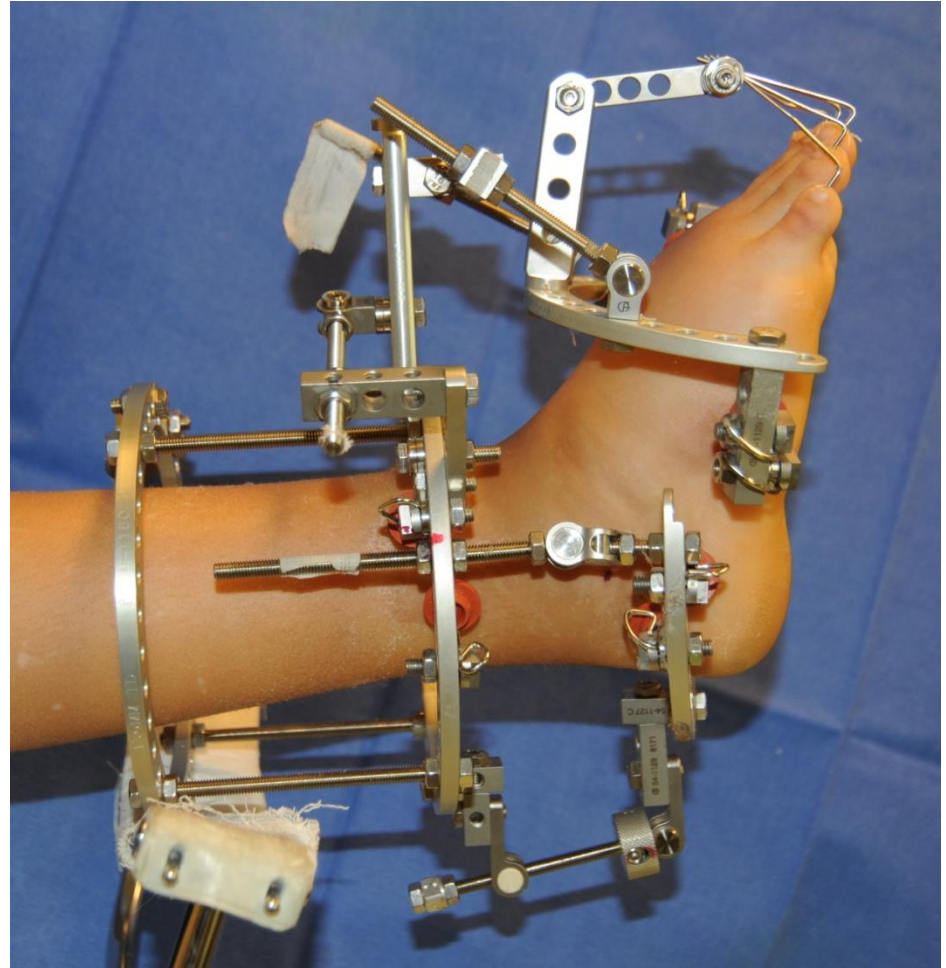
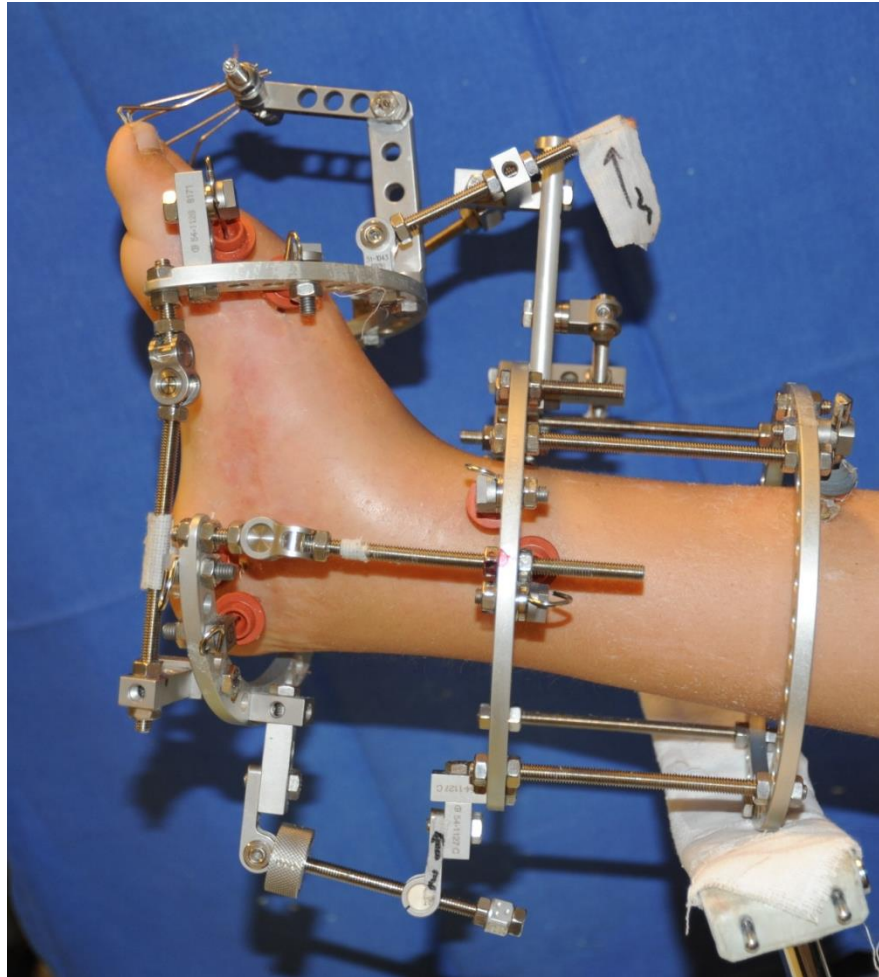
# Toes fixation



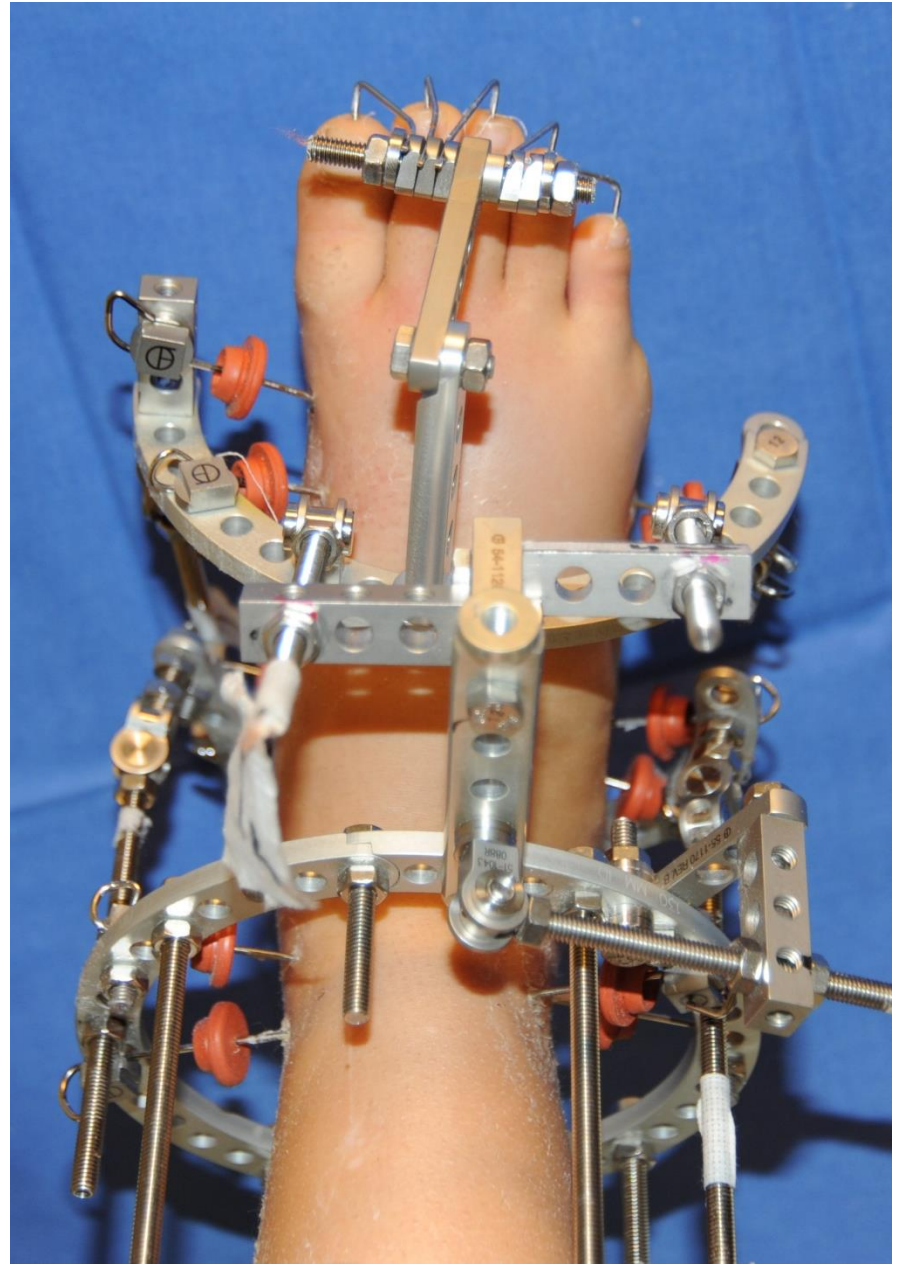
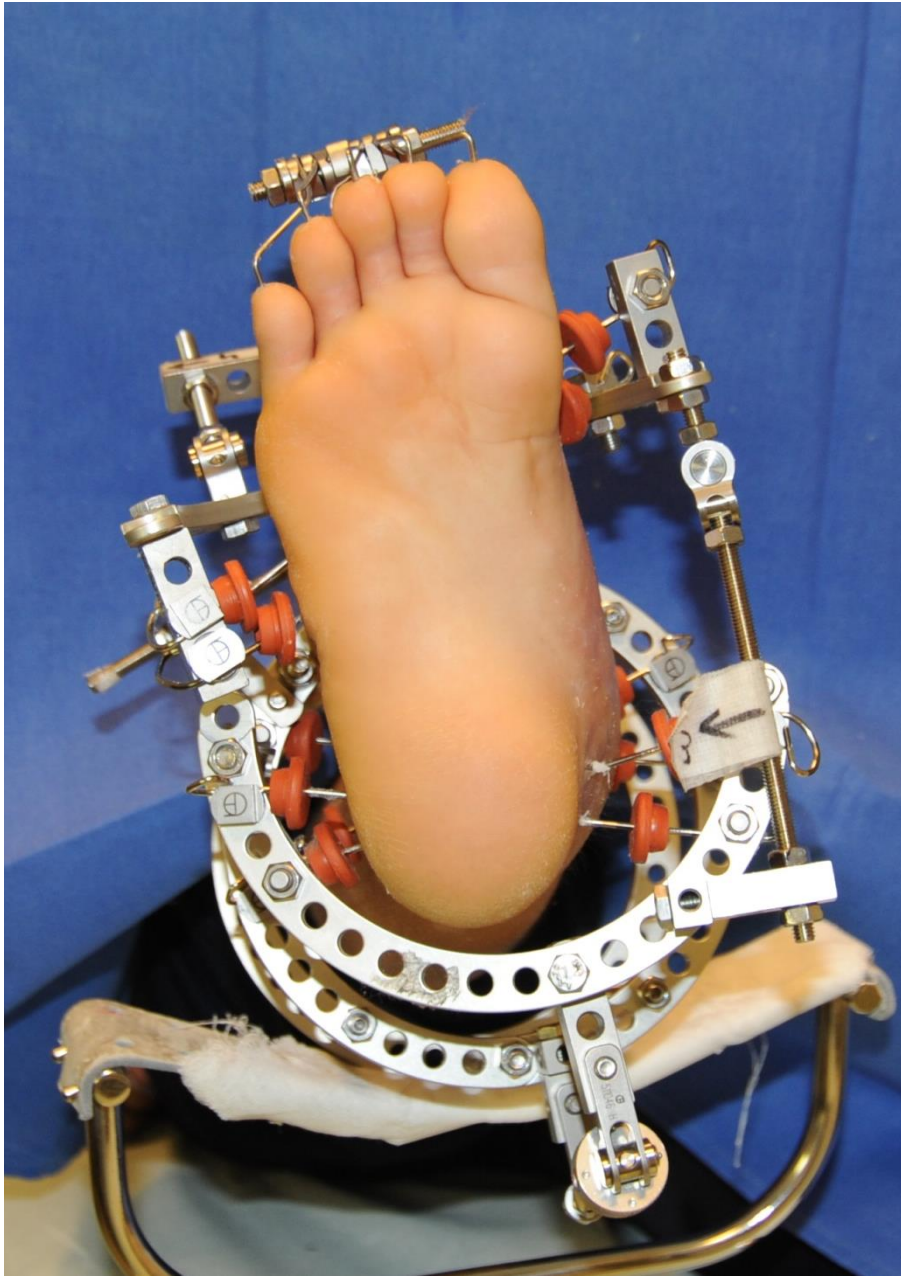




