

Limb Length Equalization & Deformity Correction

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of long bones. Methods such as subepiphyseal implantation of foreign material,^{8,23,48} periosteal stripping,^{28,34,46} repeated osteotomy,^{7,45} drilling and curettage,¹⁵ shortwave diathermy,^{19,21,36} arteriovenous fistula formation,^{38,42} redistribution of the intraosseous circulation,⁴⁷ and sympathectomy^{5,25,26} have been tried and have resulted in very unpredictable amounts of leg lengthening.

Initial trials for leg lengthening

**Prof. Codivilla
of Italy- 1905**



**The first successful lengthening.
Osteotomy → immediate traction
force to a calcaneal pin, with or
without the use of narcotics.**

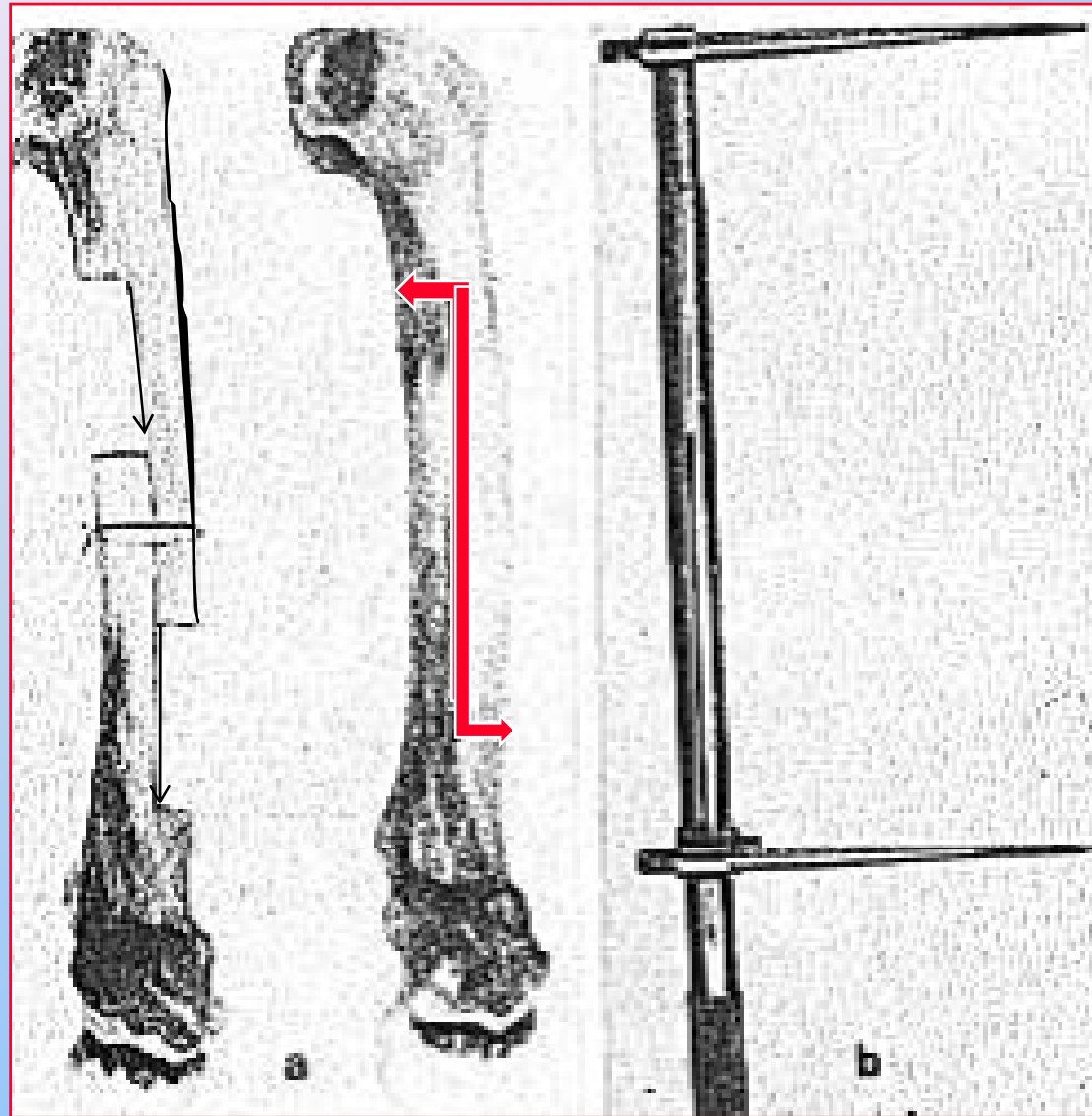
Ombredanne 1913

The first to use **External fixation** for lengthening.

Oblique osteotomy → lengthening at a rate of **5mm/ day**

Putti 1921

Lengthening at a rate **2-3mm/ day** with a monolateral fixator and half-pins.



**Jones and Lovett
Osteotomy**

Putti apparatus

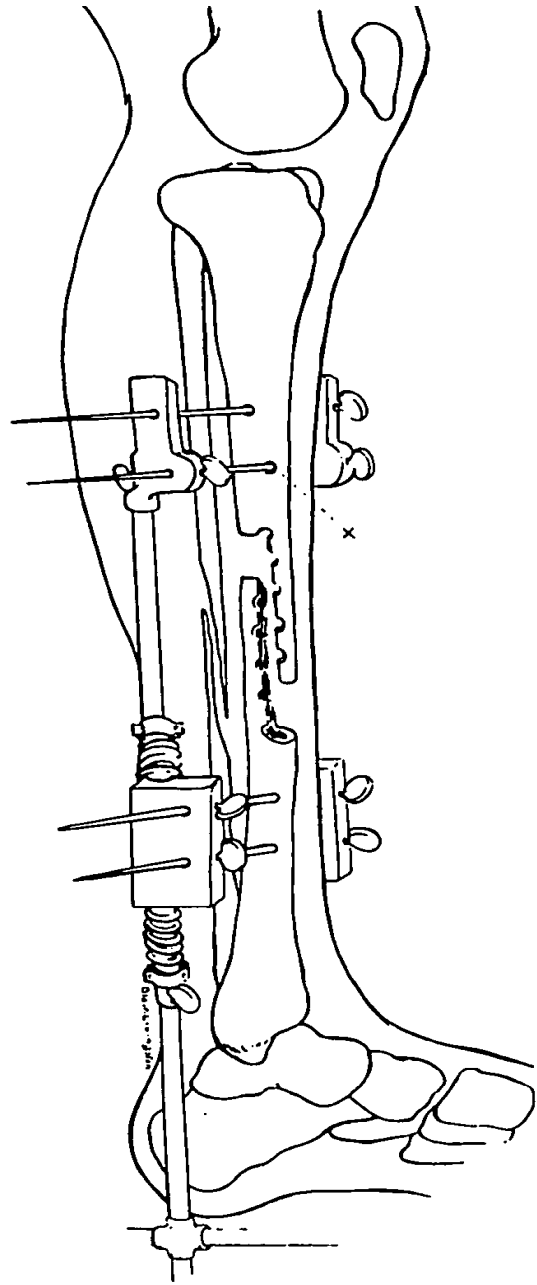


FIG. 2. A diagrammatic representation of Brockway and Fowler's method of placing the second tibial pin slightly more anterior than the other three pins.

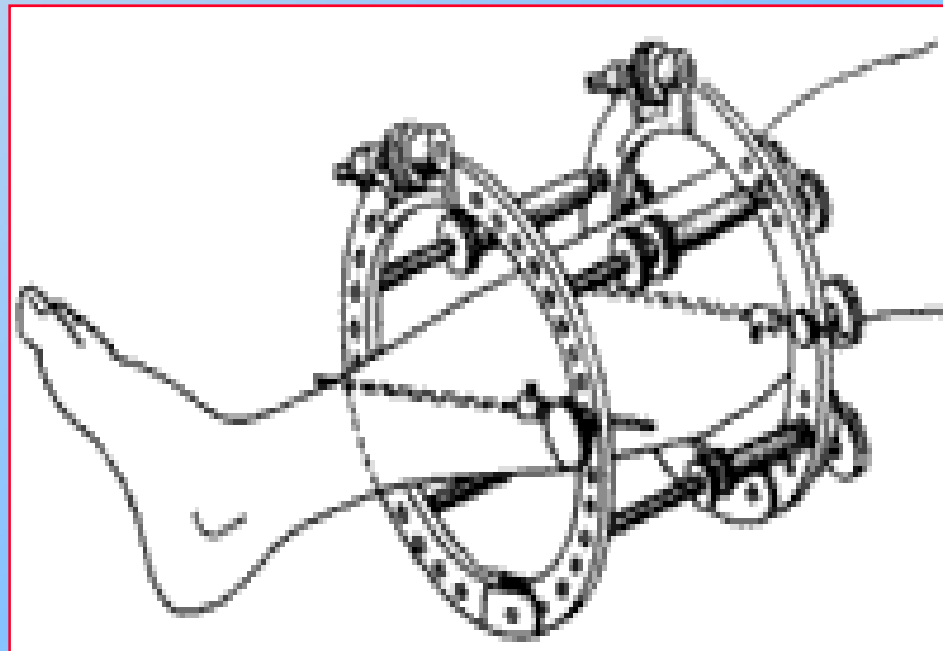
Abbott 1927

= Step-cut osteotomy, with preservation of the periosteum,

= After **7-10 days period** distraction through a spring-loaded controlled device **1-1.5mm/day**

Joseph E. Bittner 1929

- = Circular tensioned-wire external fixator for fracture reduction.**
- = Wires tightened by expanding hinged ring.**
- = Device is removed then cast is applied.**



Ilizarov worked as a GP in the small industrial town of Kurgan, Siberia, after World War II. In 1943

*Gavriil A.
ILIZAROV
Academician of the
Russian Academy
of Medical Sciences
(1921-1992)*





- 800 bed, 17 specialized departments**
- = 200 Orthopaedic Surgeons**
- = 60 Scientists with Ph.D. degrees**

Ilizarov discovery

One patient had bony ankylosis of his knee in the flexed position → osteotomy → distraction gradually to straighten out the limb.

To his surprise, Ilizarov found a newly regenerated bone at the site of osteotomy when distraction was finished.

The first case of leg-lengthening by Prof. G. A Ilizarov in 1972, for a dwarf on both lower limbs.



Causes of LLD

- ✉ **Congenital.**
- ✉ **Growth arrest.**
Trauma ,infection
- ✉ **Neoplastic.**
- ✉ **Neurological.**

Biological principles of lengthening

**Closed osteotomy (5-7 days delay)
→ Distraction → Tension.**

Distraction Osteogenesis

Distraction Histogenesis

Ilizarov Tension Stress Theory

Bone and soft tissue, including skin, muscle, & NV structures, will heal and regenerate in a predictable manner under tension.

Effects of $>2\text{cm}$ LLD

- 1. Asymmetrical gait.**
- 2. Pelvic obliquity**
- 3. Scoliosis**
- 4. Hip & Patello F. OA on the
long limb side**
- 5. Cosmetic.**

LLD in general population

= 70% had some LLD

= 25% had 1-1.5cm LLD

= 5% had 2-2.5cm LLD

Advantages of LLD

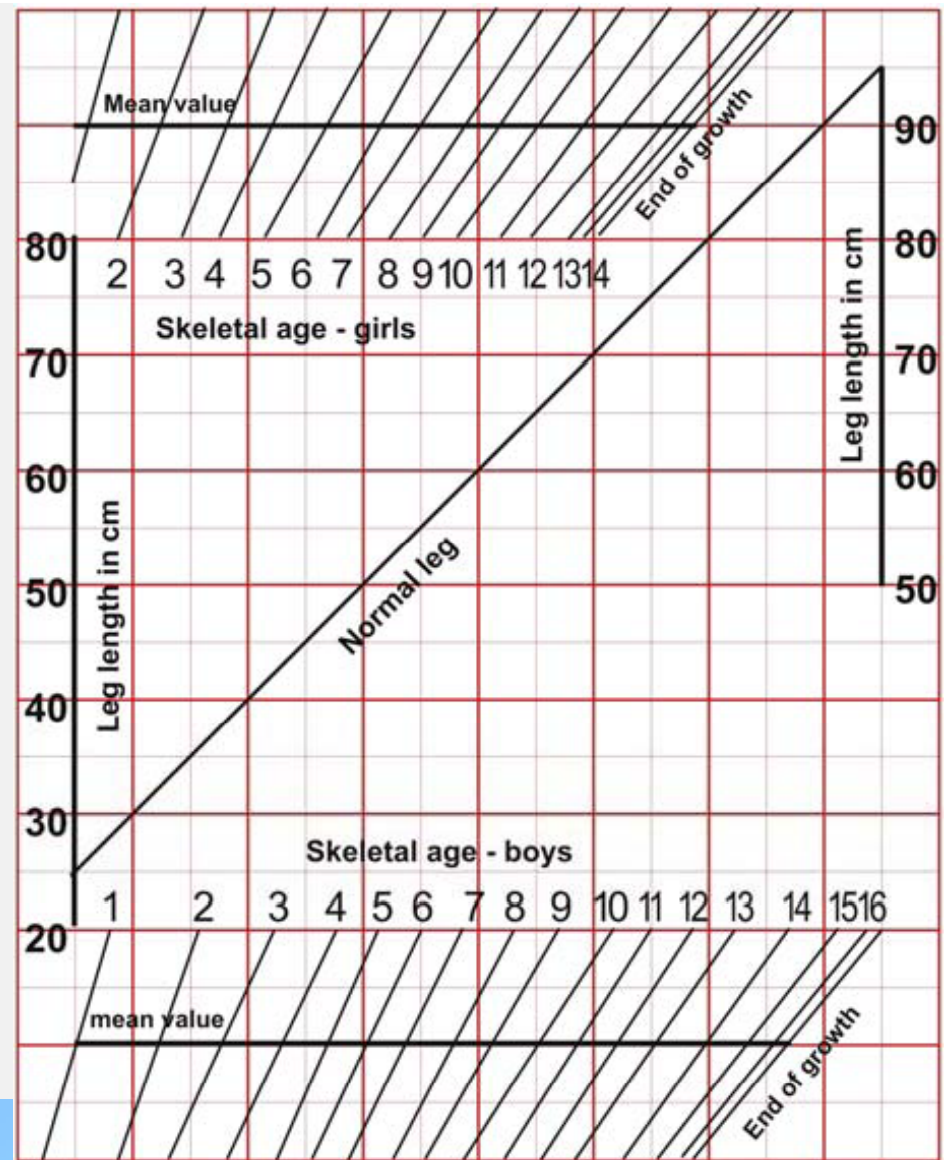
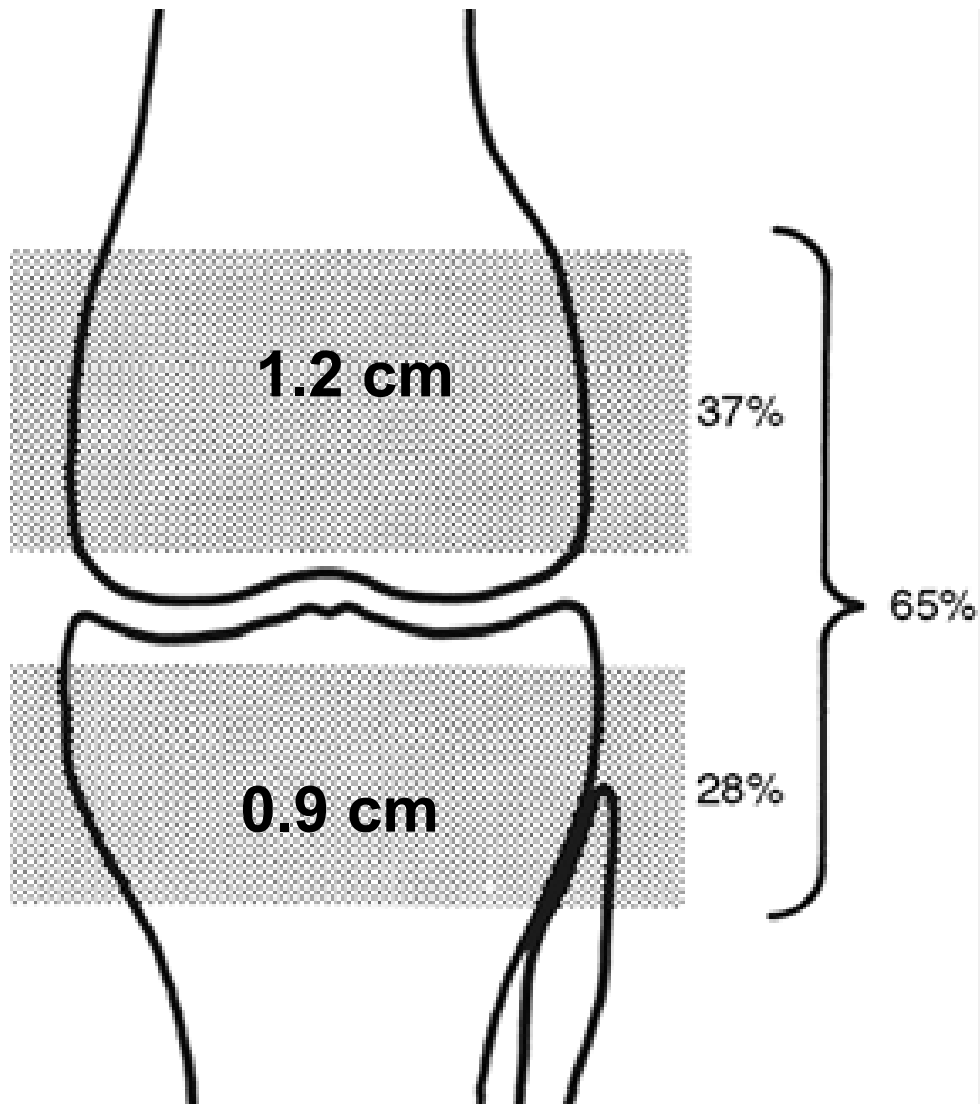
-  **Stiff knee.**
-  **Paralytic limb.**

Preop Assessment of LLD

- # Exam of the patient.**
- # Types of LLD.**
- # Radiological.**
- # Expected LLD at maturity**
- # Photography.**
- # Patient education.**

Expected LLD at maturity

Three length measurements at minimum intervals of 12-18 months are required for a reasonably reliable prognosis.



Contraindications to lengthening

- ⚡ **Sensory & motor deficit.**
- ⚡ **Unstable joint.**
- ⚡ **Psychological problem.**
- ⚡ **Inability to discard the orthosis post op.**
- ⚡ **Uncooperative patient.**

Principles of correction

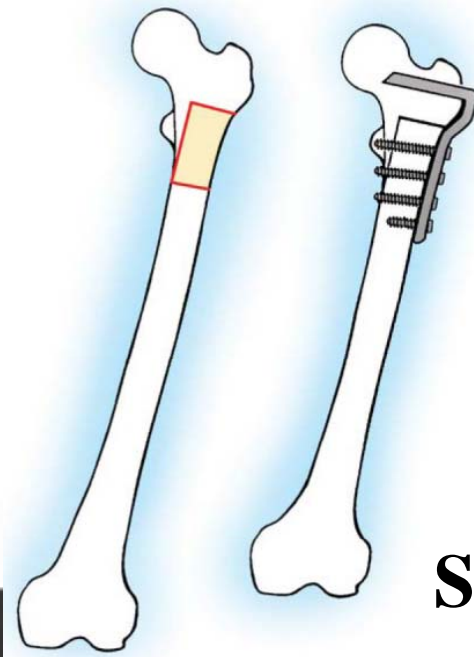
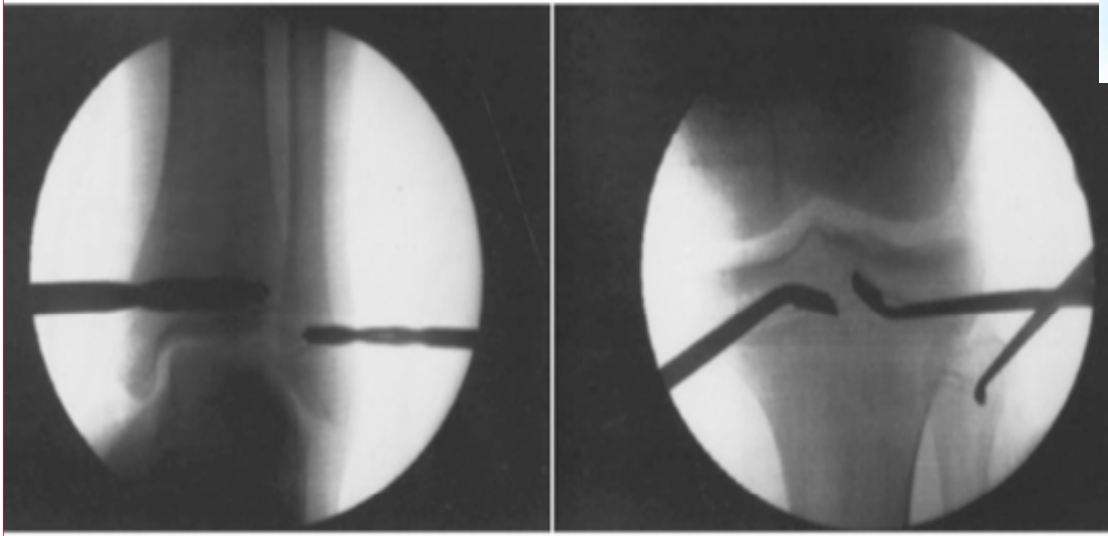
- 1. Deformity first.**
- 2. Leave paralytic limb shorter.**
- 3. Length of shortening. (<2cm)**

Options for treating LLD

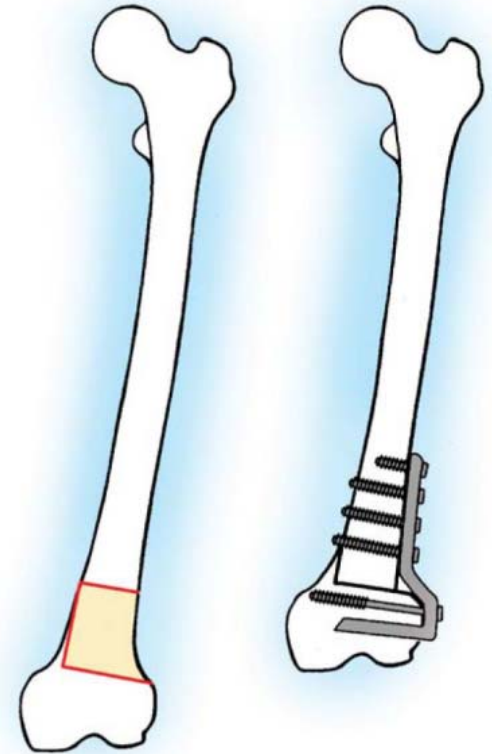
- = **Shoe elevation or orthoses**
- = **Epiphysiodesis**
- = **Surgical leg shortening**
- = **Surgical leg lengthening.**



Epiphysiodesis



Shortening

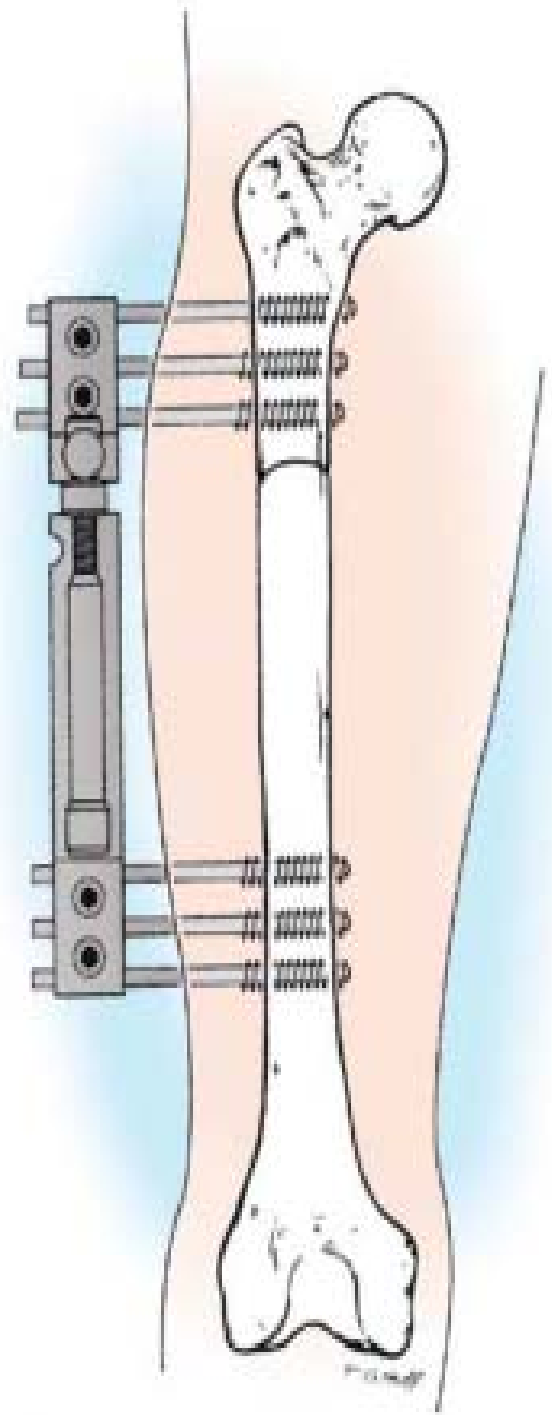
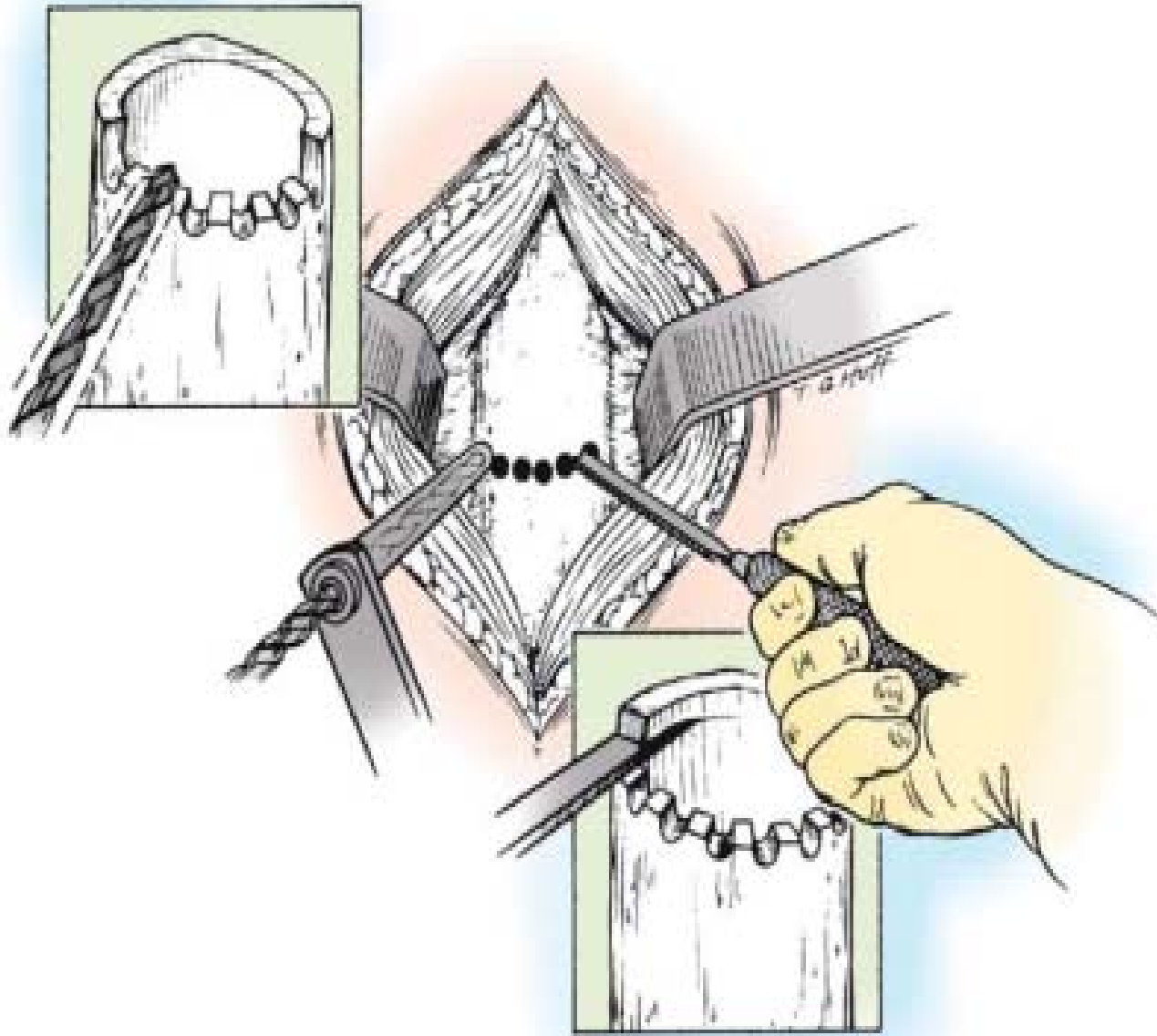


General Guidelines for the R of LLD

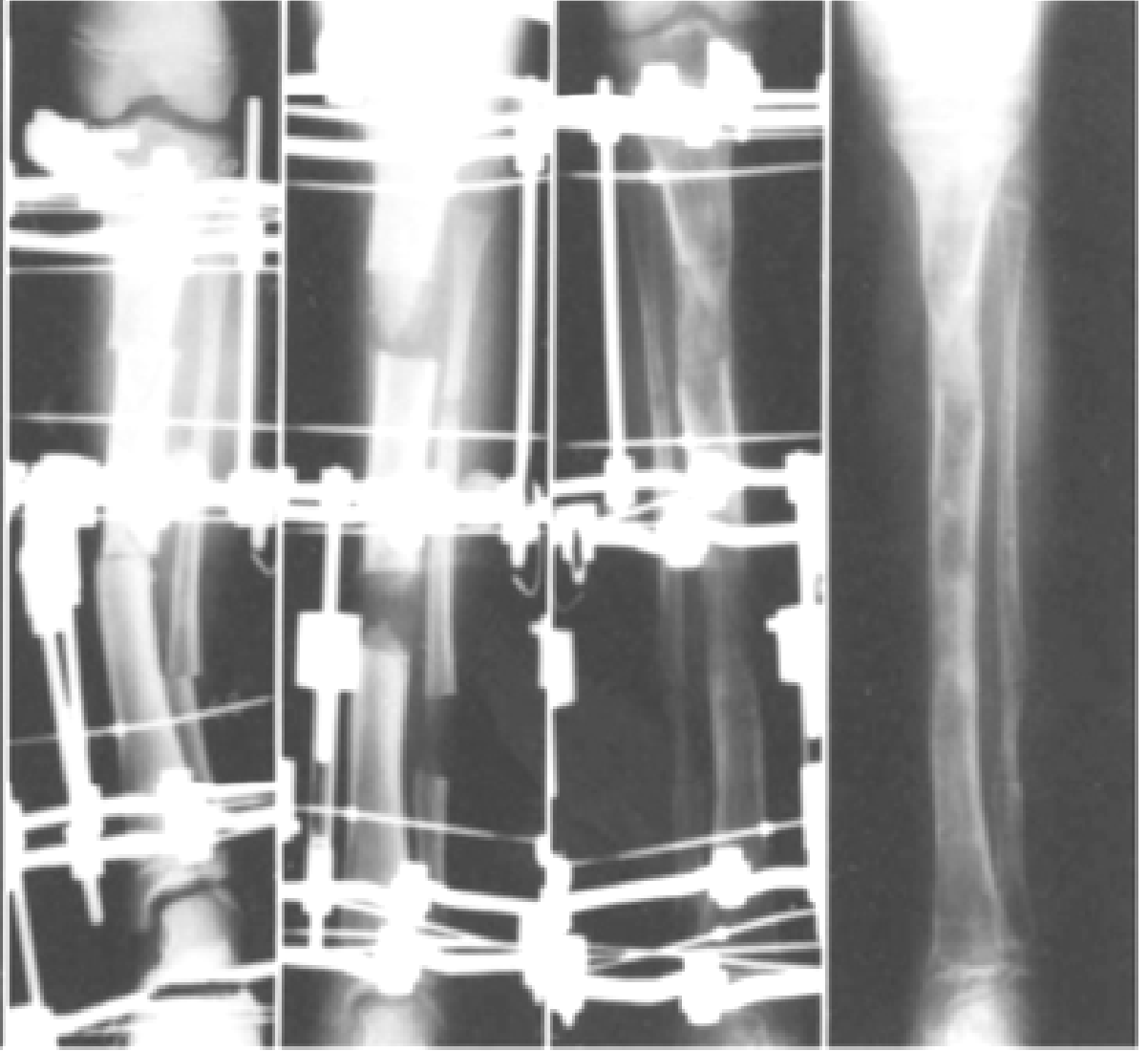
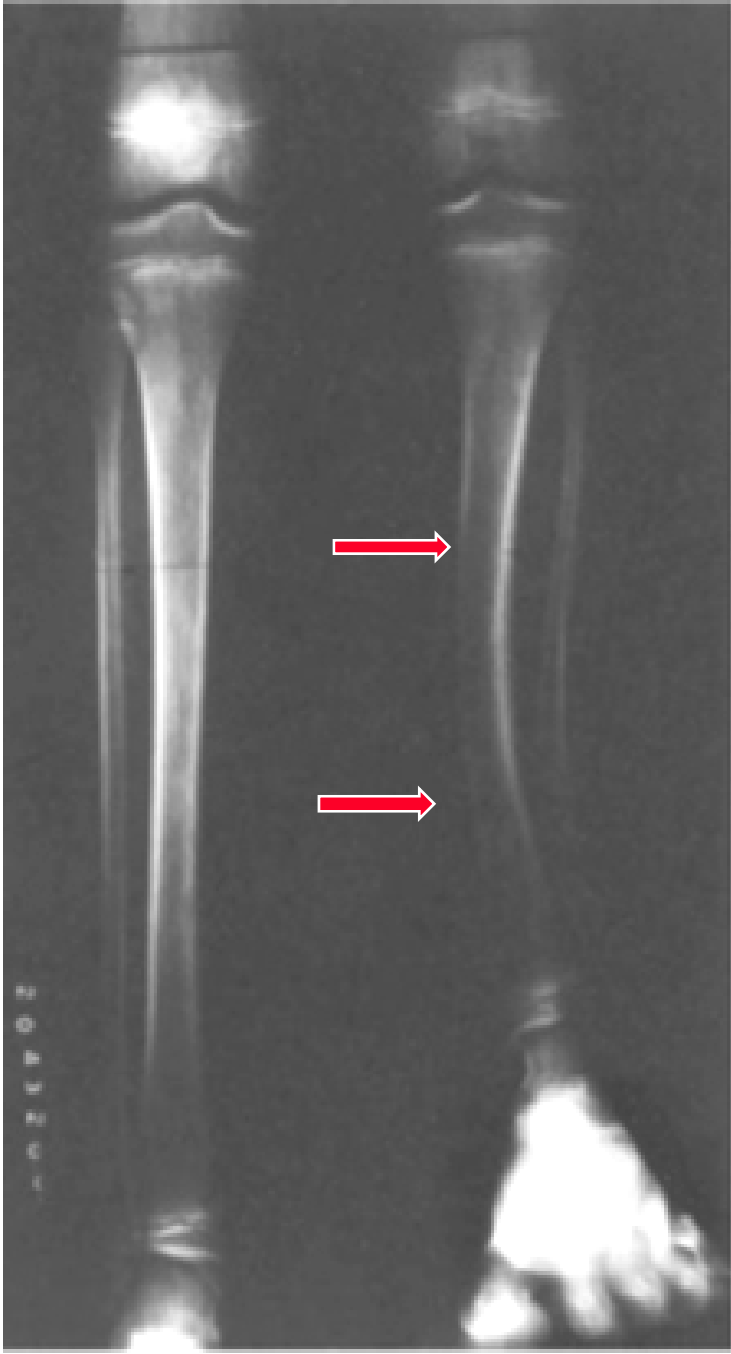
LLD	Treatment
<2 cm	= None (or lift in shoe)
2-6 cm	= Epiphysiodesis or shortening
>6 cm	= Lengthening
>15-20 cm	= Lengthening (staged or combined with epiphysiodesis).