# During correction









# Results

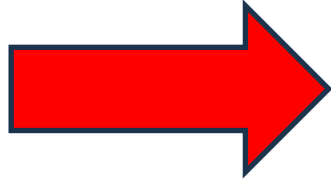
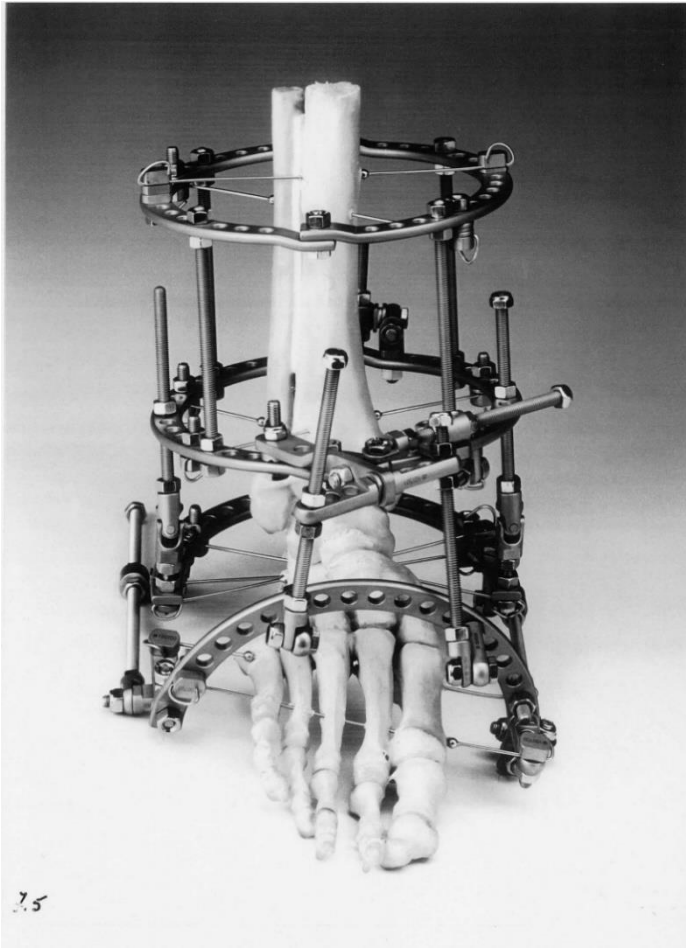








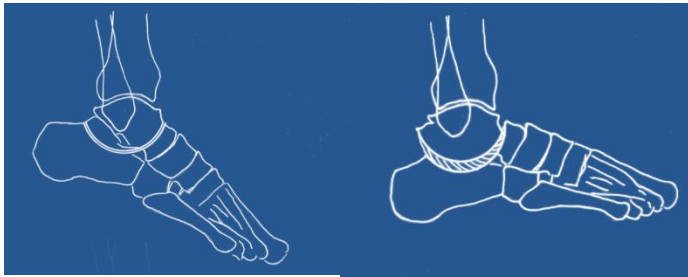
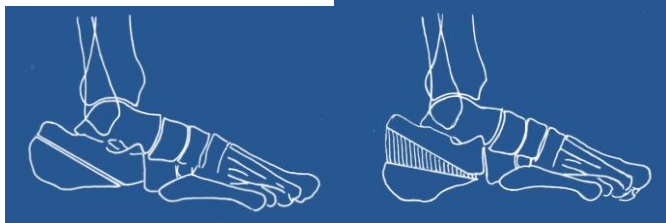
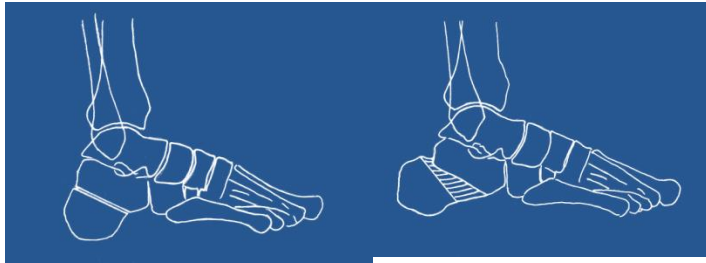
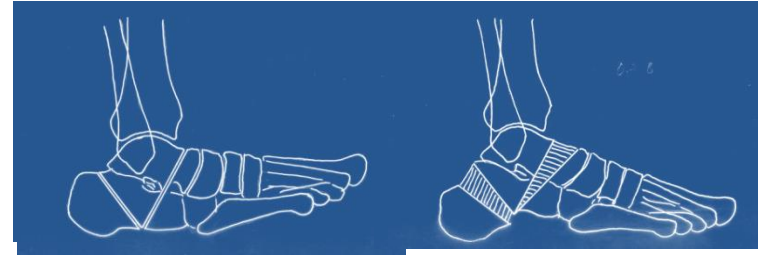
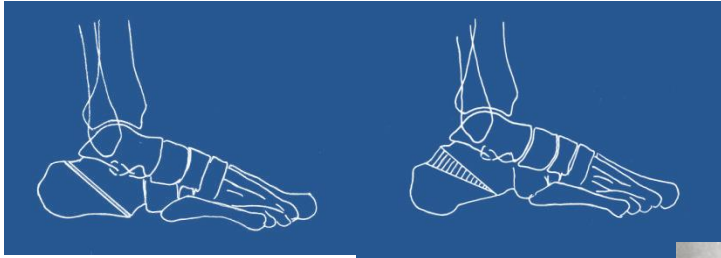




- **Correzione progressiva + osteotomia**

# OPEN TREATMENT

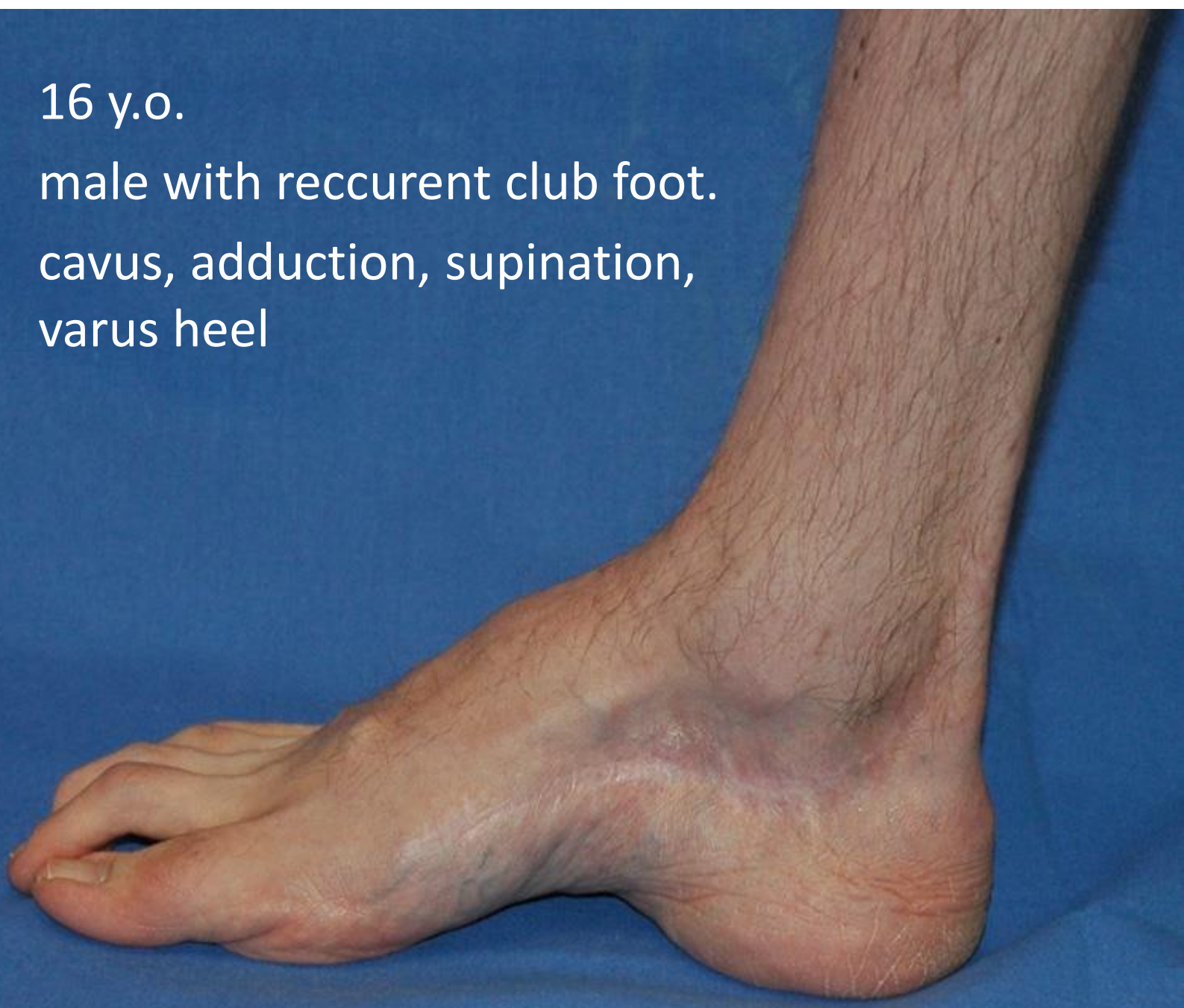
## *The Ilizarov distraction osteotomies*