Surgical Technique

- Image I.
- Fixator.
- Fibular division for leg.
- Periosteal respection.
- Cortical osteotomy.







Advantages of Metaphyseal osteotomy

- =Greater blood flow,**
- =Better collateral circulation,**
- =Greater trabecular surface area, a thin cortex that**
- =Facilitates separation with a chisel, and**
- =Greater inherent stability.**

Post operative

- ⚡ **Pin site dressing.**
- ⚡ **Analgesia - ? Compartment synd.**
- ⚡ **Physiotherapy.**
- ⚡ **Patient education.**

Complications of lengthening

1. Bone

- ⚡ **Consolidation problems.**
- ⚡ **Axial deviation.**
- ⚡ **Fracture.**

2. Joints

⚡ **Contracture & subluxation.**

⚡ **Loss of ROM.**

3. Nerves

⚡ **Direct injury.**

⚡ **Traction injury.**

4. Blood vessels

⚡ Hypertension.

⚡ Compartment syndrome.

⚡ DVT.

⚡ Direct injury.

5. Pin sites.

⚡ Infection.

⚡ Tethering.

6. Psychological

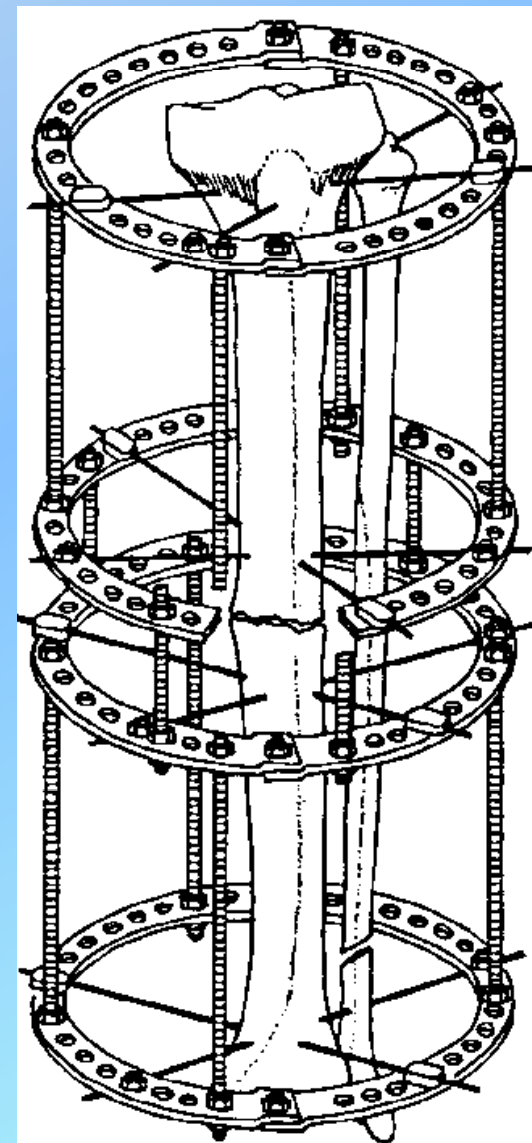
7. Wound.

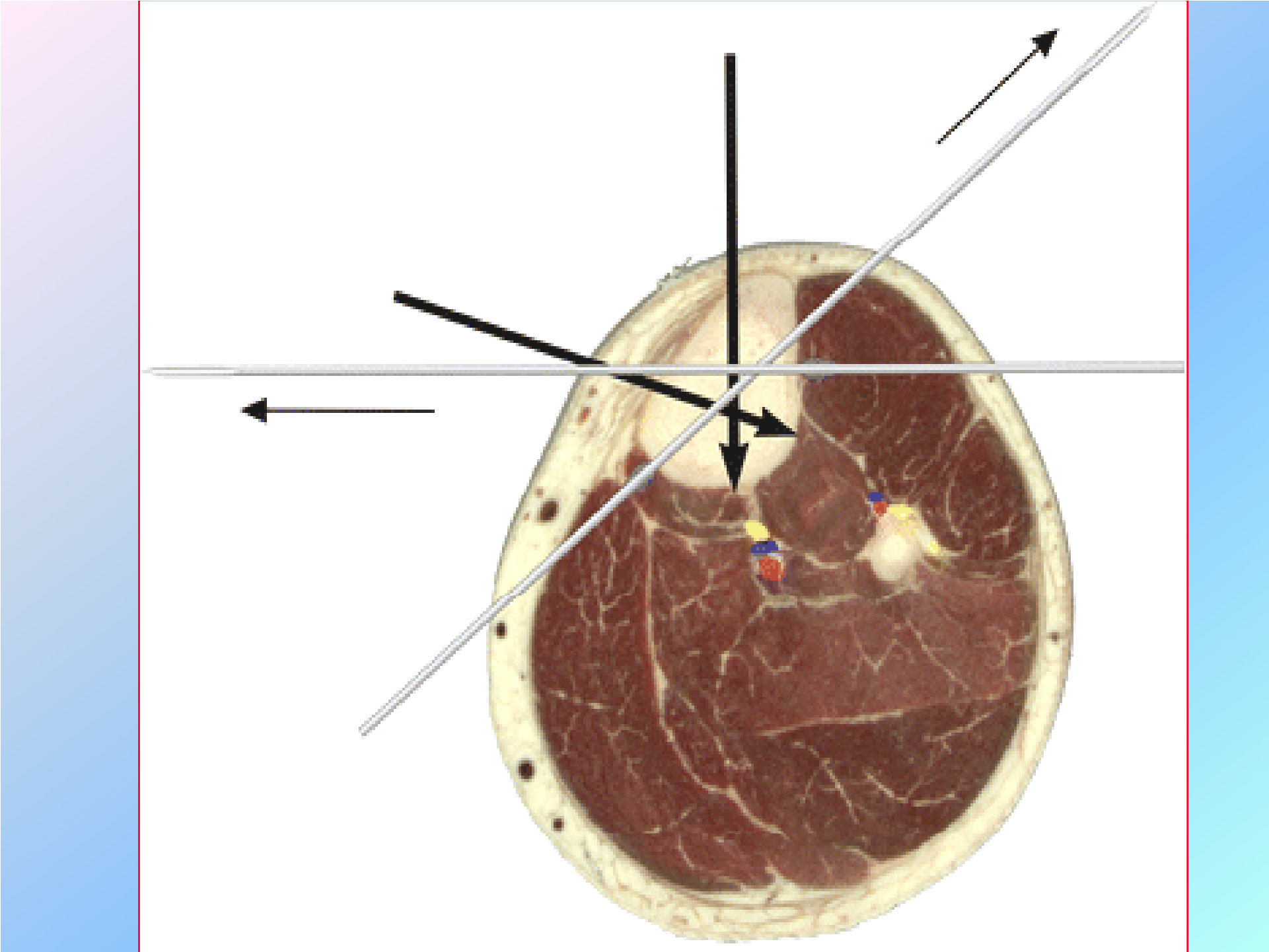
⚡ Pain.

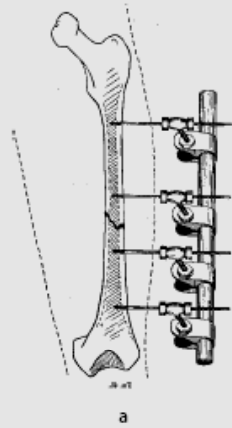
⚡ Infection.

Current modes of lengthening

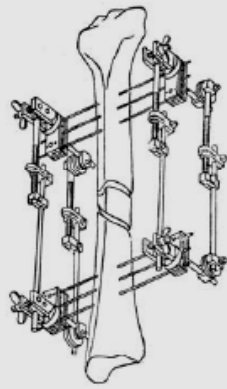
1-Circular Bone Lengthener



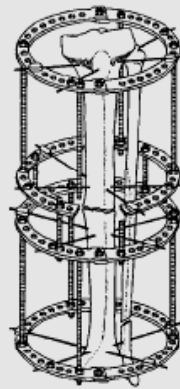




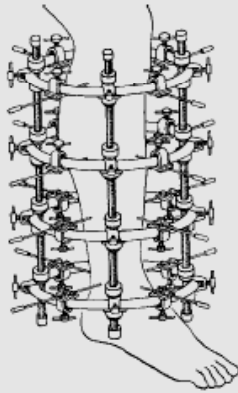
a



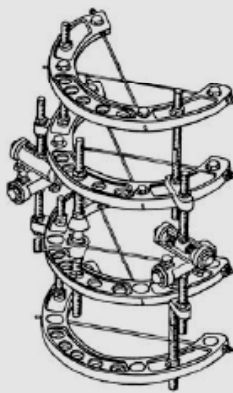
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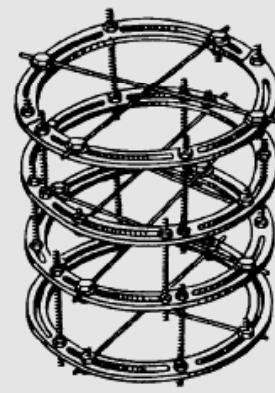
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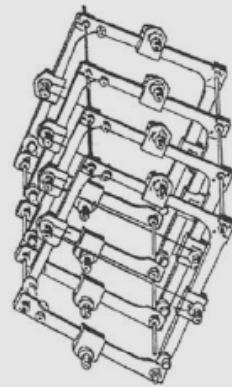
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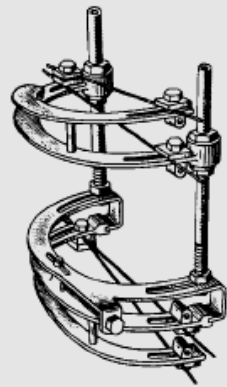
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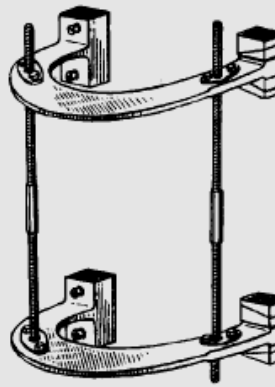
f



g



h



i

Fig. 1.2.2a–i. Fixation devices. a Lambotte, b Hoffman-Vidal, c Ilizarov, d Kalnberz, e Volkov-Oganesyan, f Demianov, g Tkachenko, h Gudushauri, i Sivash

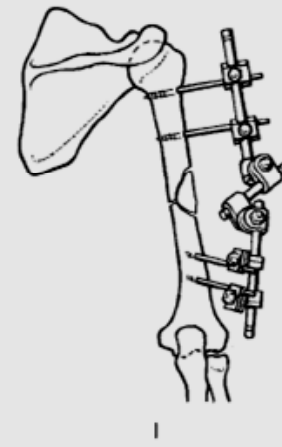
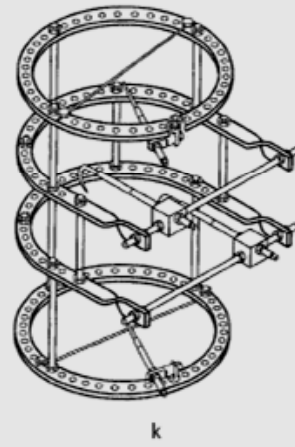
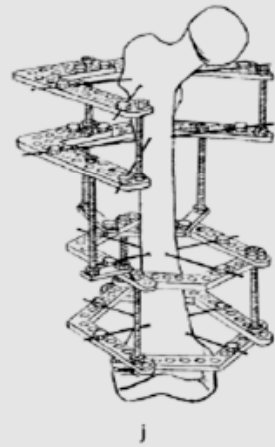


Fig. 1.2.2j-r. j Lee, k Barabash, l Synthes, m Biomet, n OrthoFix, o Stryker, p Taylorspatial frame, q SUV-frame, r Poli Hex

Problems of ilizarov method

- Non-standardized techniques
- Dependence on **personal creativity** of surgeons
- More **labour**-consuming assembly
- Multiple **outpatient visits** necessary
- Decreased **quality of life** while fixator in place
- Problems with **non-compliant** patients
- High incidence of **pin-site** infection
- **Contractures** of adjacent joints caused by transfixation of muscles



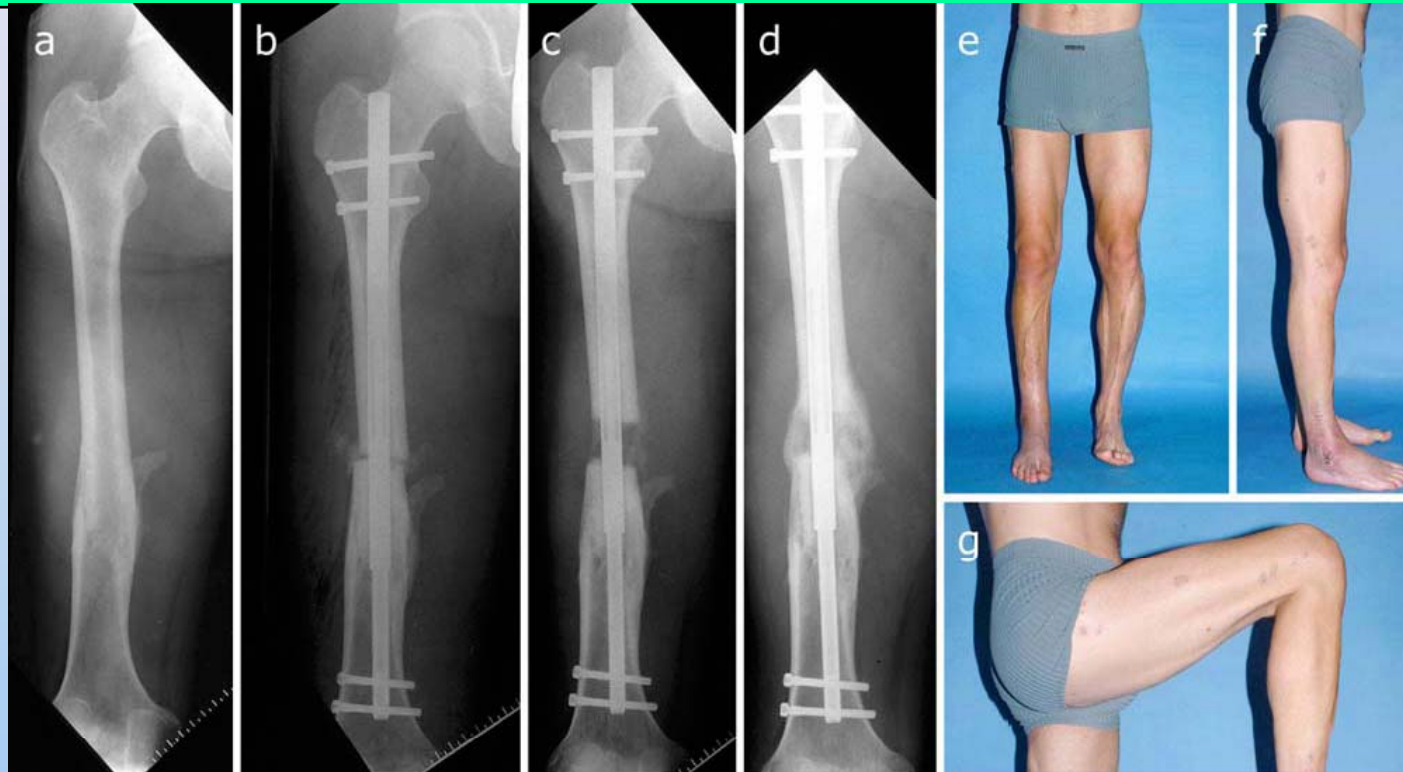
Automatic lengthening

2-Unilateral External lengthener

Orthofix



3-Intramedullary Skeletal Kinetic Distractor- *ISKD*



It is designed to lengthen for a predetermined distance, then stop.