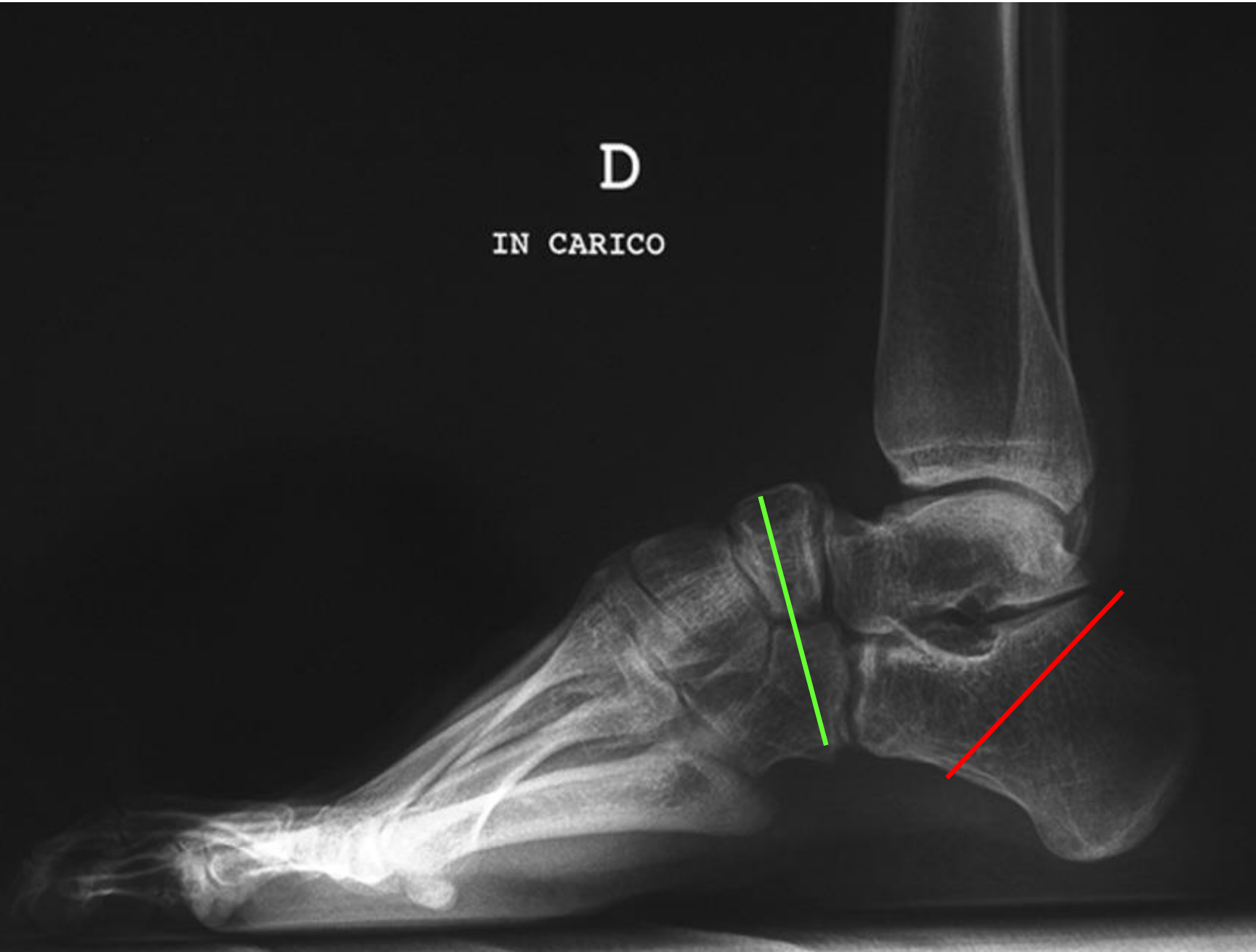
16 y.o.

male with recurrent club foot.  
cavus, adduction, supination,  
varus heel



D

IN CARICO







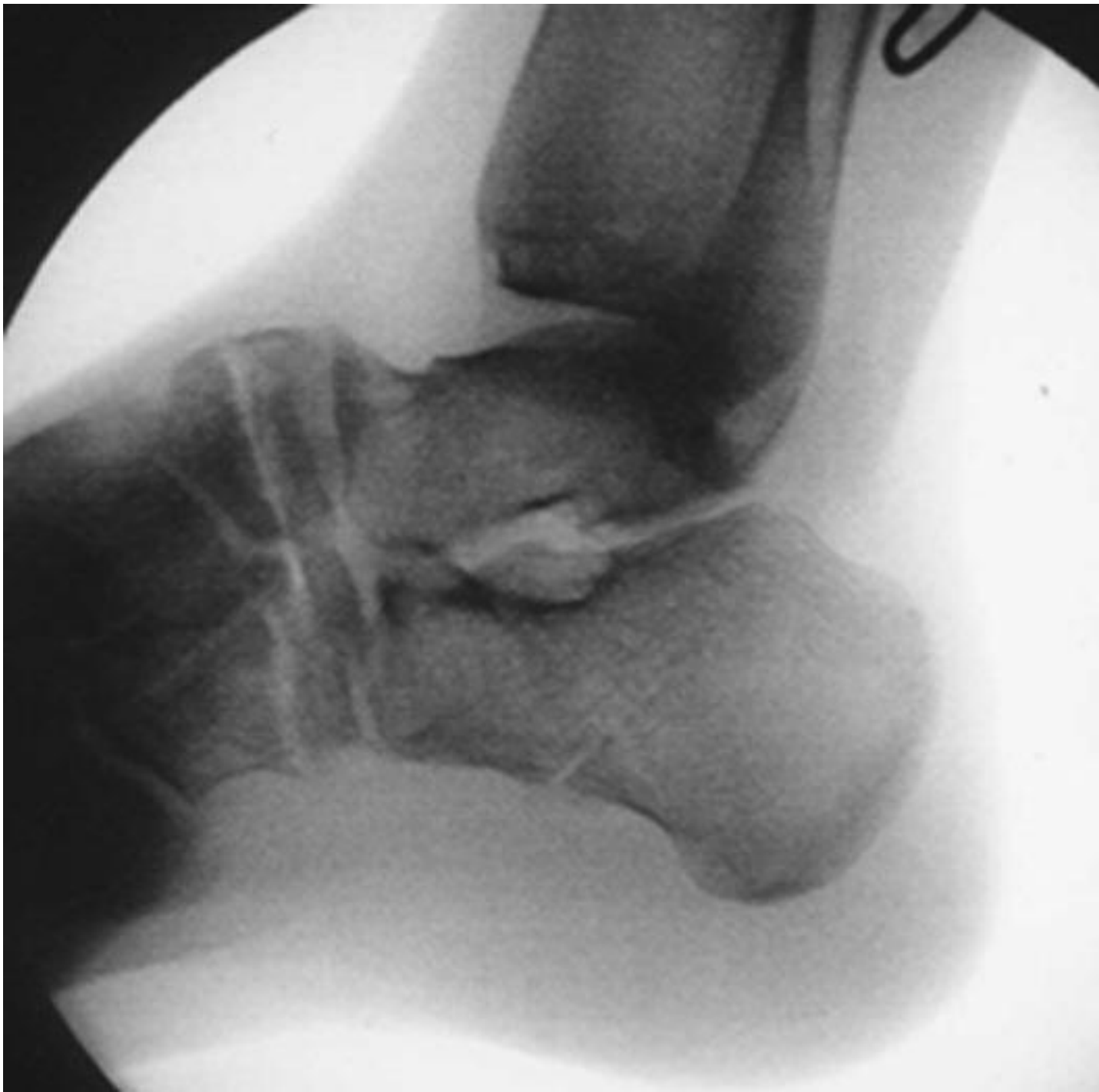


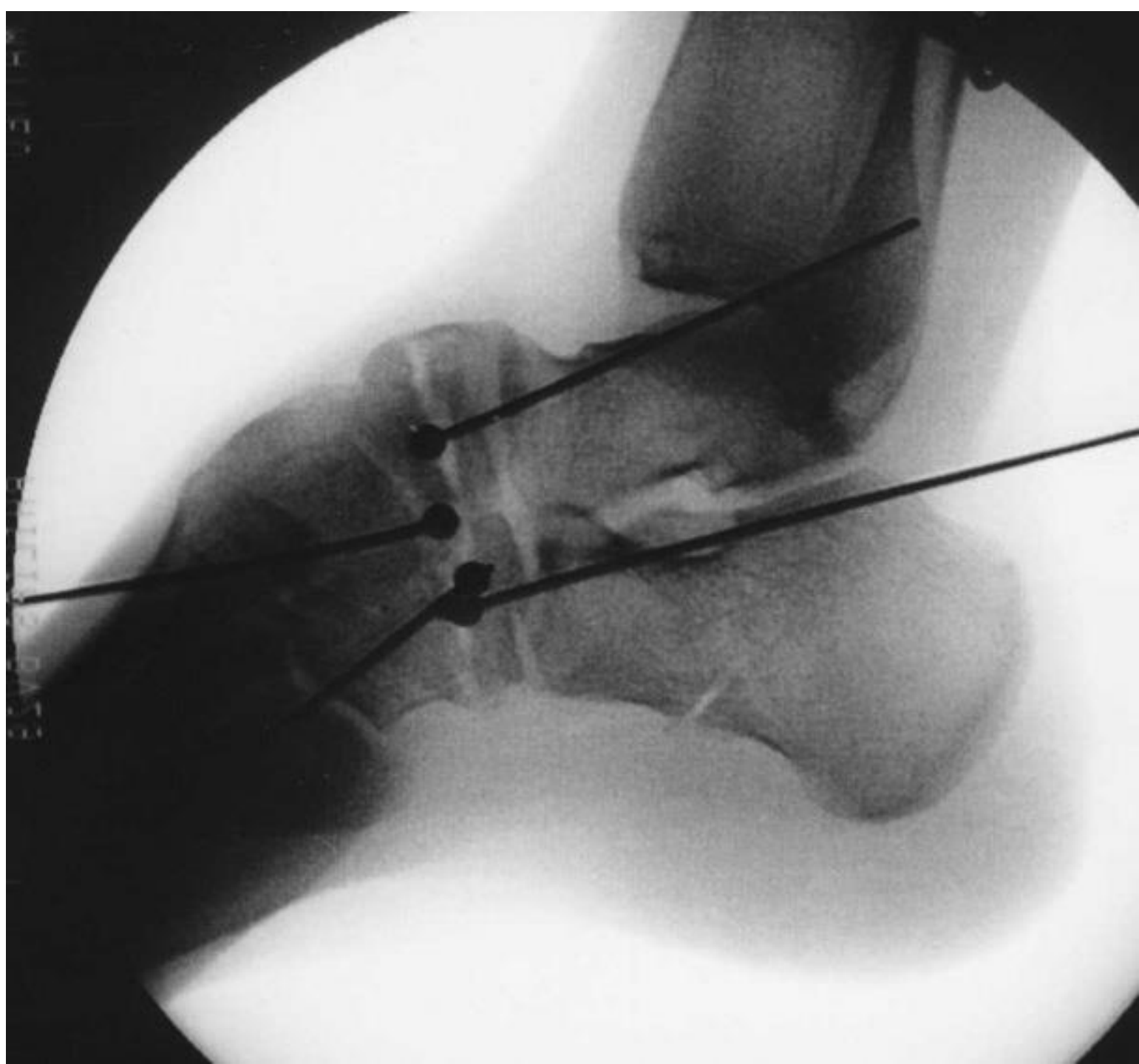


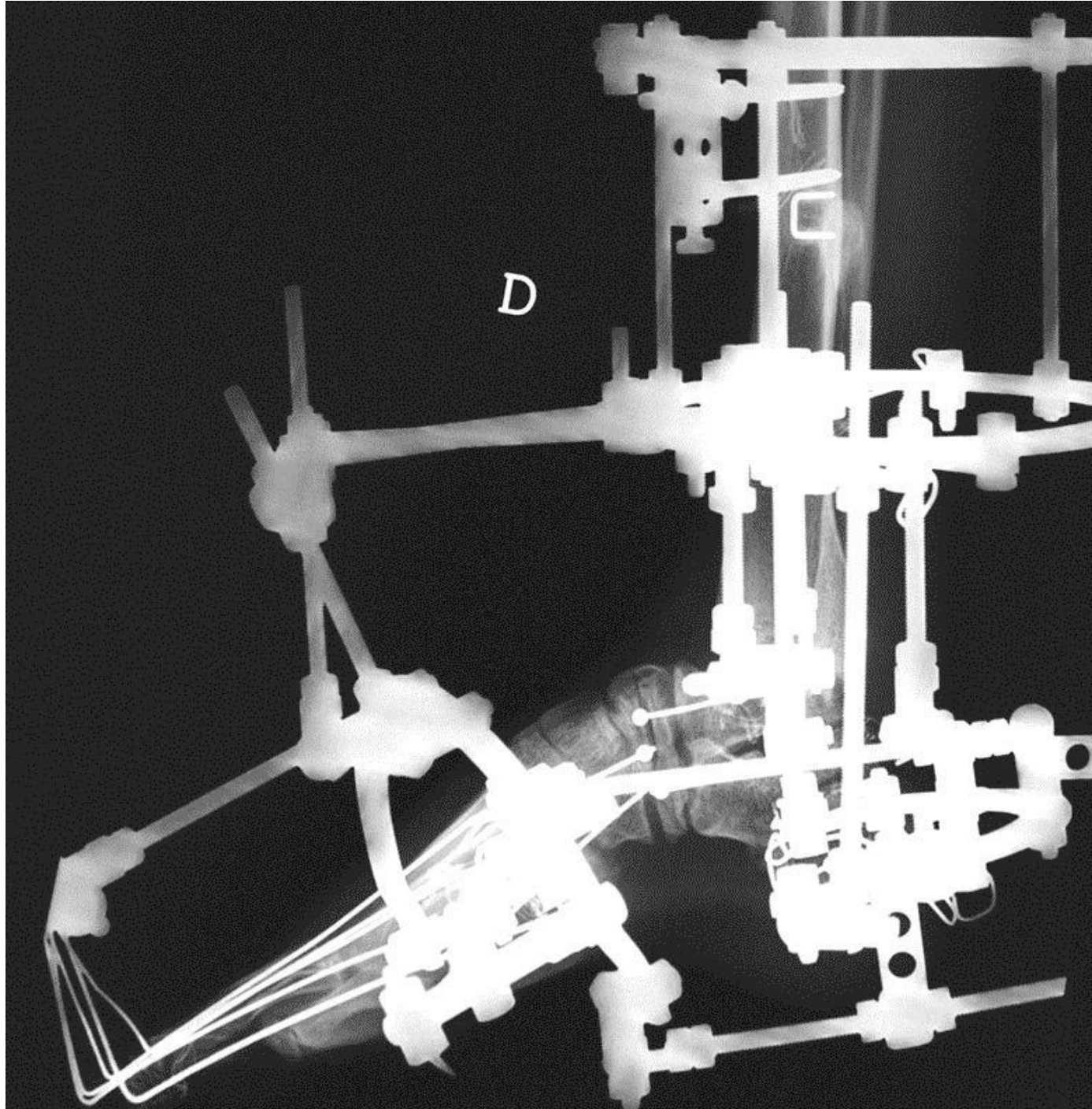




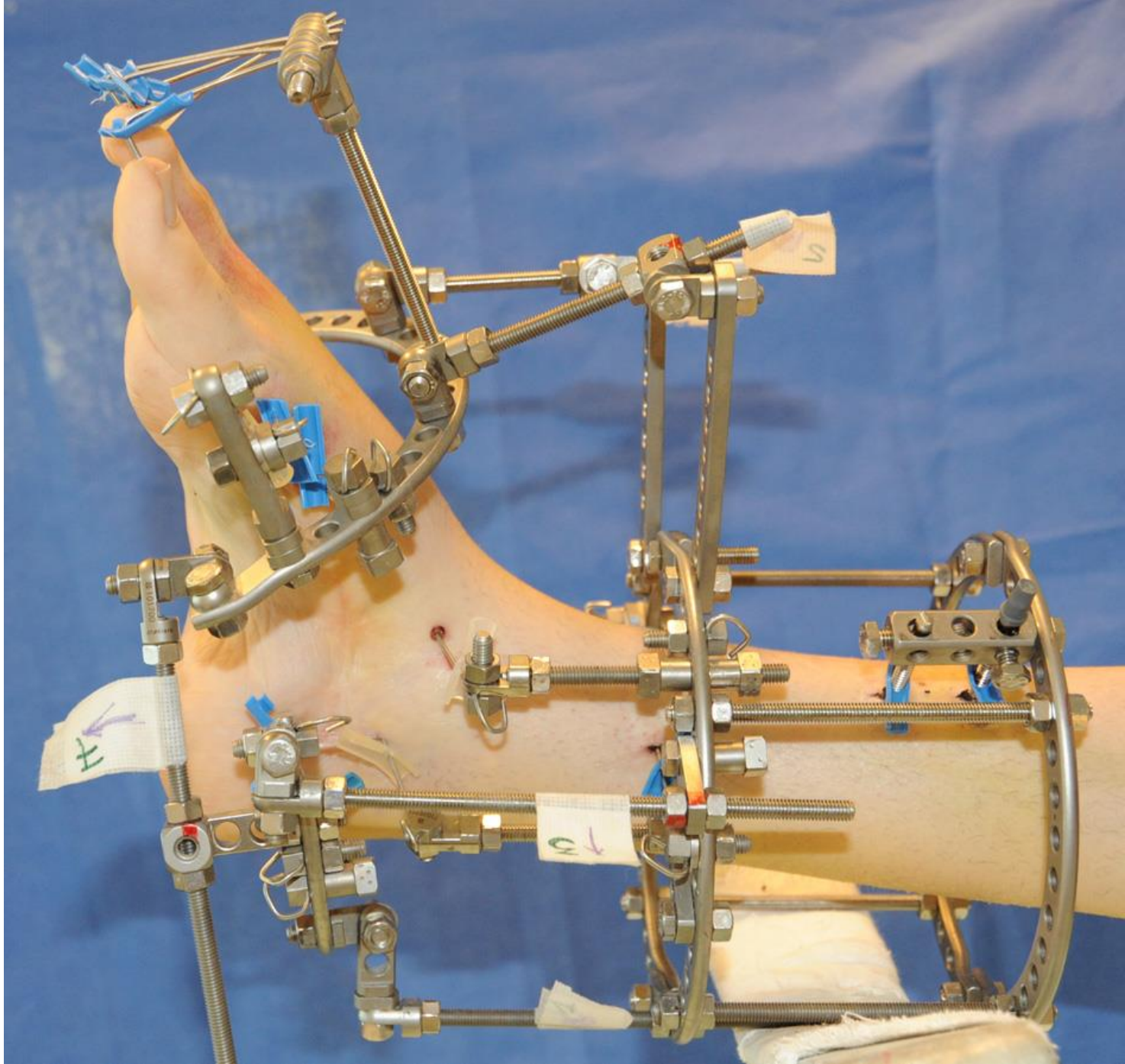


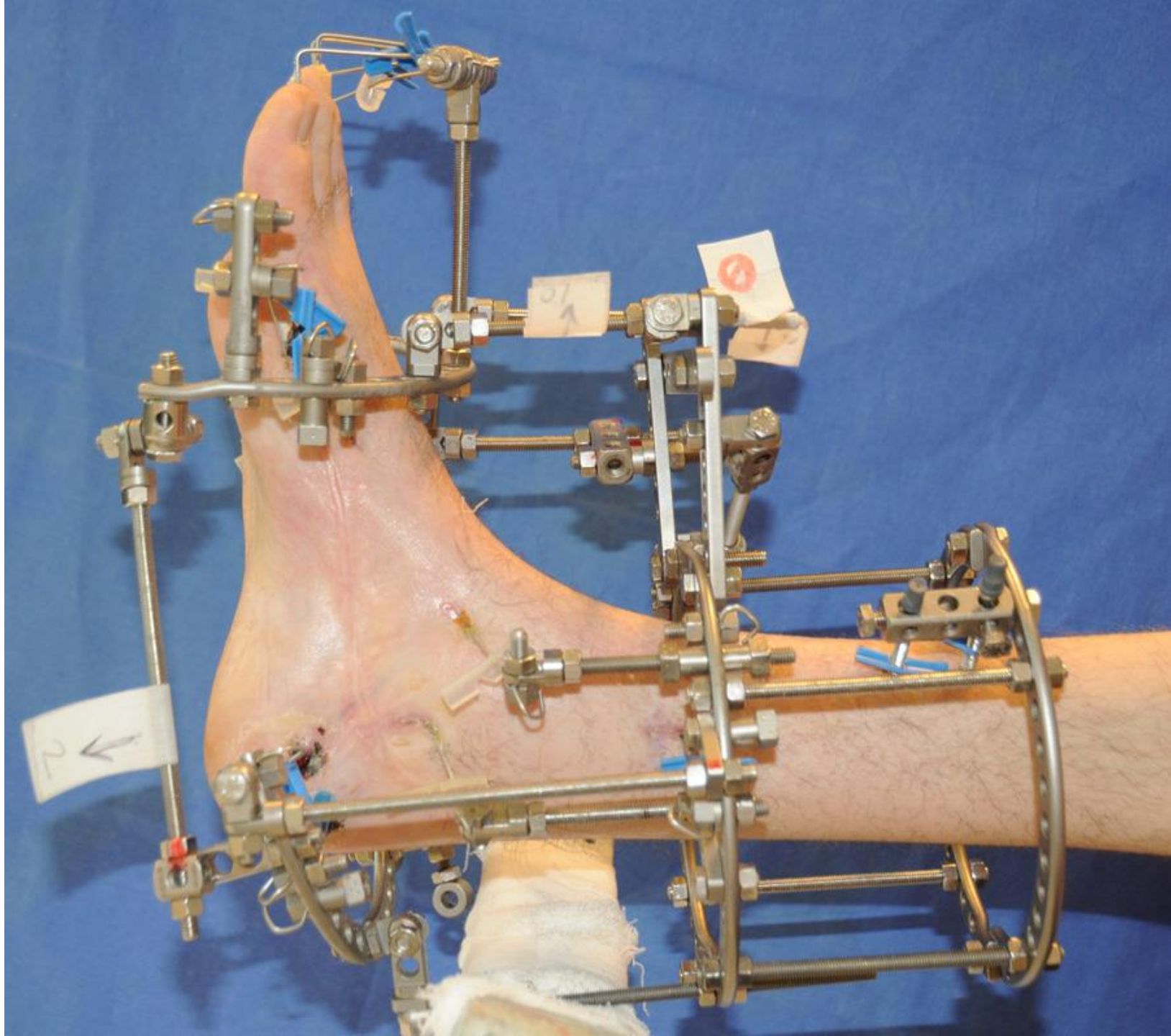




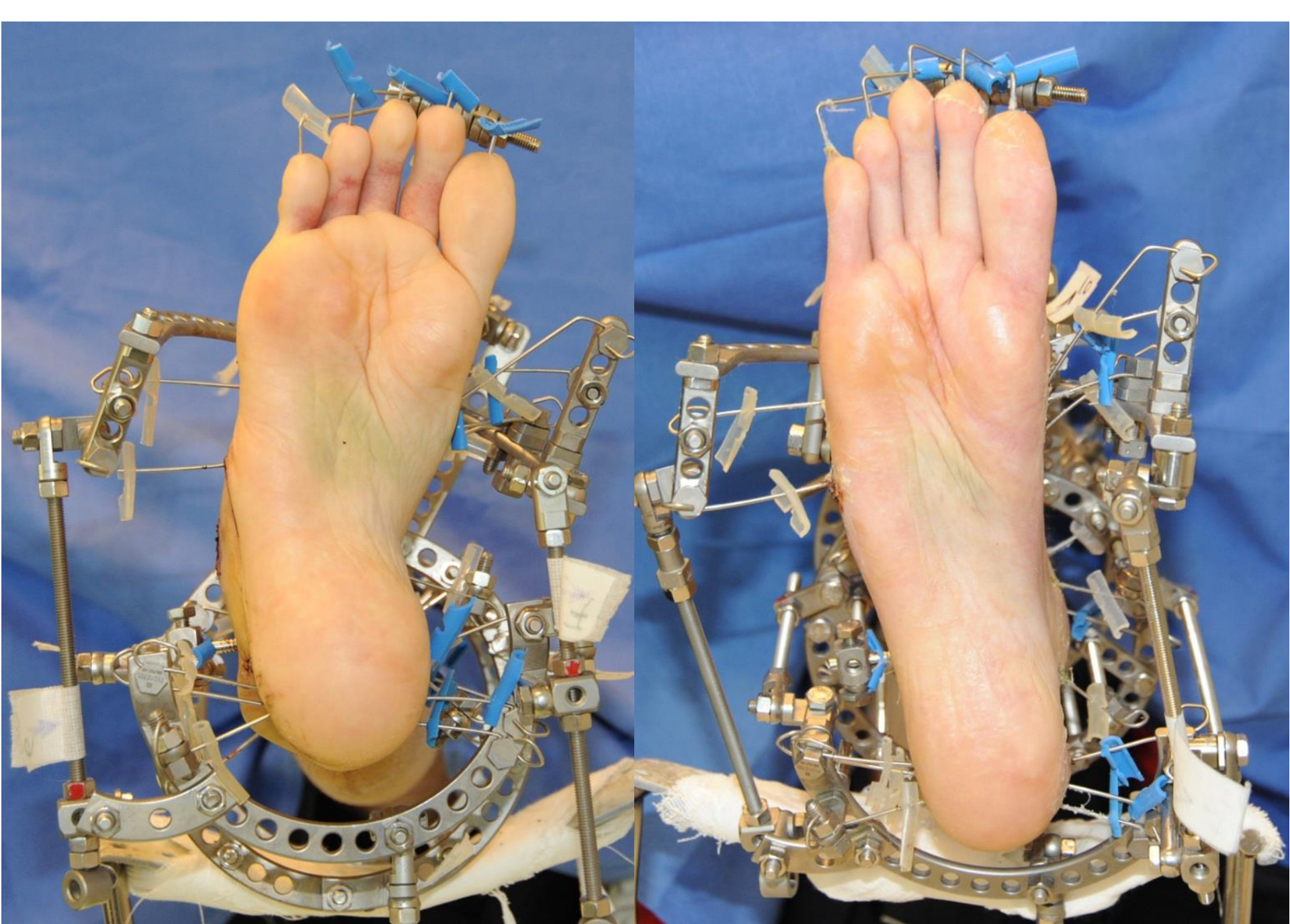
















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- Correzione progressiva a cielo chiuso + artrodesi

M, 1999, 23 anni.