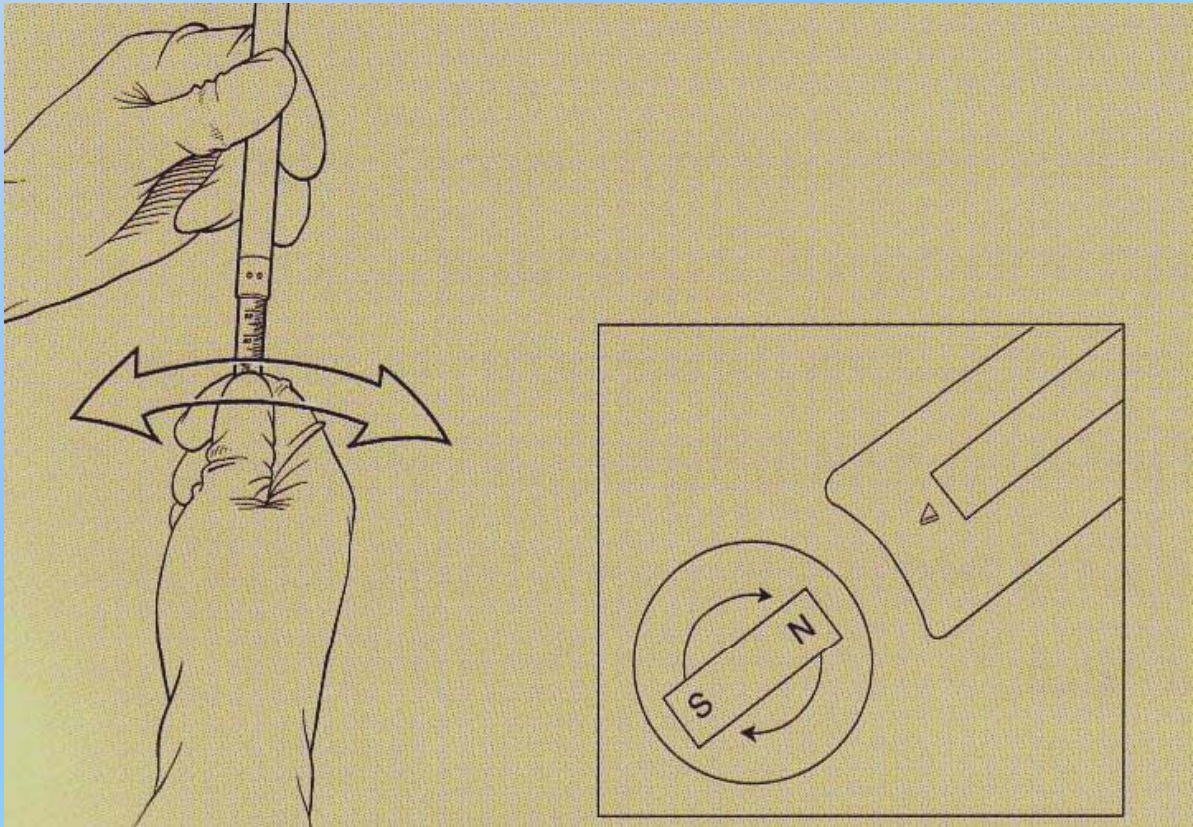
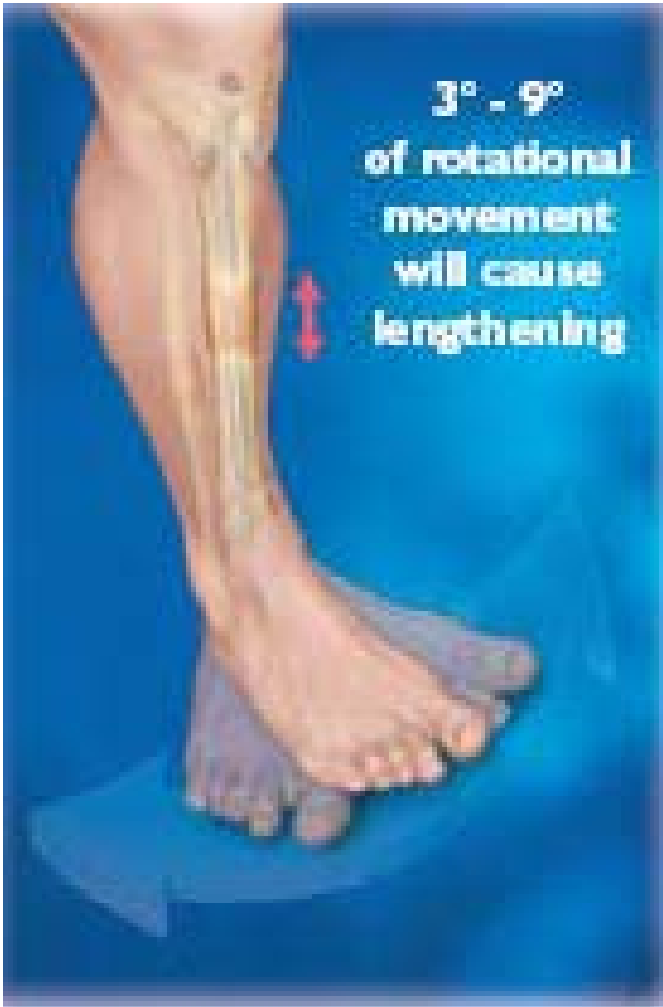


Table 2 Exclusion Criteria for the ISKD

Physiological factors

Open growth plates

Limb-length discrepancy of <20 mm or >80 mm

Nonunion, open wounds, or active infection

Significant angular or translation deformity

Tight soft tissues or unstable knee or hip joint

Metabolic bone disease, systemic diseases, steroid use, or smoking

Existing implantable stimulator (eg, pacemaker, defibrillator, cochlear implant, or dorsal column stimulator)

Patient factors

Unable to understand the device or monitor

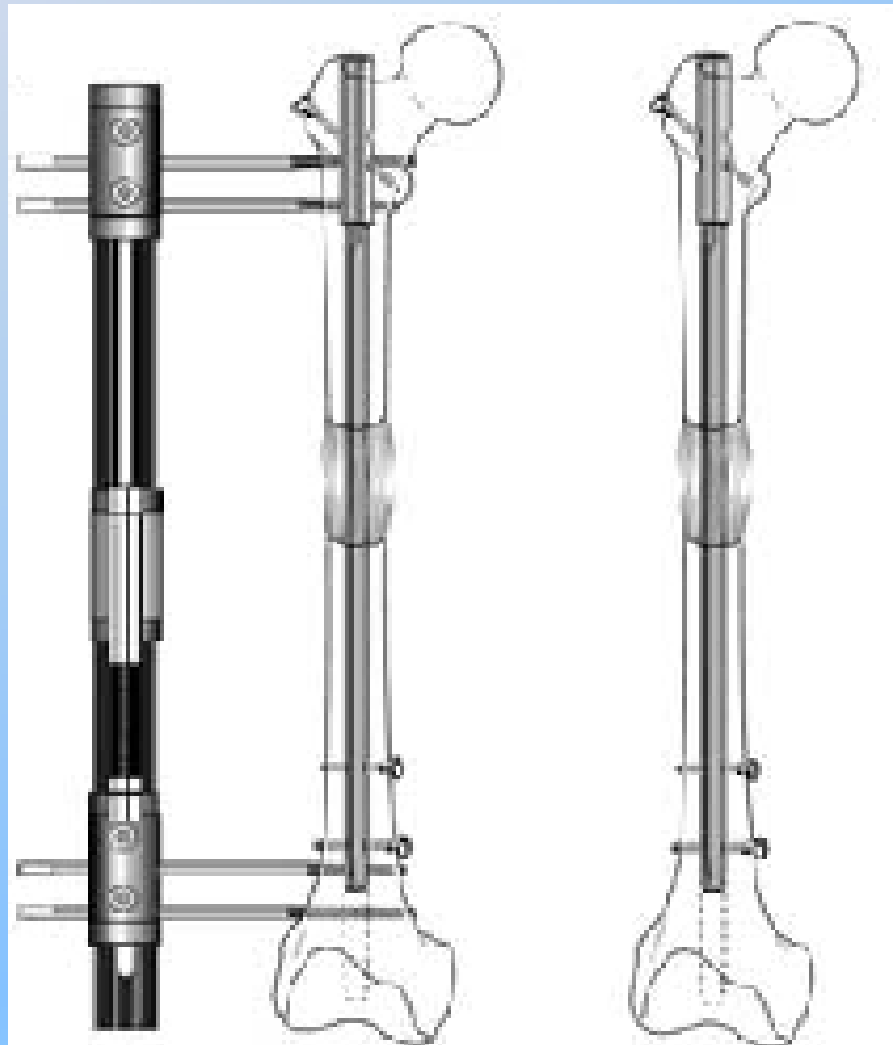
Inability to comply with follow-up

Inadequate support network

Unable to deal with uncertainty

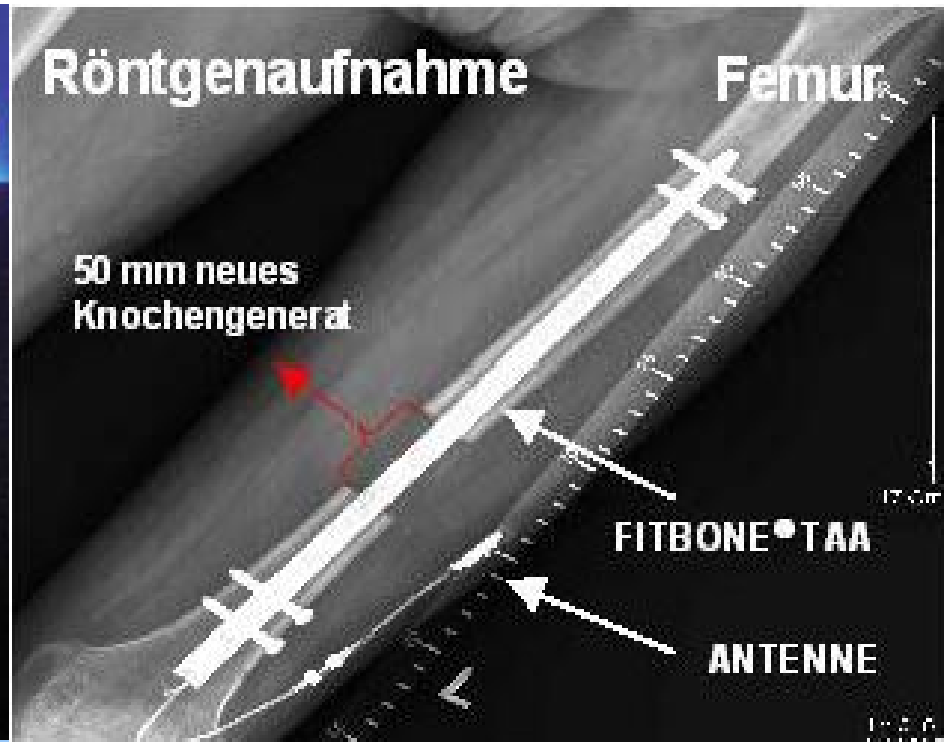
Pregnancy

4-Combined external and internal bone lengthening system

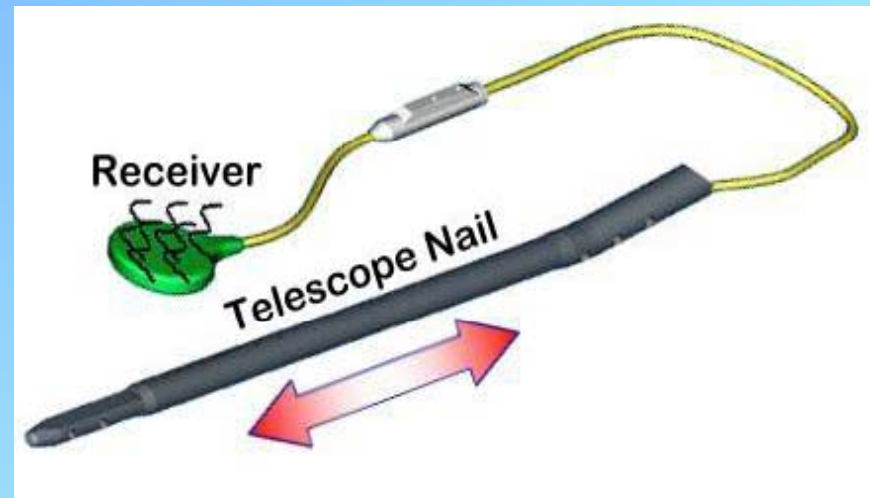
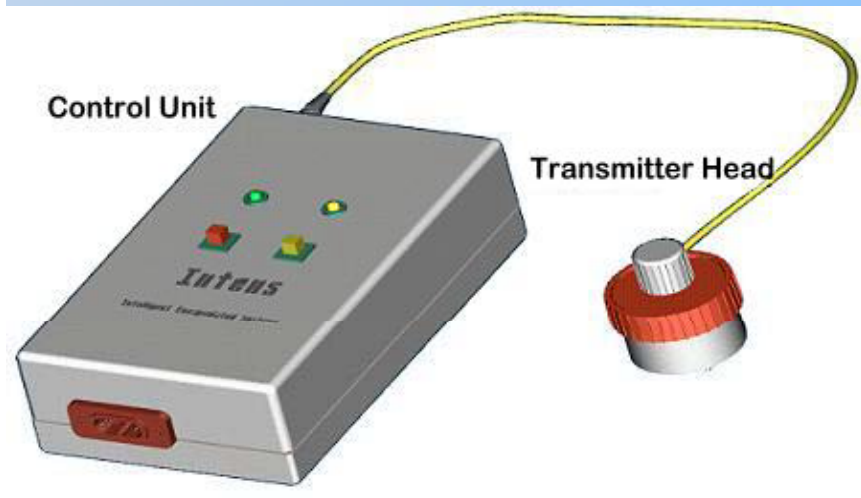


5-Limb lengthening with a fully implantable, computer controlled distraction device

- = The only device that uses a powered system**
- = The nail is connected to an induction receiver that is placed just under the skin.**
- = An external control unit powers the telescope nail through the induction plate.**
- = A similar technique has been used to power artificial heart.**