Grave equino varo supinato in esiti di  
Guillain-Barrè in età pediatrica

*(Polineuropatia infiammatoria acuta)*

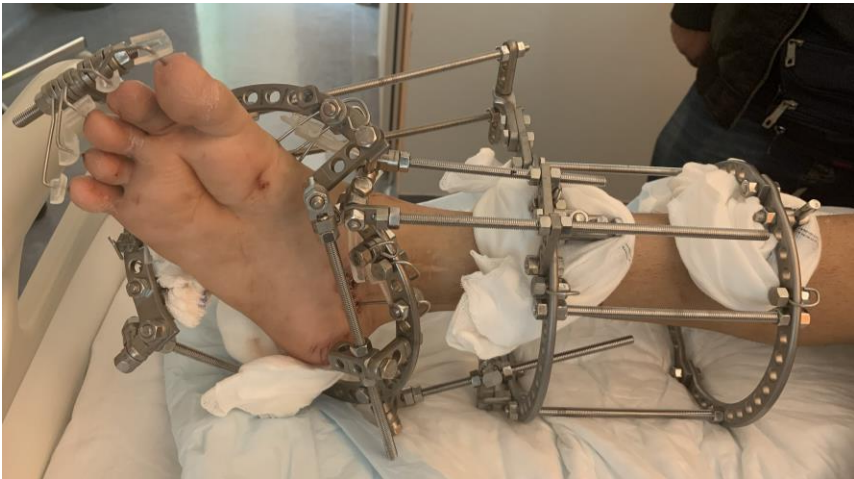
















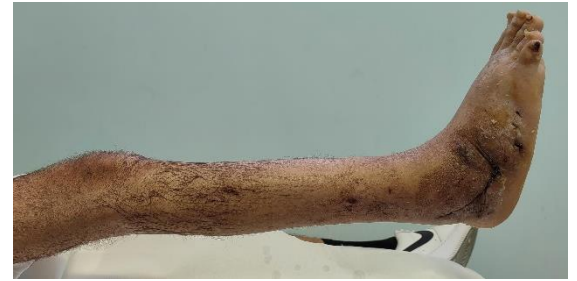
















- Correzione progressiva a cielo chiuso
- Correzione progressiva a cielo chiuso + artrodesi
- Correzione progressiva + osteotomie
- **Correzione acuta in artrodesi**
- **Correzione progressiva su artrodesi**

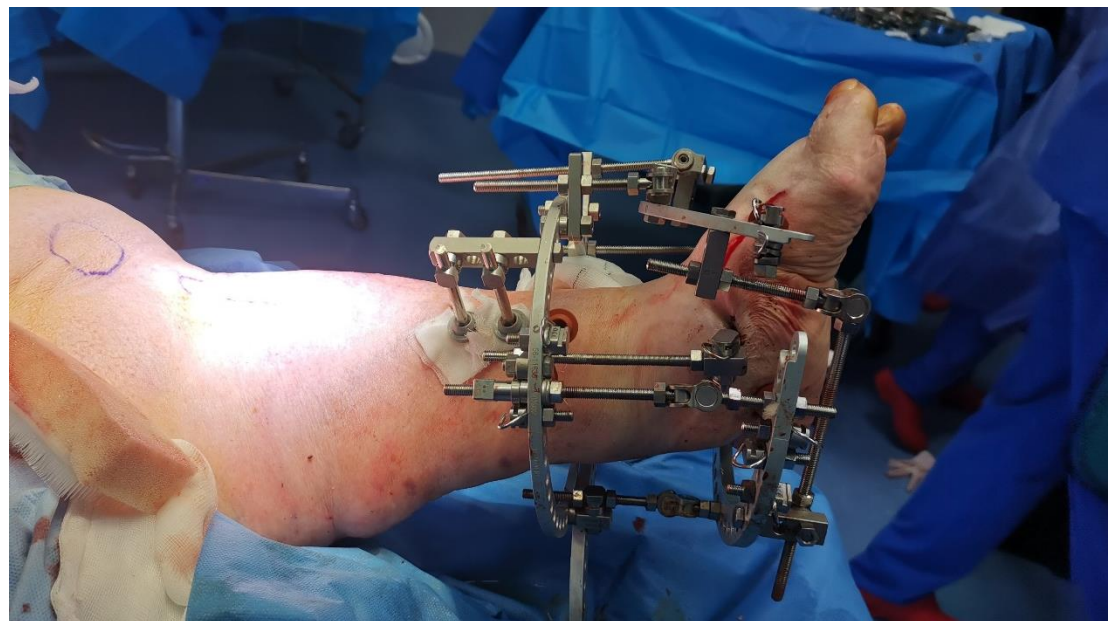
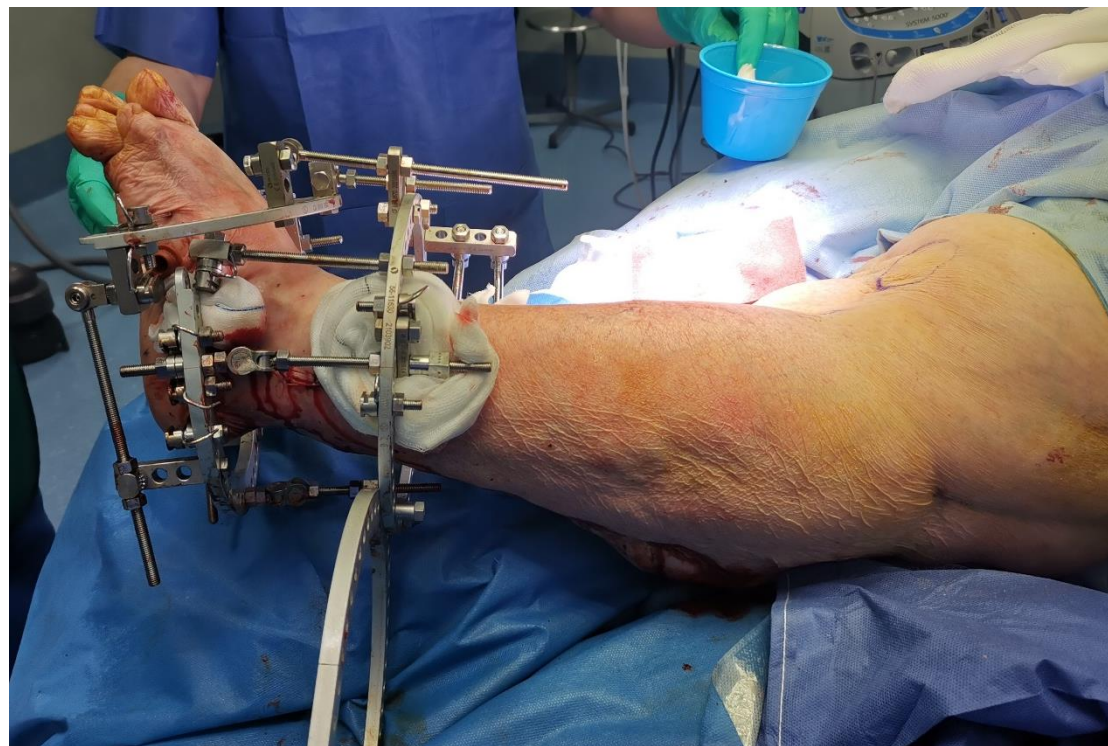
F, 77 anni, AR

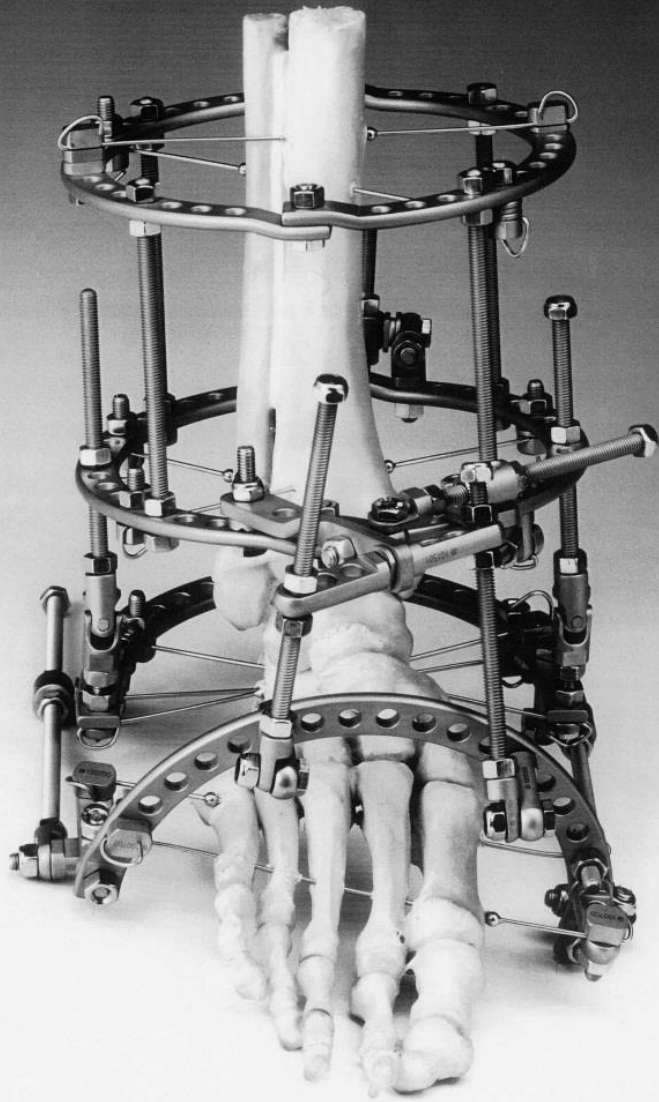
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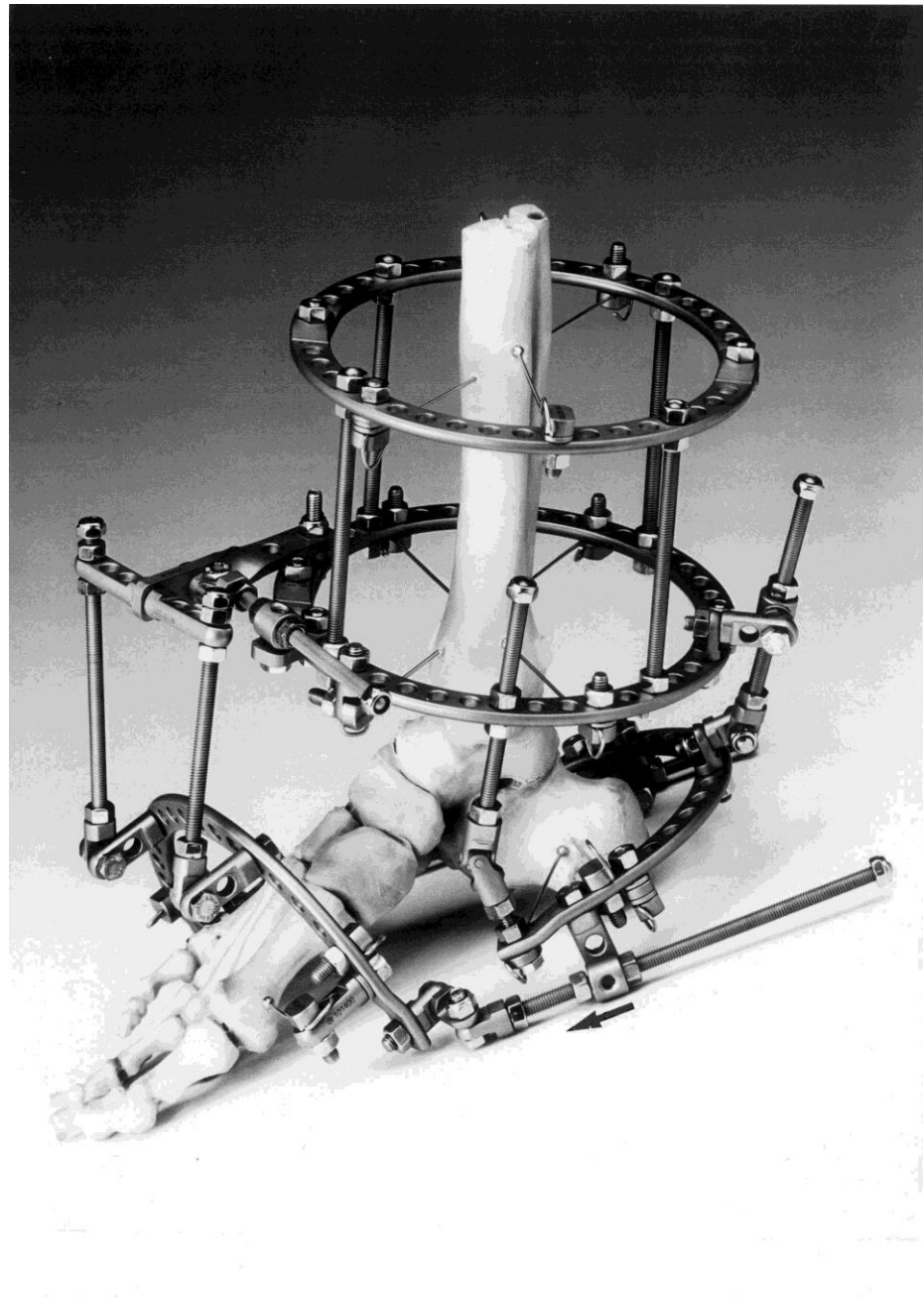








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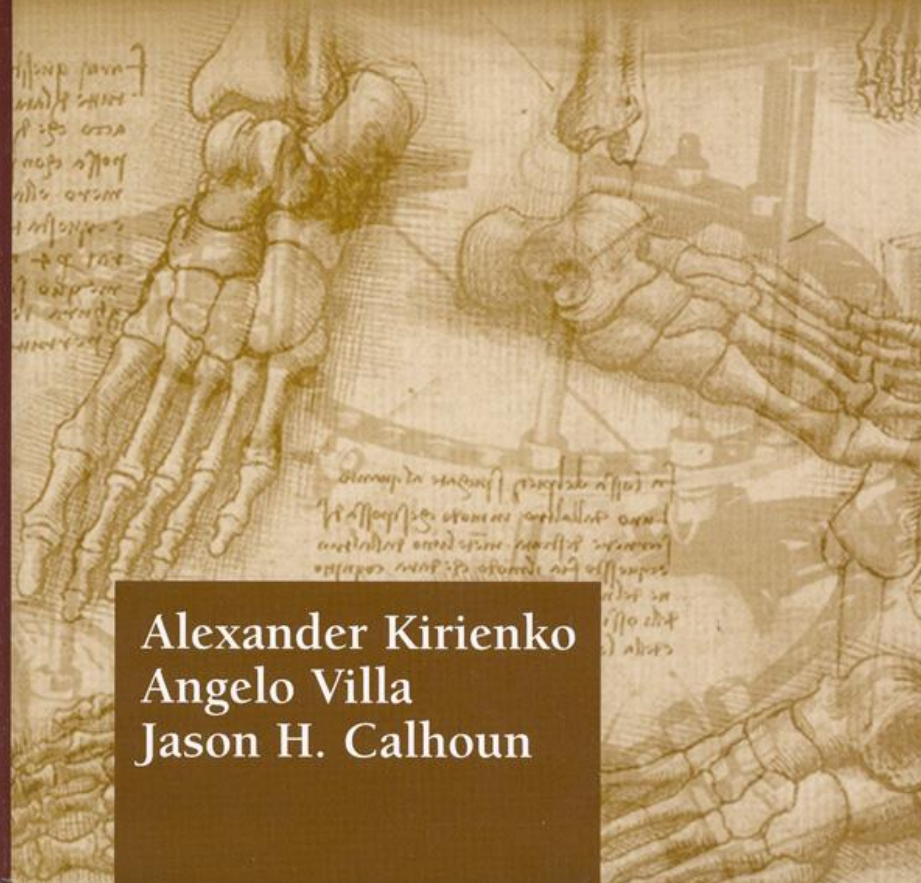






# Ilizarov Technique for Complex Foot and Ankle Deformities

Marcel & Dekker NY 2004



Alexander Kirienko  
Angelo Villa  
Jason H. Calhoun

Grazie

# Equinus deformity





# Correction of equinus deformity



## Closed surgery

(without osteotomy)

- 2-12 years

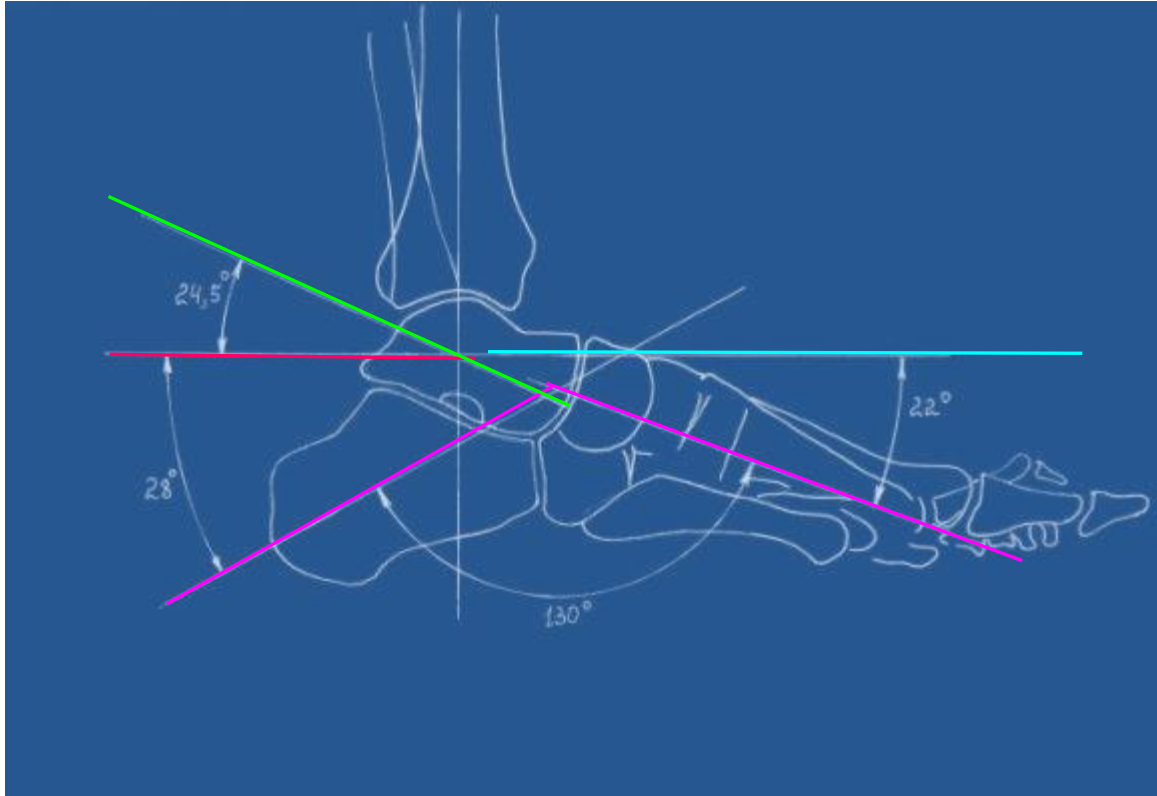
*the skeleton is in the active growth phase,*

- *Posttraumatic equinus in adults without bony ankle deformity*

## Open surgery

(Ilizarov's osteotomies)

- Children after 12-14 years
- Adults with structured ankle deformities



## Normal foot geometry

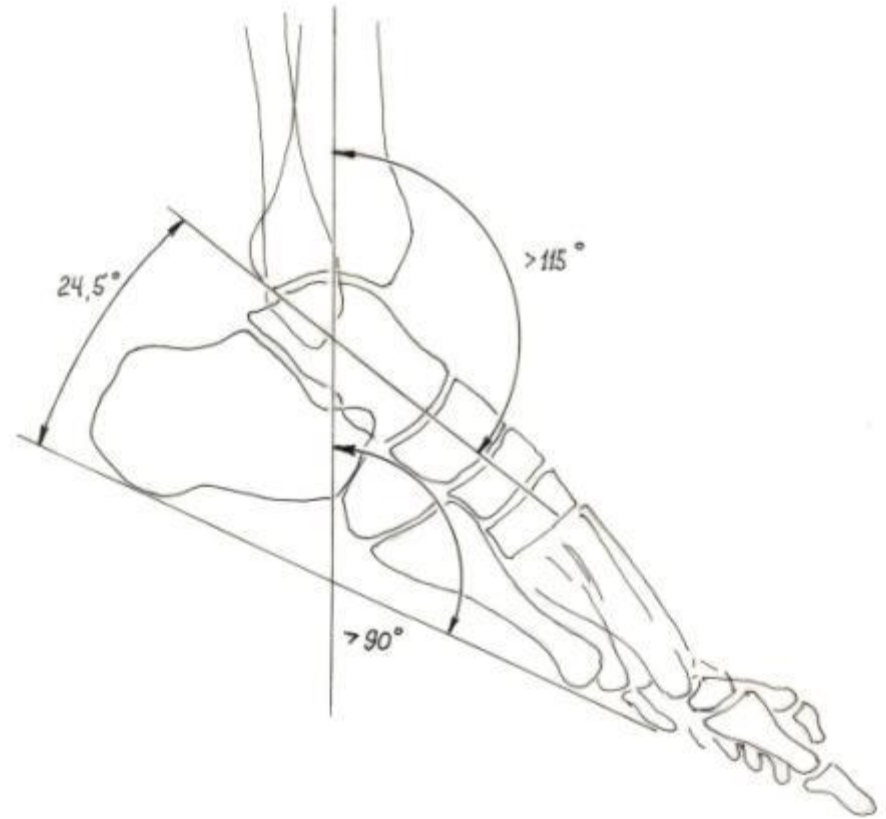
- The angle between calcaneus and the forefoot axes is 130 degrees. █
- The angle between the horizontal plane and forefoot axis is 22 degrees █
- The angle between the calcaneus axis and horizontal plane is 28 degrees █
- The angle between talar axis and the horizontal plane is 24.5 degrees █

# Equinus foot definition

Tibio-plantar angle is greater  
90 degrees

The angle between the tibial  
axis and the talus is greater  
115 degrees

The angle between the tibial  
axis and the talus is most  
important in definition of  
the equinus foot