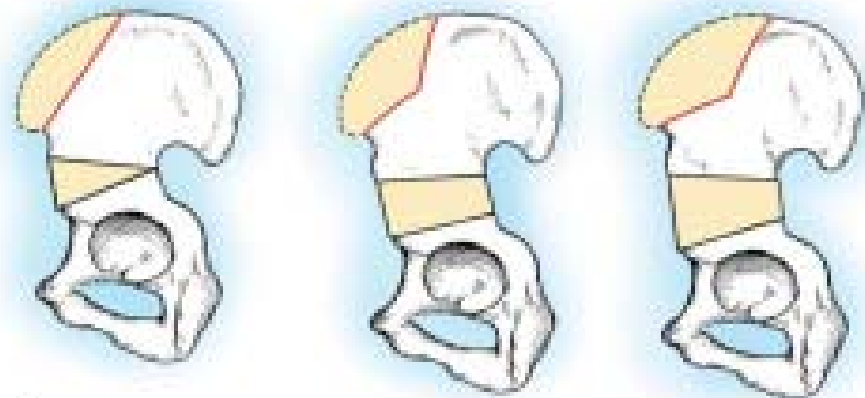


The Fitbone device

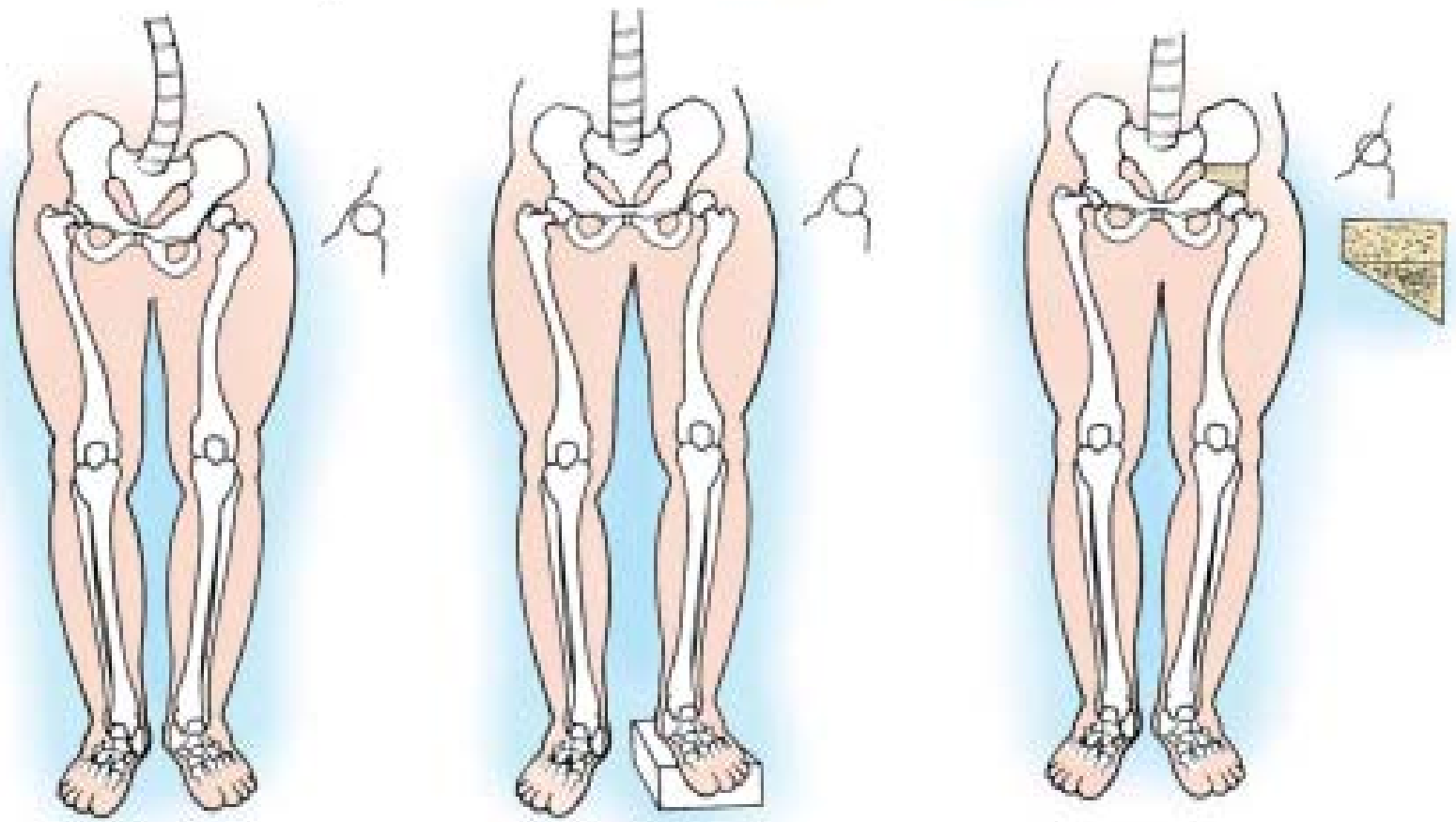


6-Taylor Frame





A

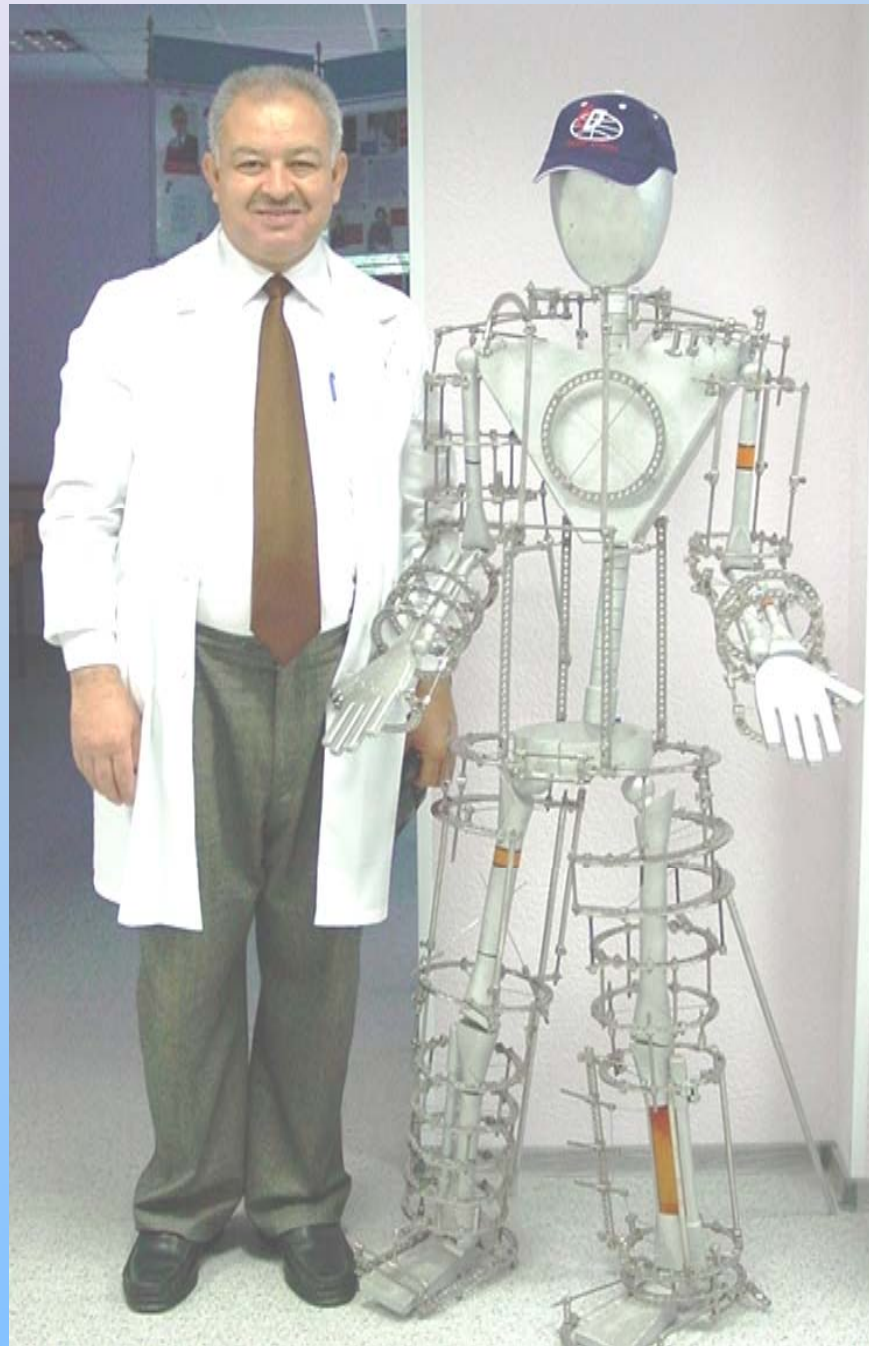


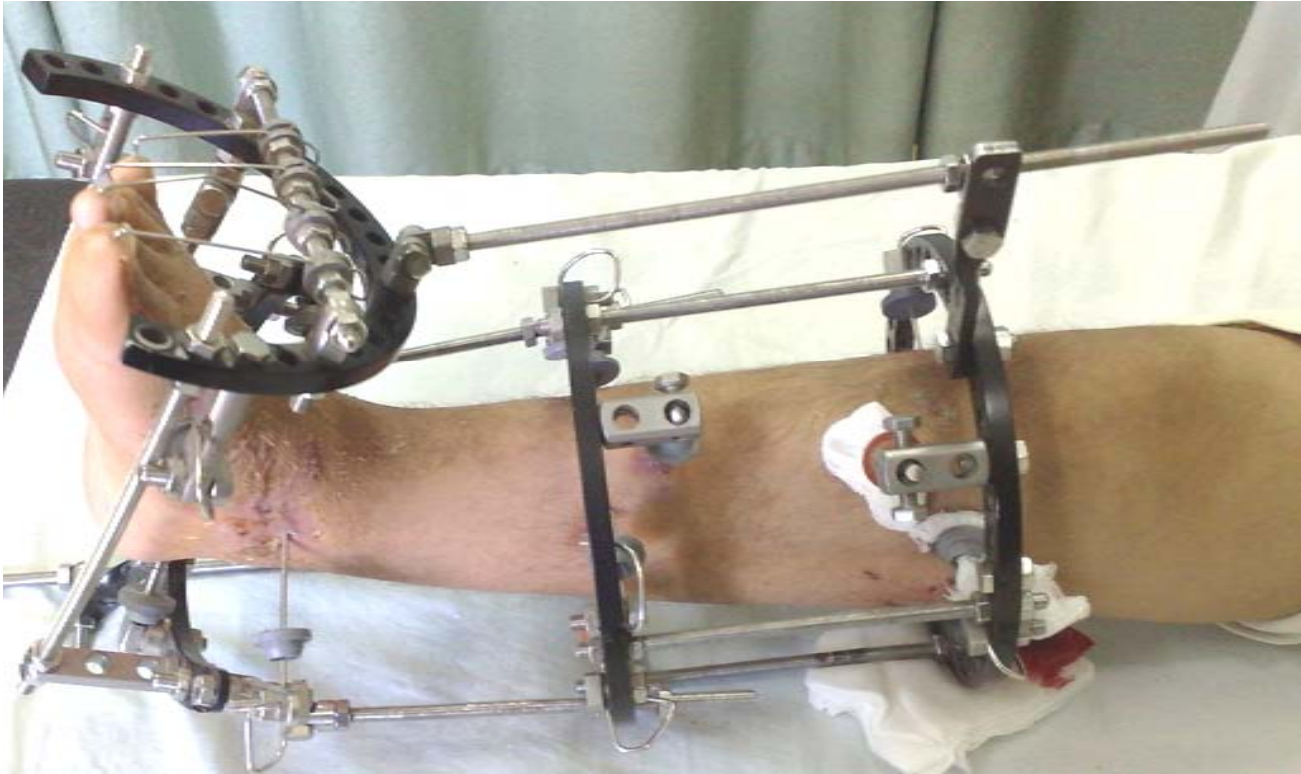
B

Which patients can be helped by ilizarov method?

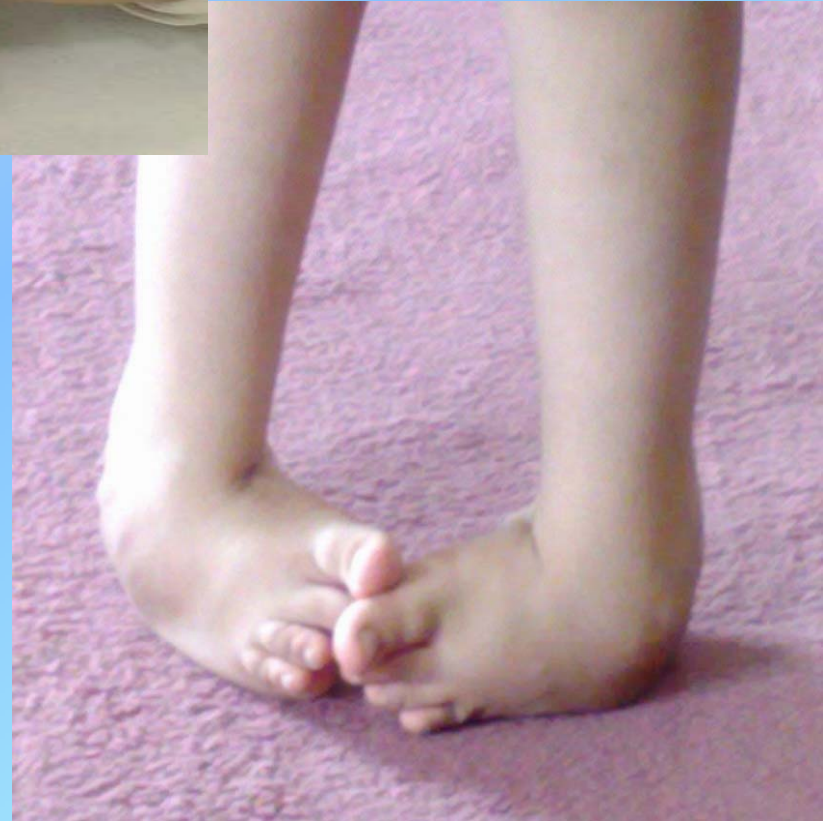
**= Any type of fracture at any site &
their complications.**

= Any type of deformity at any site.