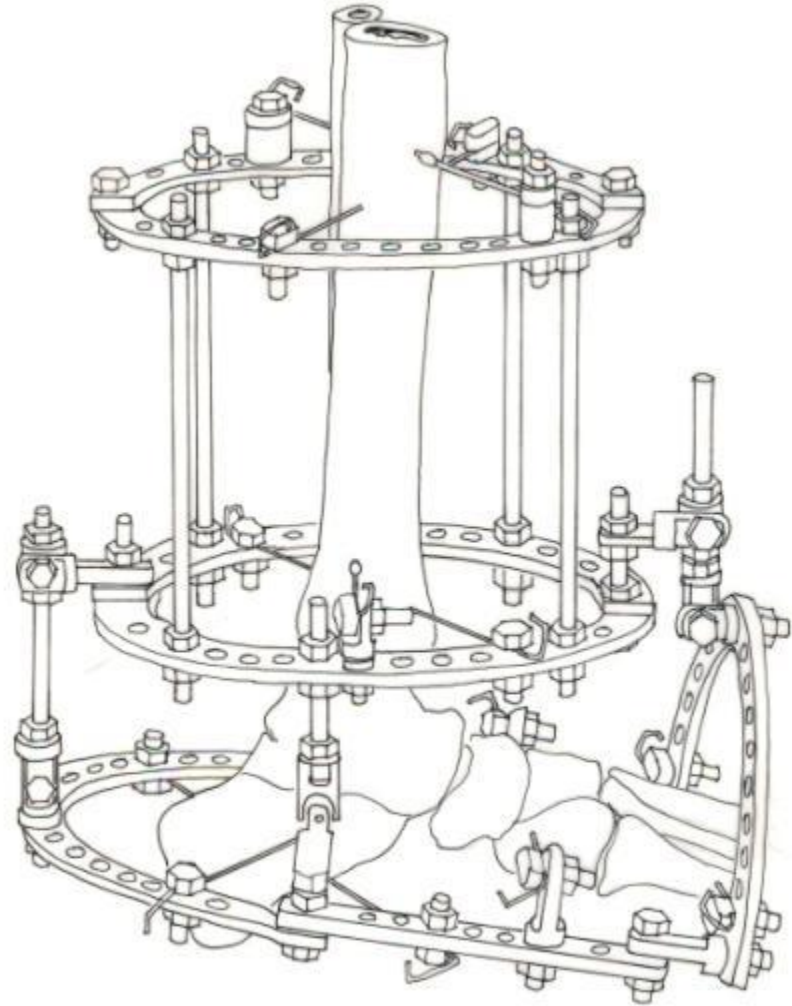




# Frame construction for closed treatment

Anterior and posterior junctions between the tibial block and foot support

The medial and lateral hinges permit foot movement in the sagittal plane

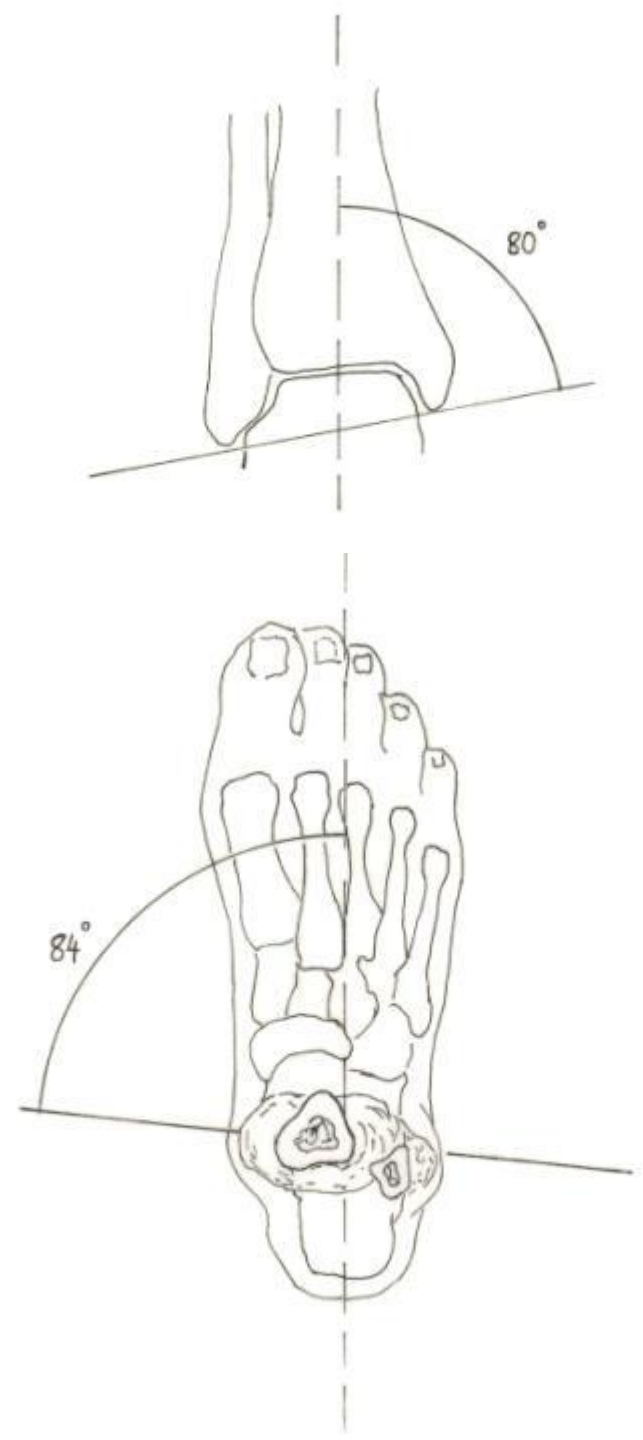


# Ankle rotation axis

Coronal plane – 80 degrees towards from the longitudinal axis (from the tip of the lateral malleolus to just distal to the tip of the medial malleolus)

Horizontal plane – 84 degrees from the sagittal plane

In the presence of deformity, the transmalleolar axis varies and is best judged on the operating room table with hinges on the lateral view



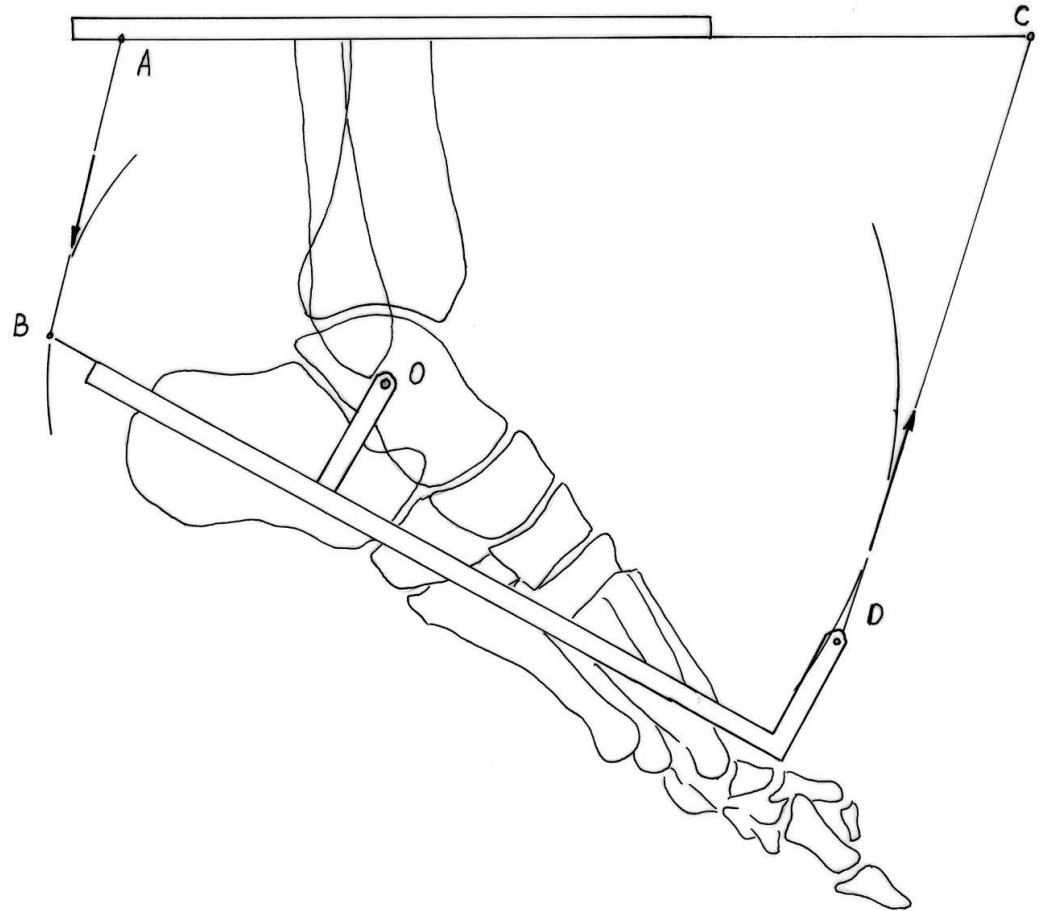
# Direction of the correction forces

O: Axis of rotation;

AB: Direction of the push forces;

CD: Direction of the traction forces.

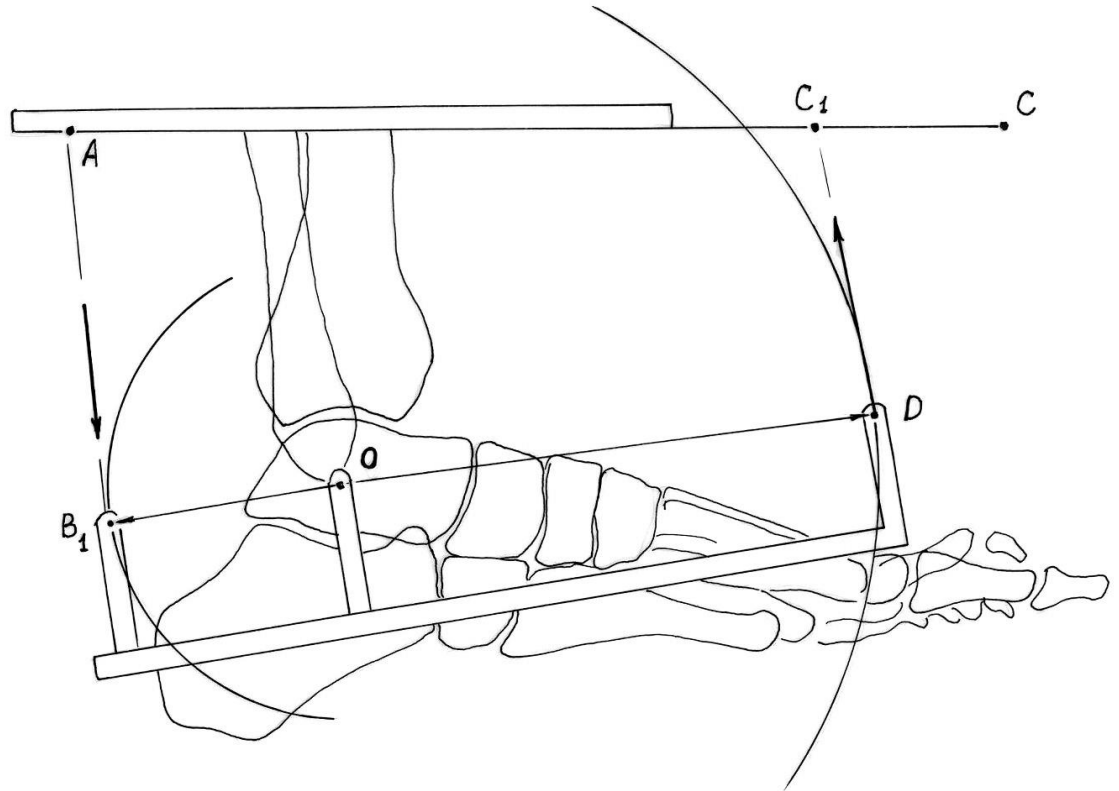
Ideally these forces should be tangential to the center of rotation