Rigid recurrent CTEV

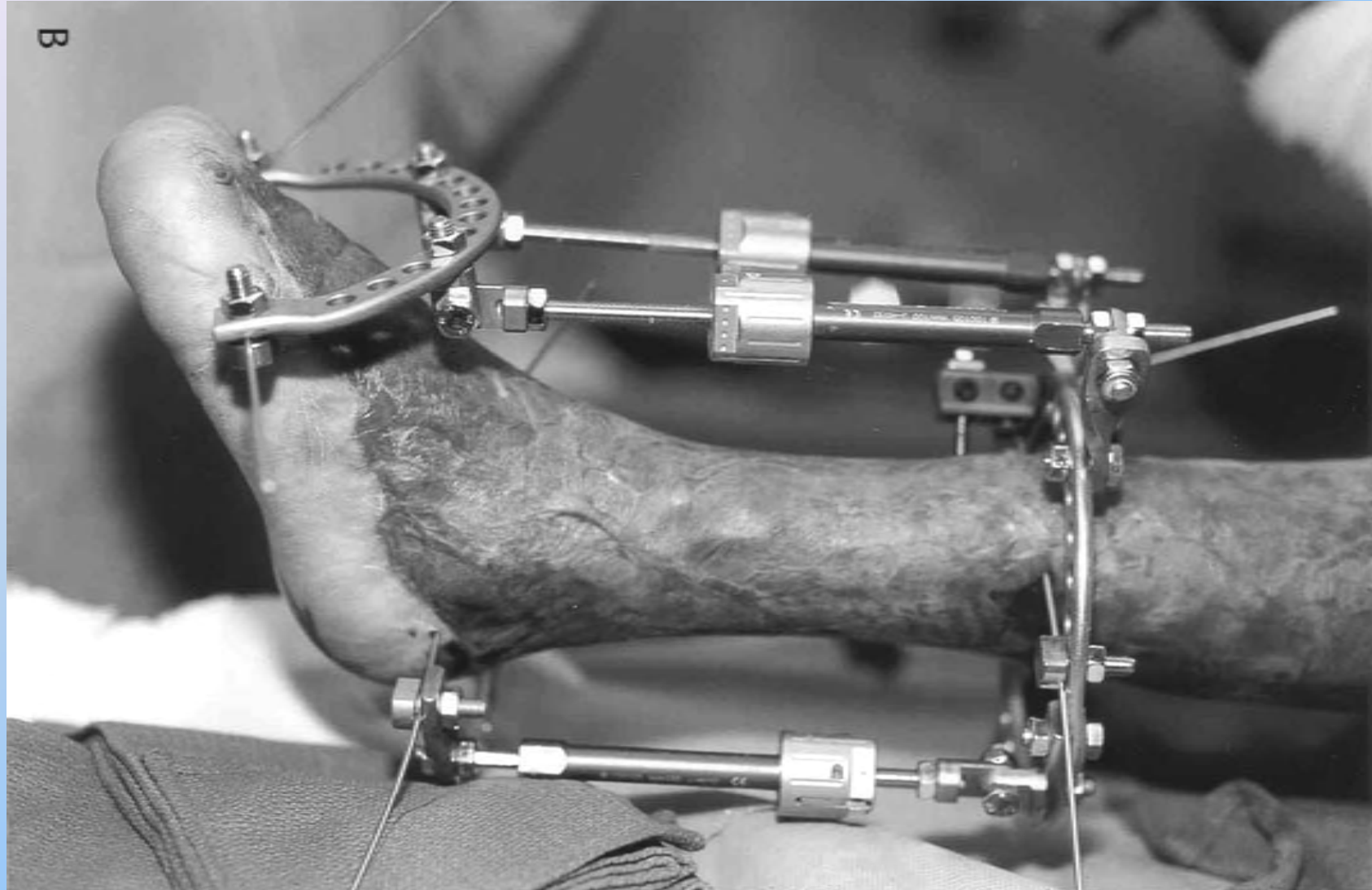




Joint contracture



Post Burn Contracture

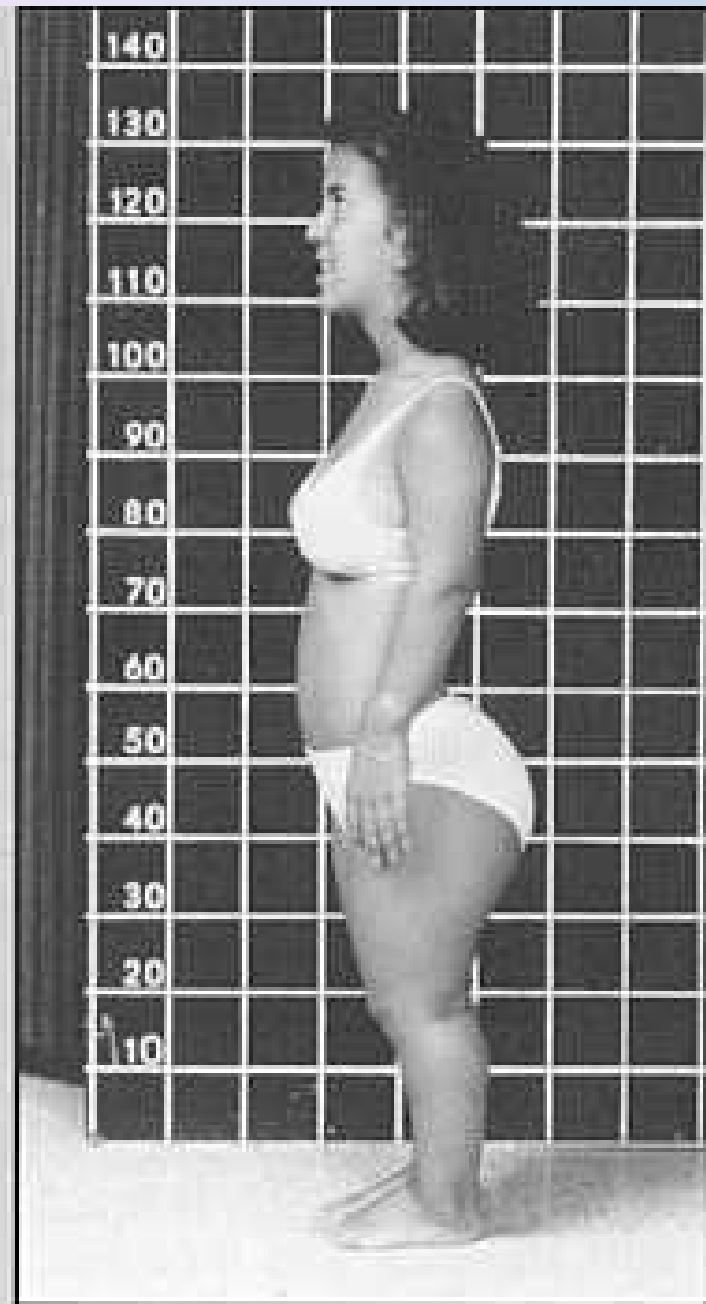




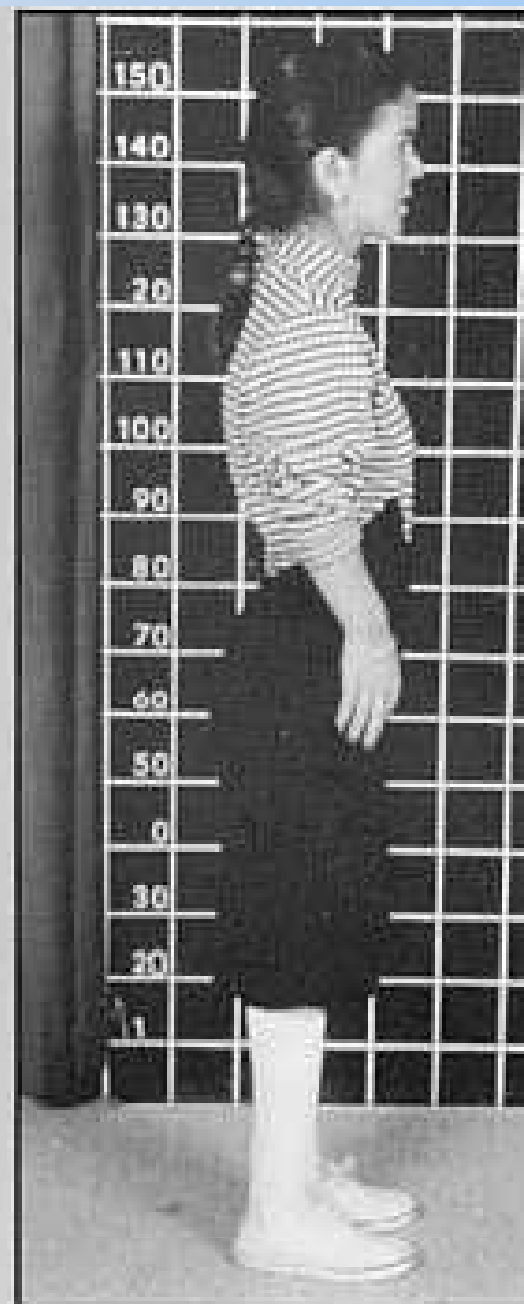
Chronic osteomyelitis



Convention 2009 - Surf School



Before

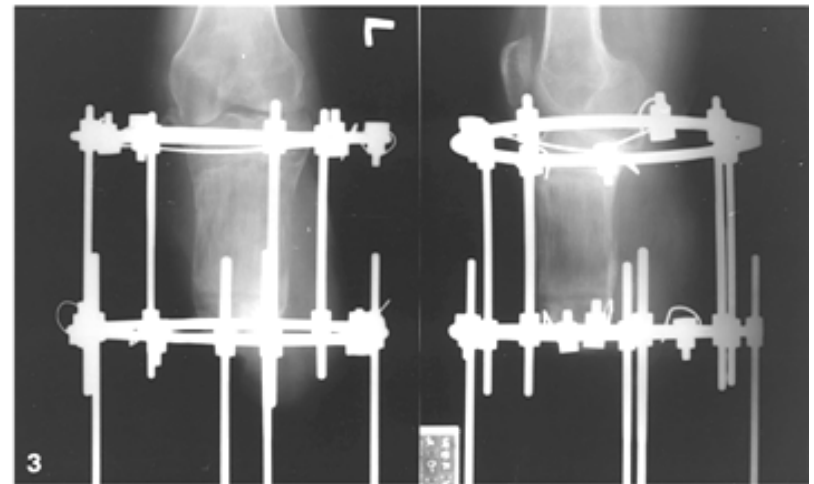
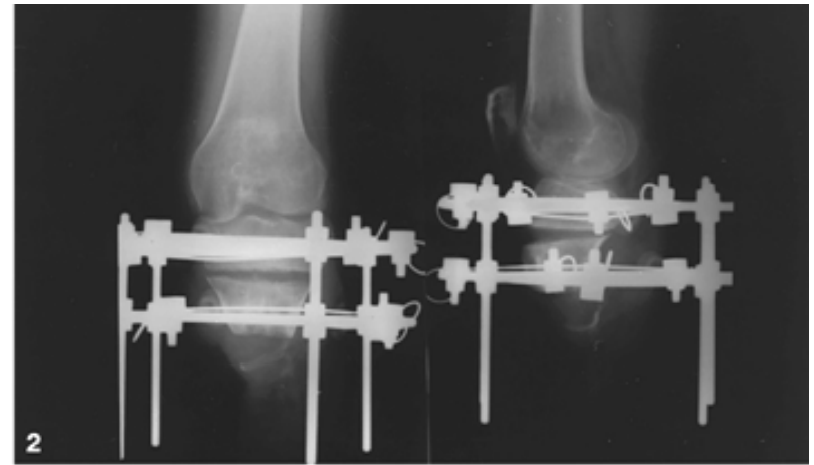
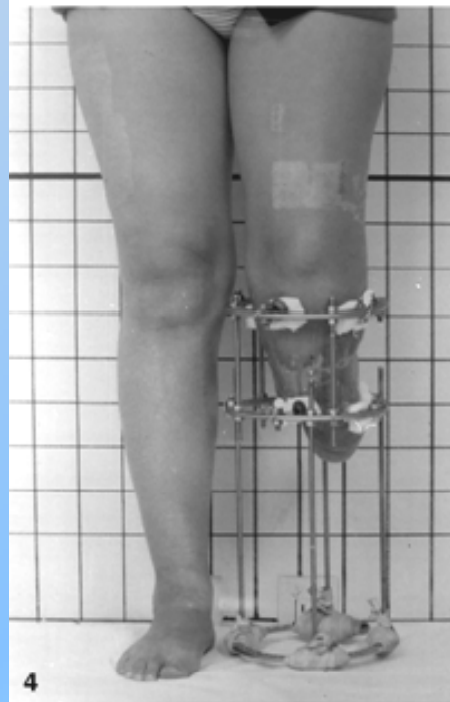


After



Limb Salvage Reconstruction

Stumps





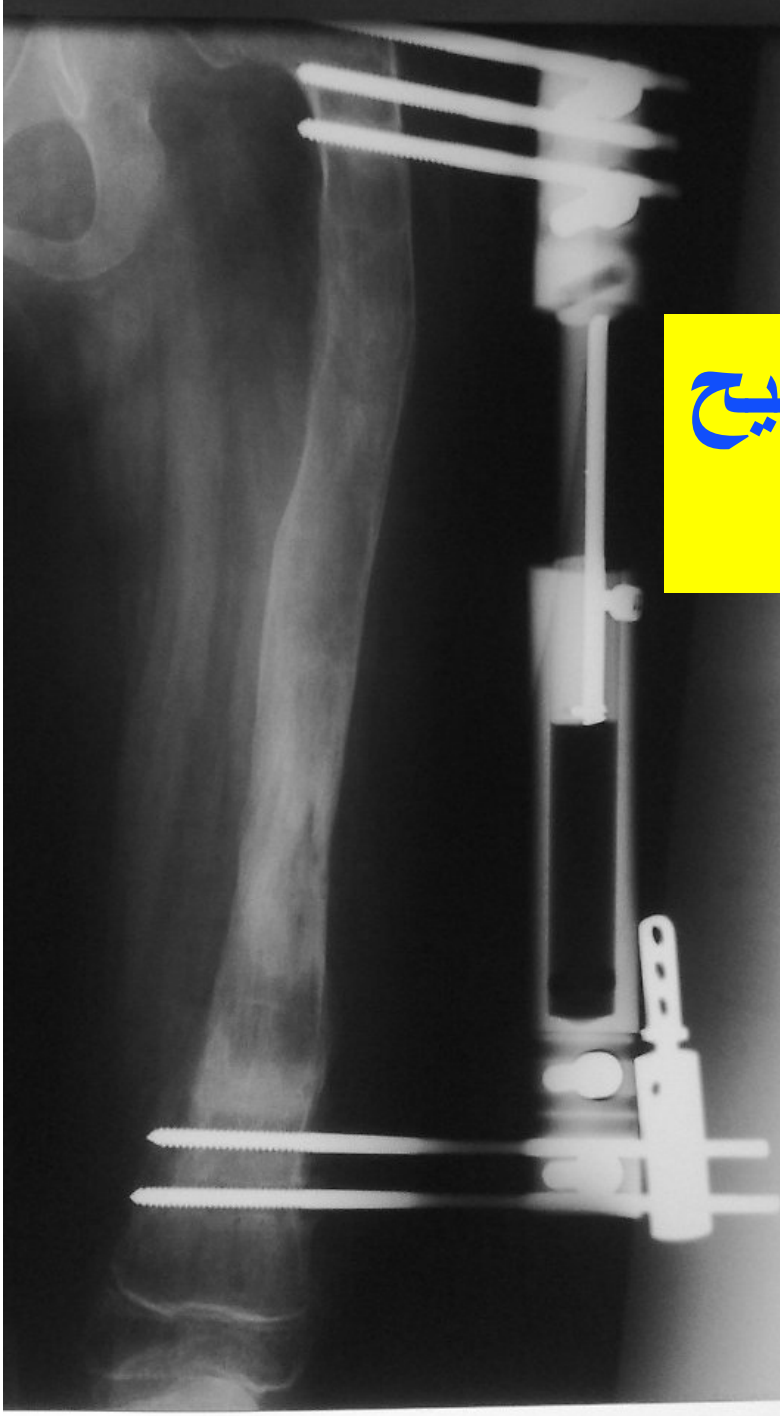
الركبه اليسرى

الركبه اليمنى

قصر ١٧ سم في عظم الفخذ

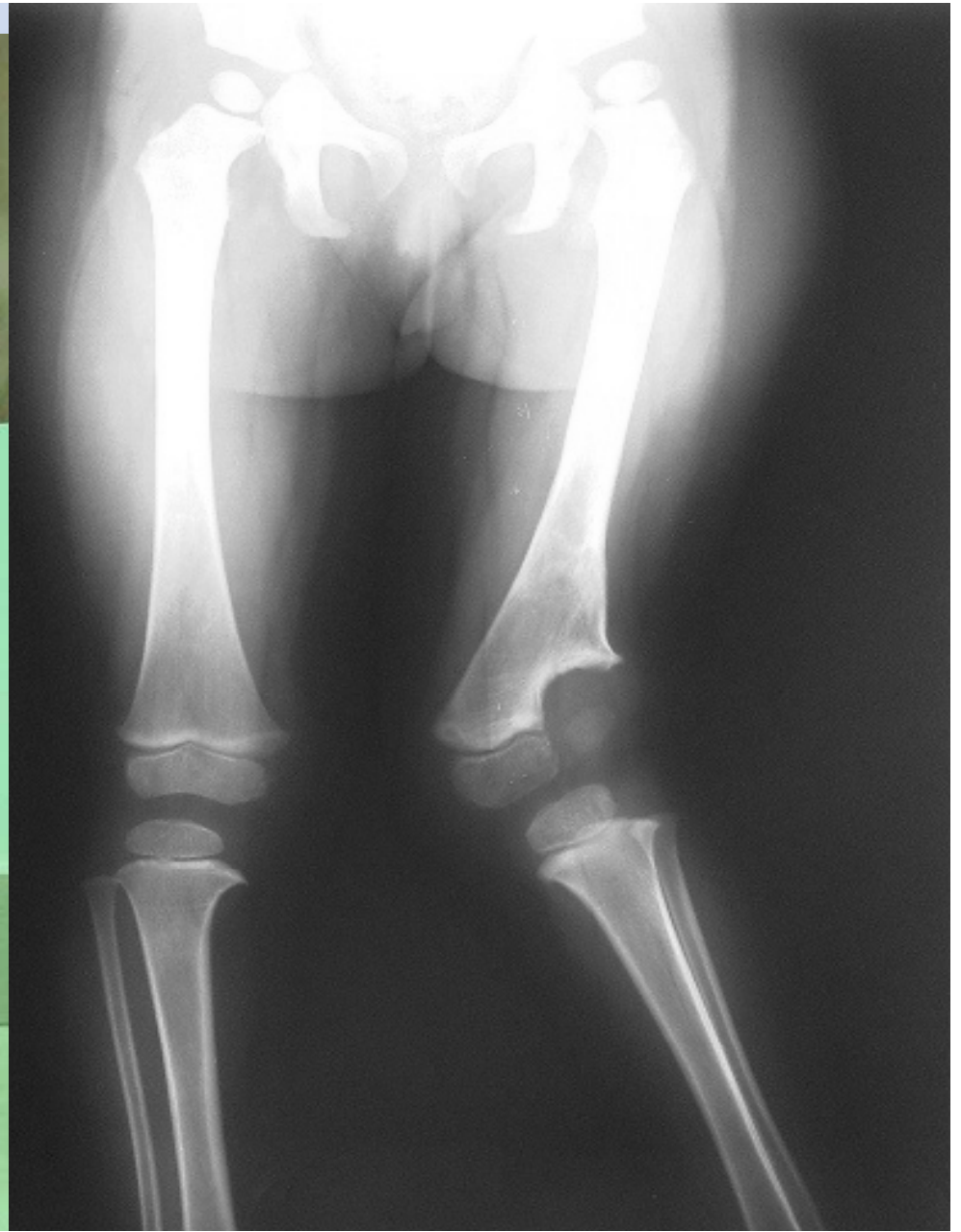


اعوجاج عظم الفخذ بشكل علامة ؟



المرحلة الثانية بعد عملية تصحيح
الاعوجاج والتطويل ٢ اسم





Deformity & shortening

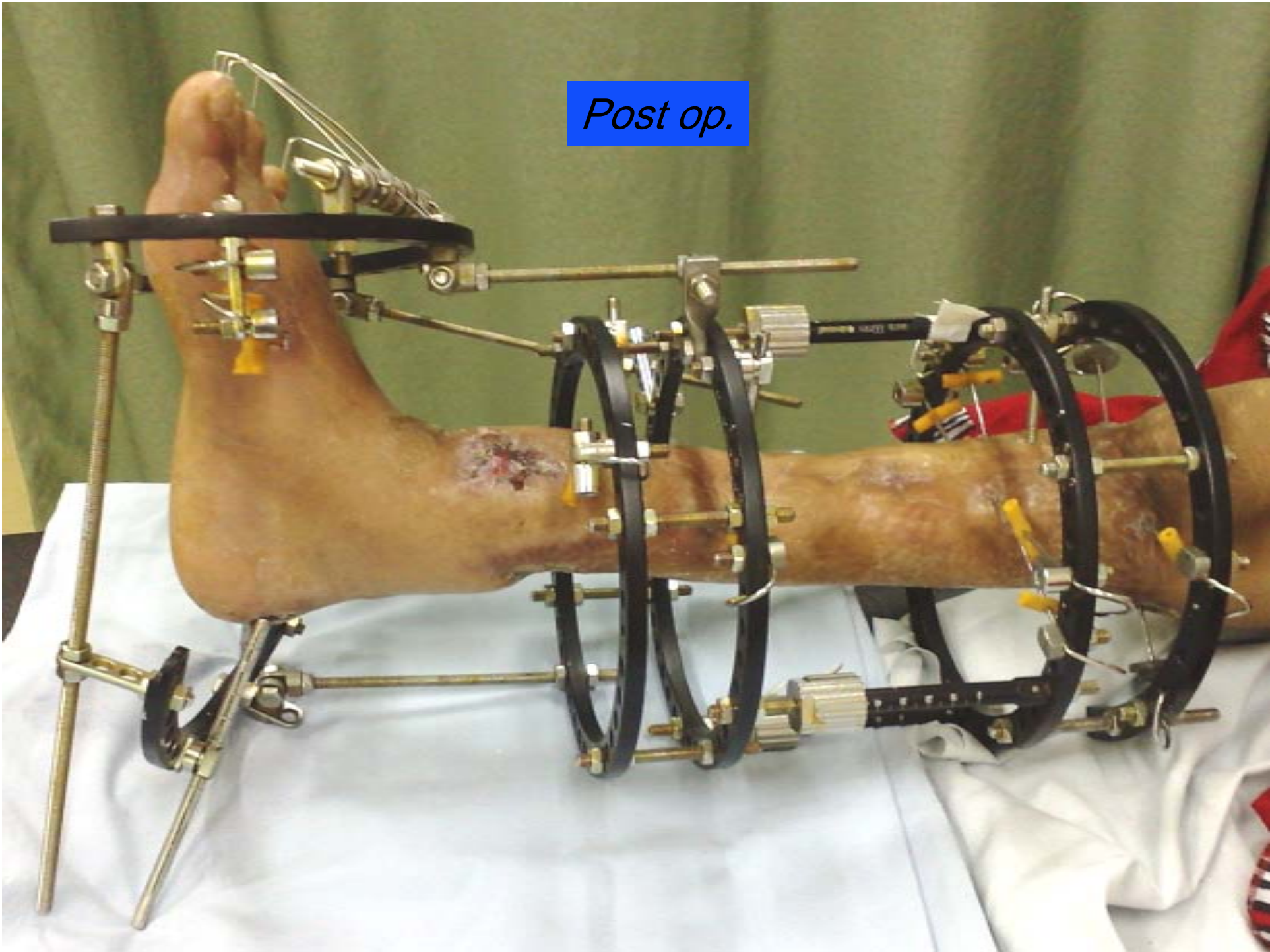




Deformity & Shortening



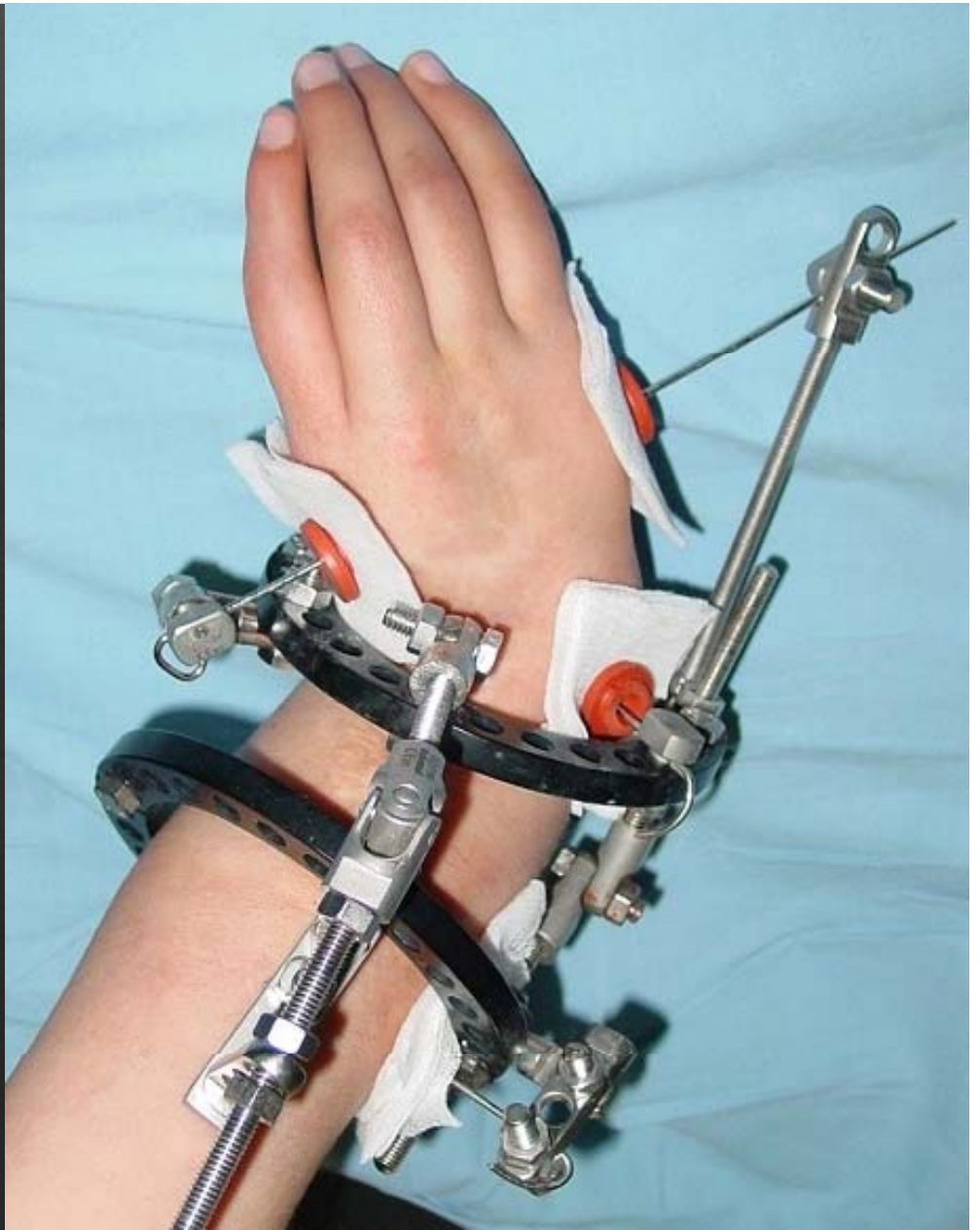
Post op.



Deformity & Shortening



Pre op.



Pre op.

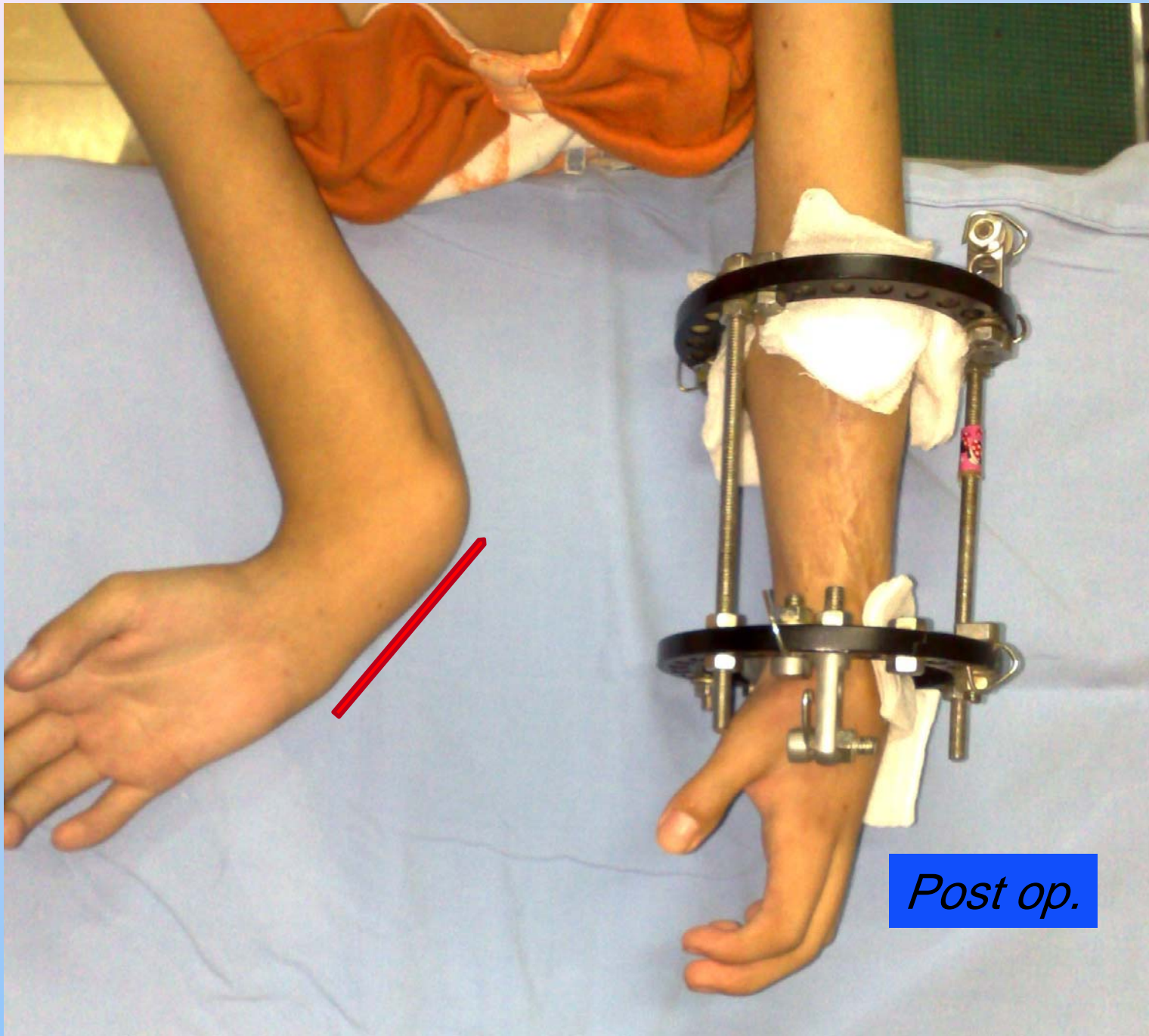


Post op.

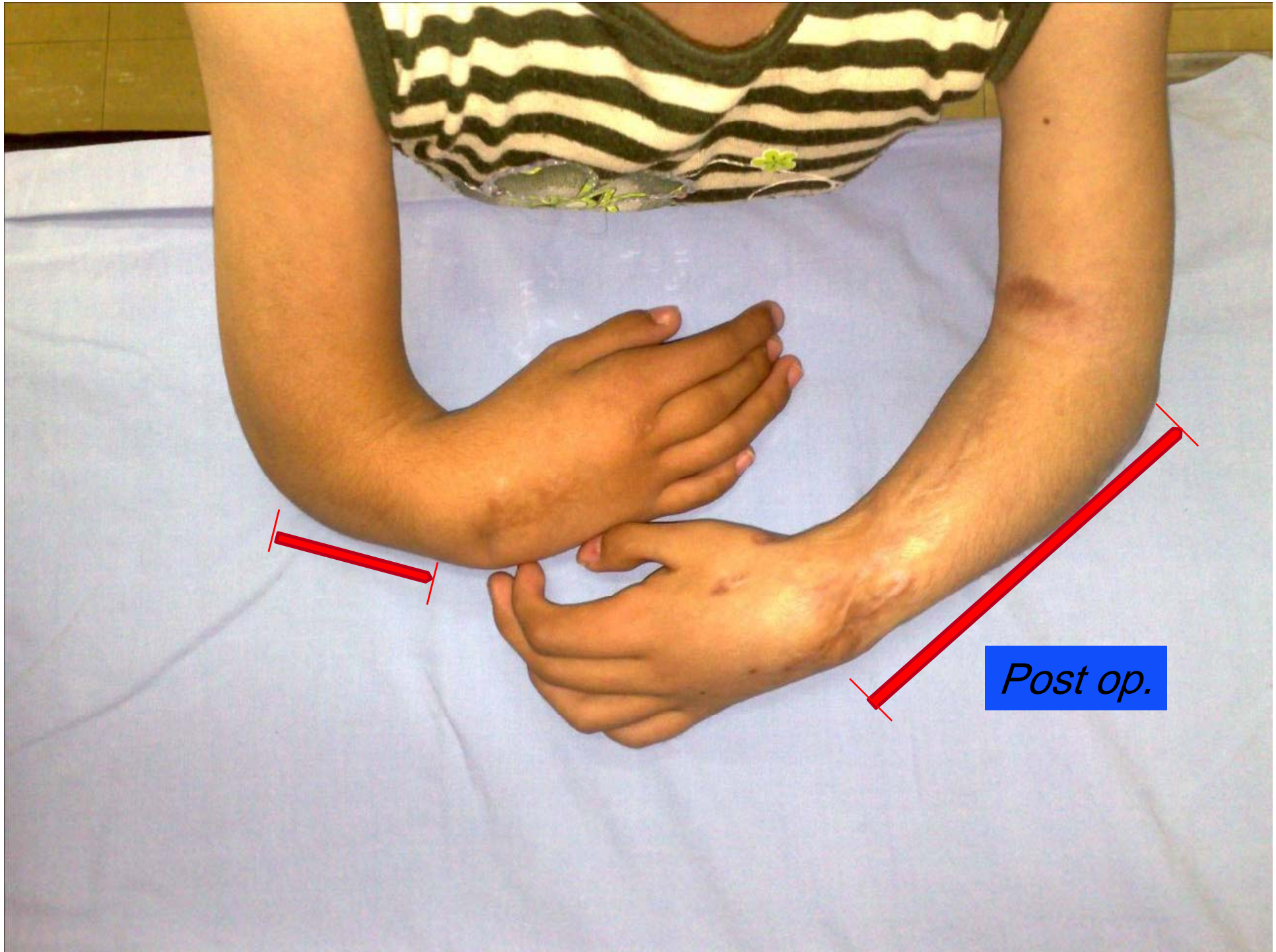




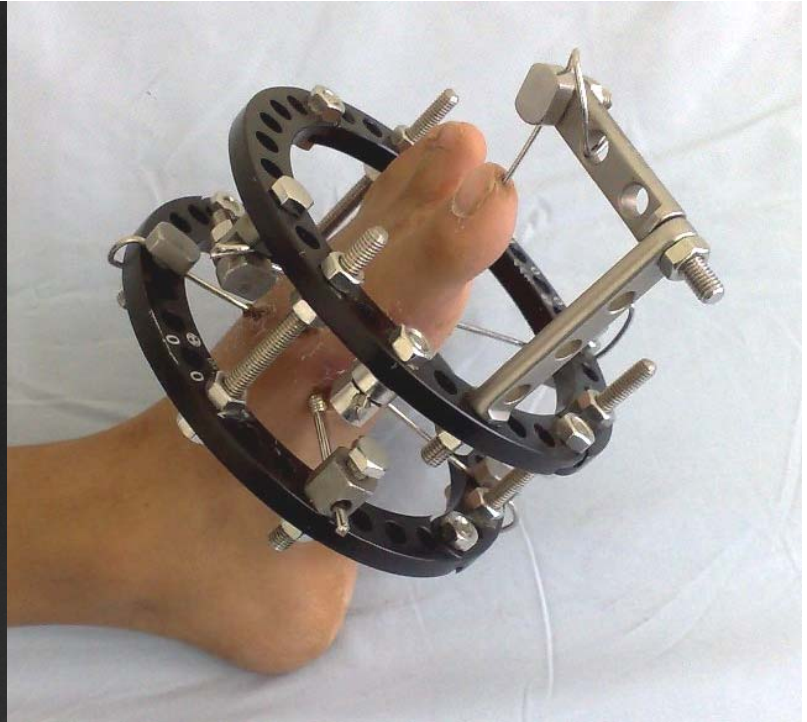
Congenital shortening



Post op.