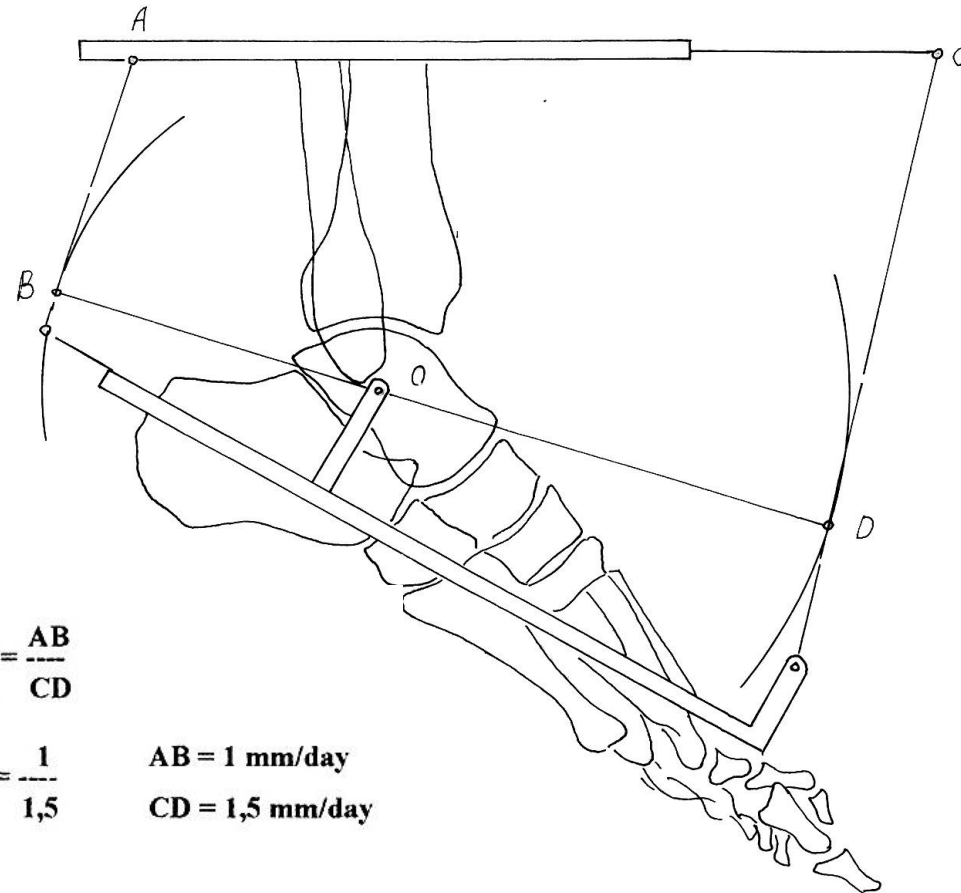


# Adaptation of force vector during correction

- O: Axis of rotation;
- C1D: Adaptation of the traction forces (The angle can be adjusted to maintain the correct direction)
- B1A: Adaptation of the push forces
- C1 & D and B1 & A: Remain tangent to the circles around the rotational axis



# Posterior distraction/anterior compression ratio



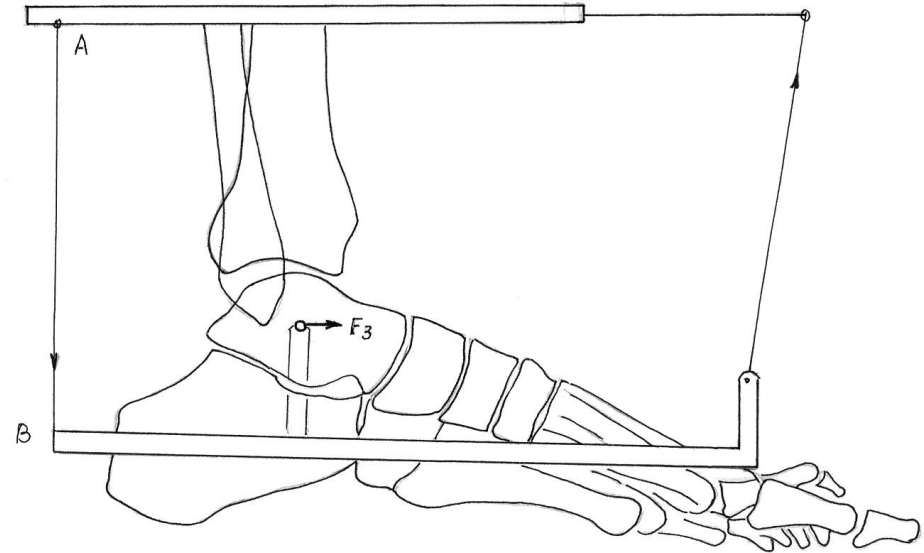
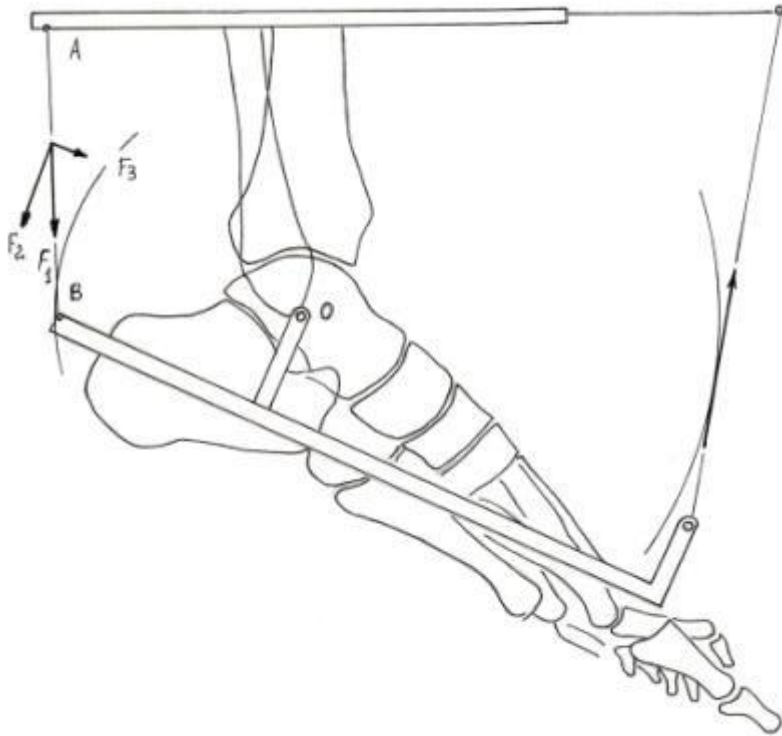
$$\frac{BO}{OD} = \frac{AB}{CD}$$

$$\frac{40}{60} = \frac{1}{1,5}$$

AB = 1 mm/day

CD = 1,5 mm/day

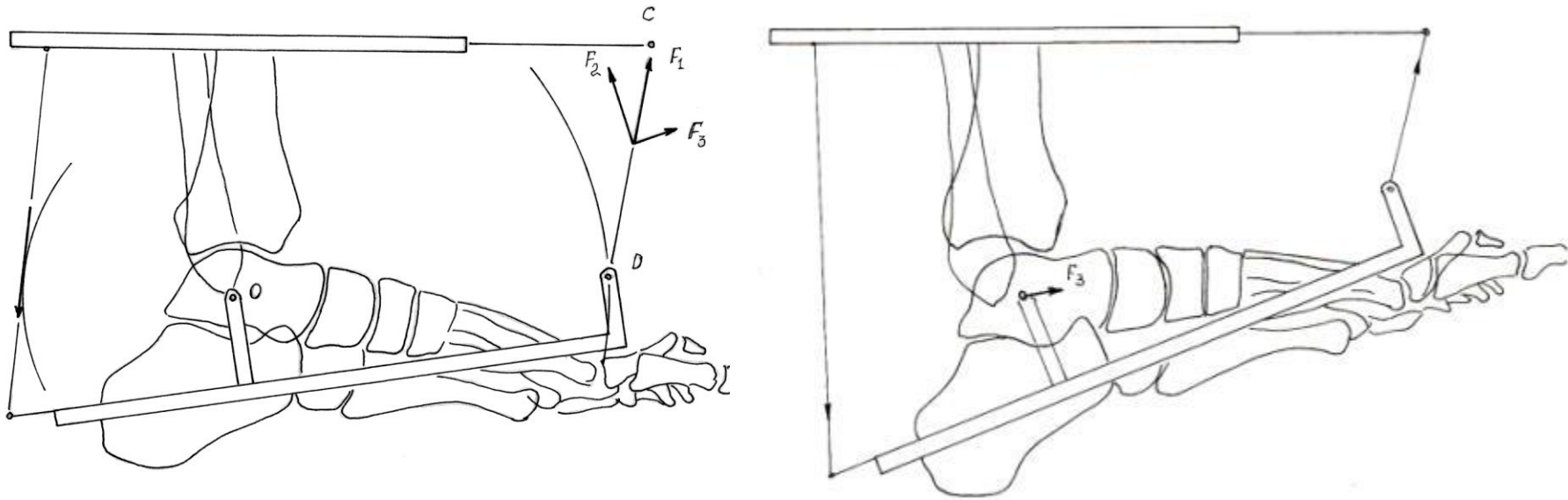
## Posterior distraction forces



- When the distraction force is not tangent to point B, it produces horizontal component  $F_3$
- $F_3$  anteriorly subluxates the talus

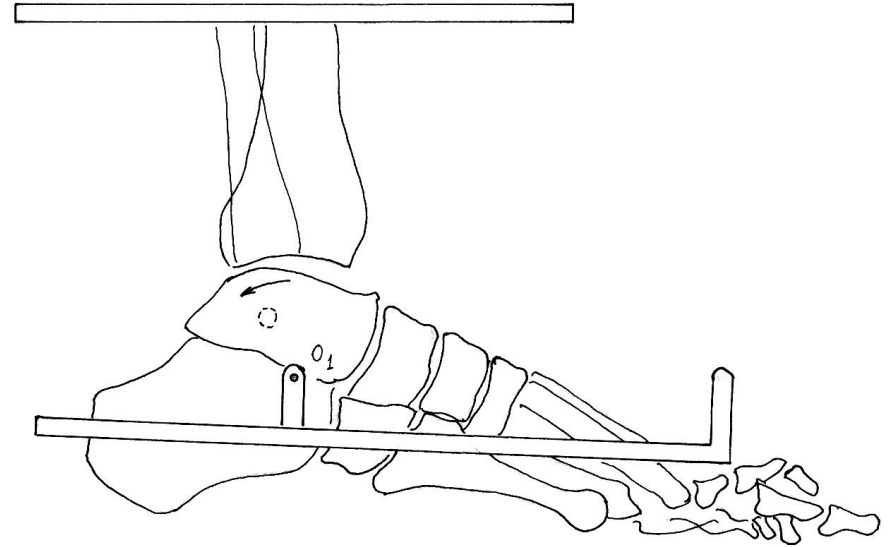
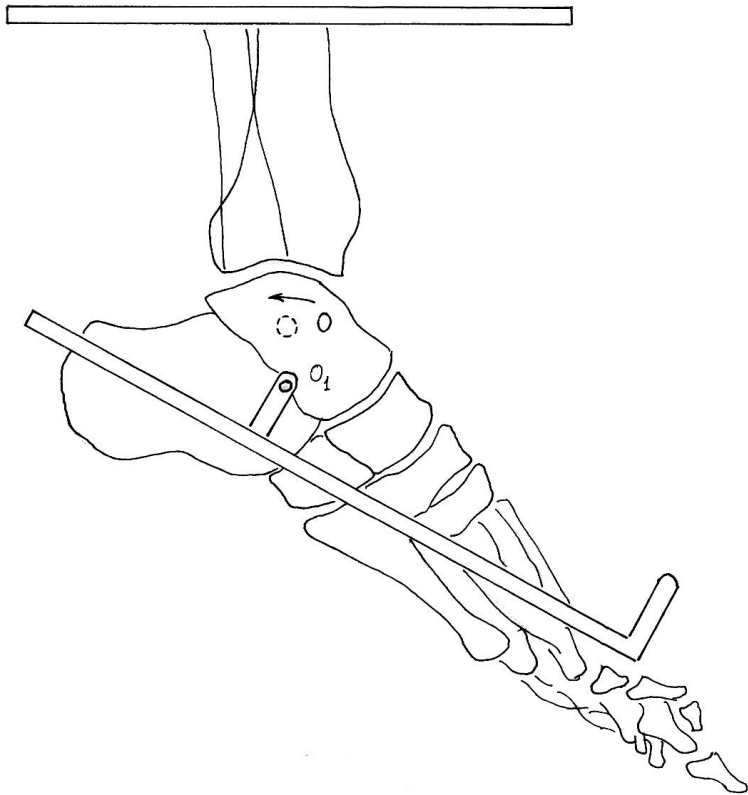


## Anterior compression forces



- When the compression force is not tangent to point D, it produces horizontal component  $F_3$
- $F_3$  also anteriorly subluxates the talus

## Hinge axis manipulating



- Shifting of the hinge axis  $O_1$  distal to the ankle axis of rotation  $O$  prevents anterior subluxation of the talus during correction