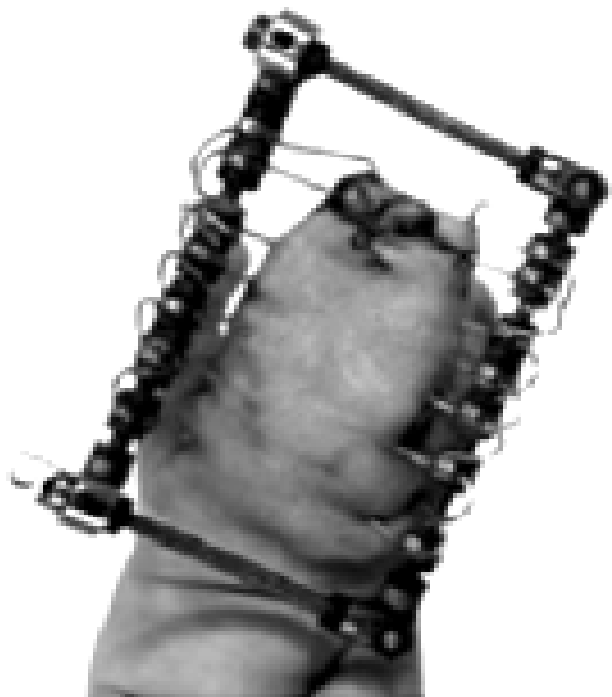
Post op.



Small bone lengthening



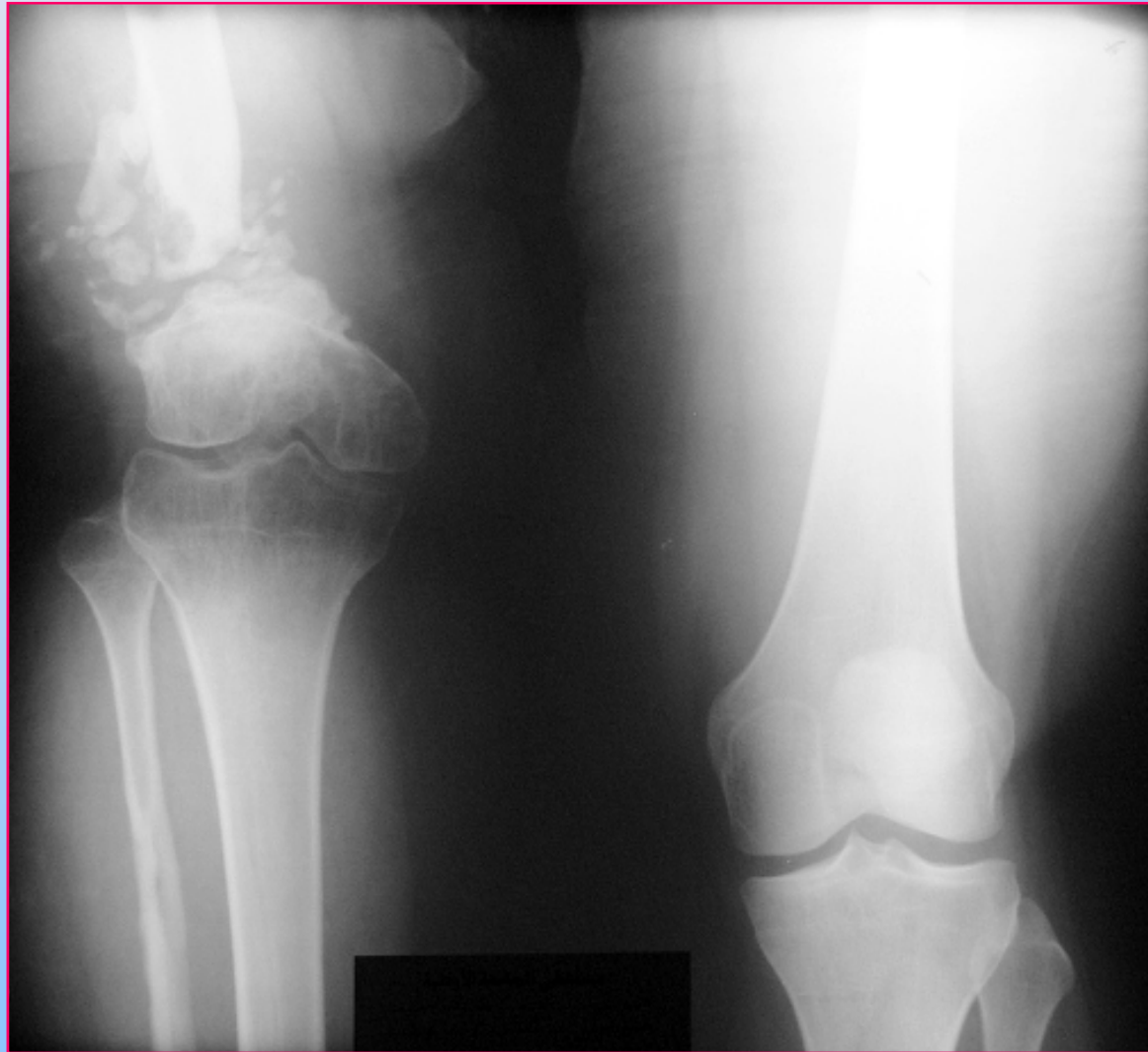
Fig. 1. — Metacarpal lengthening of the thumb in an 11-year-old girl.
A. Postoperative appearance on day one after surgery.
B. Fourteen months after osteotomy, radiography showing good bone healing.

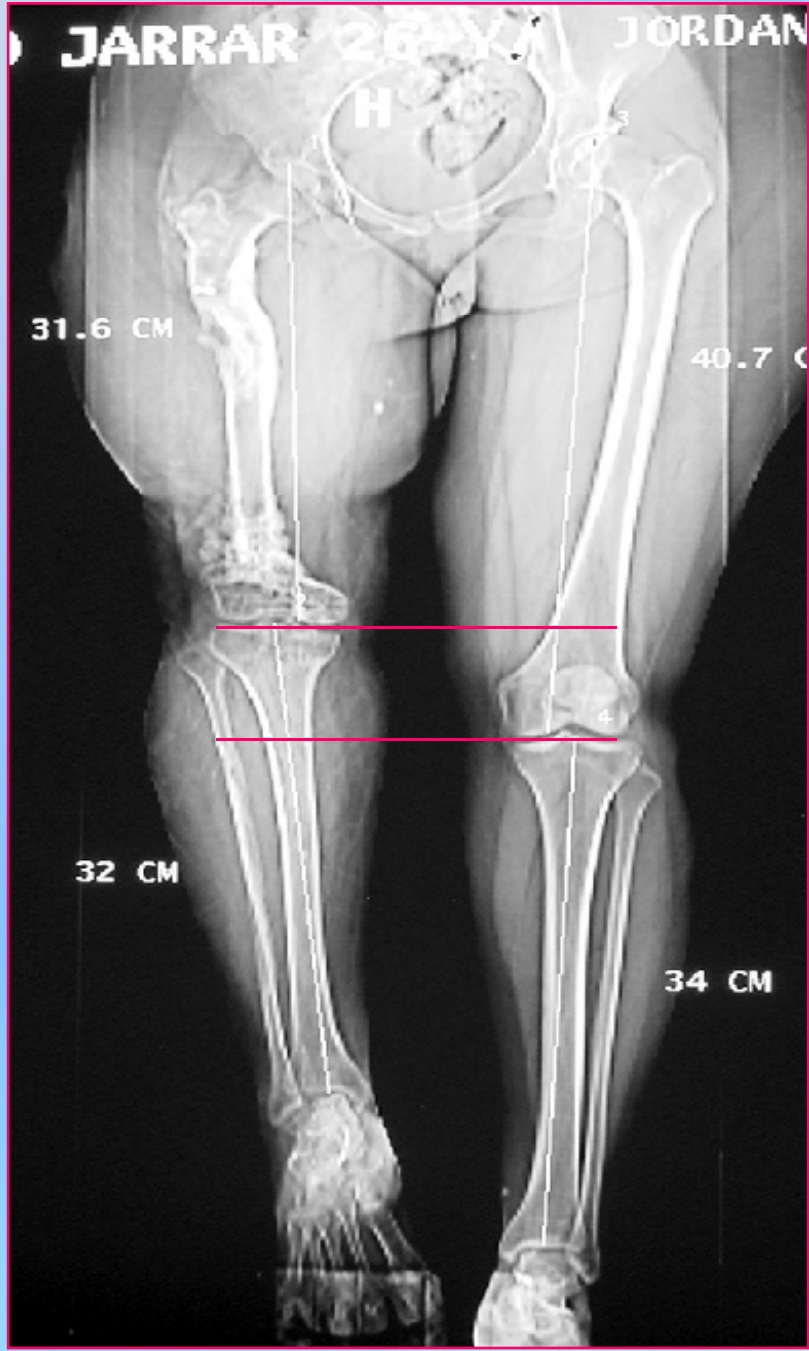
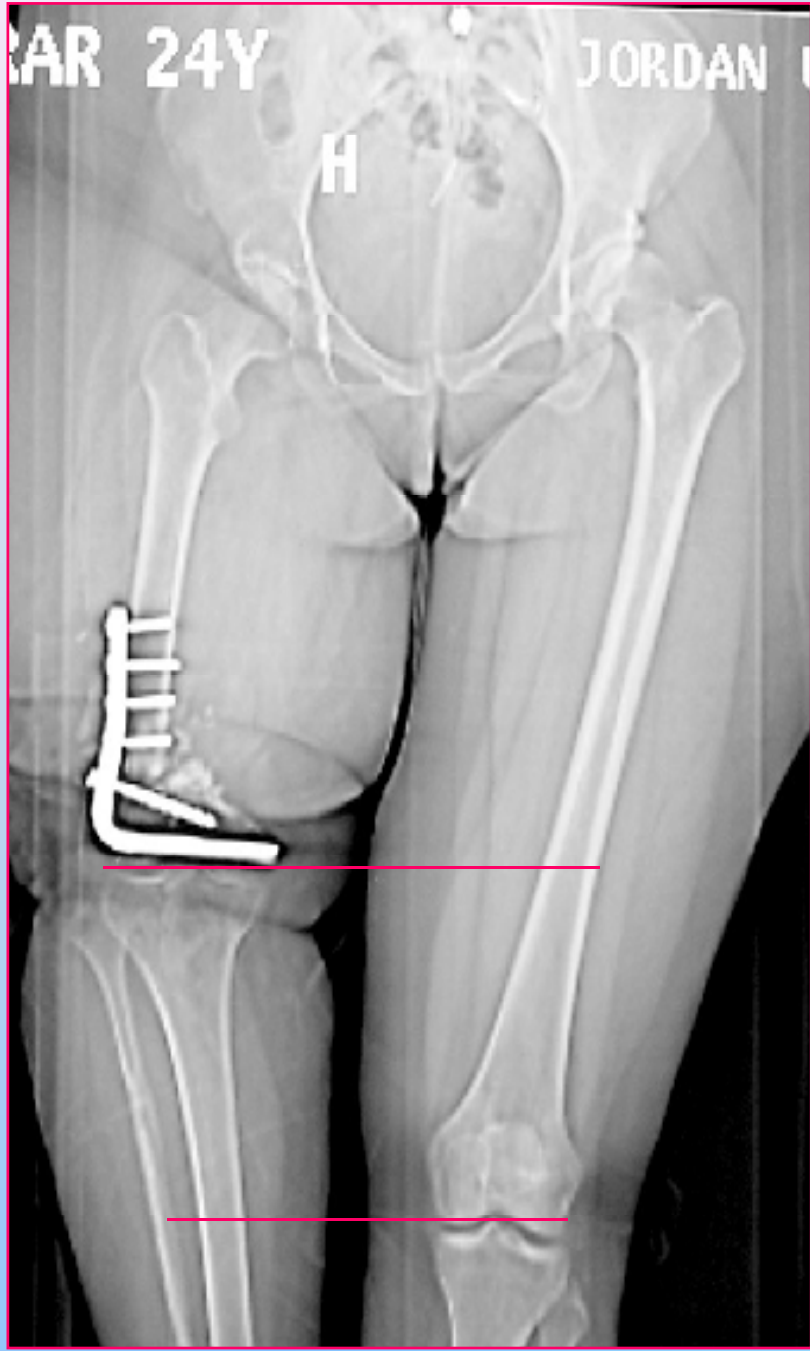


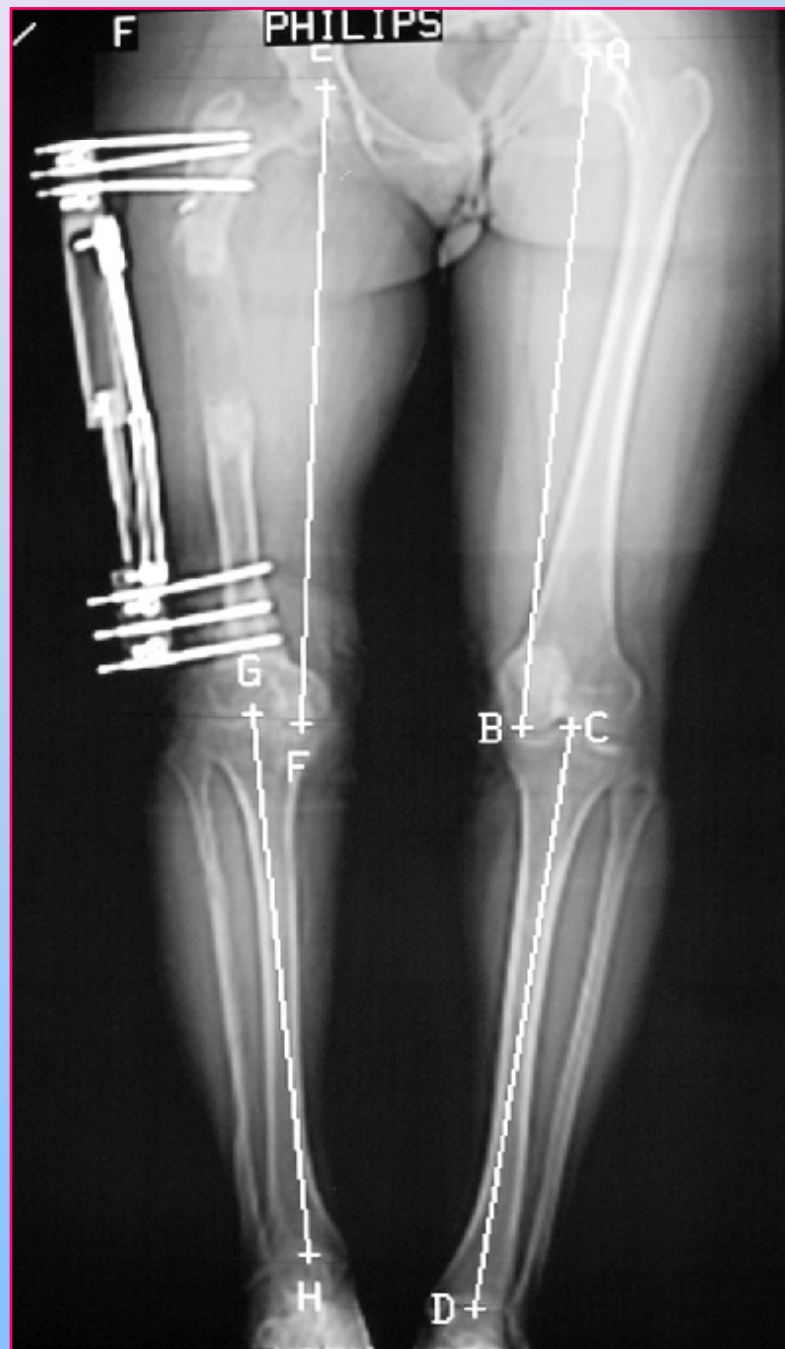


- = Peripheral vascular disease**
- = Decreased Cerebral perfusion**
- = Cosmetic lengthening**
- = Diabetic foot**

Sad but not bad story







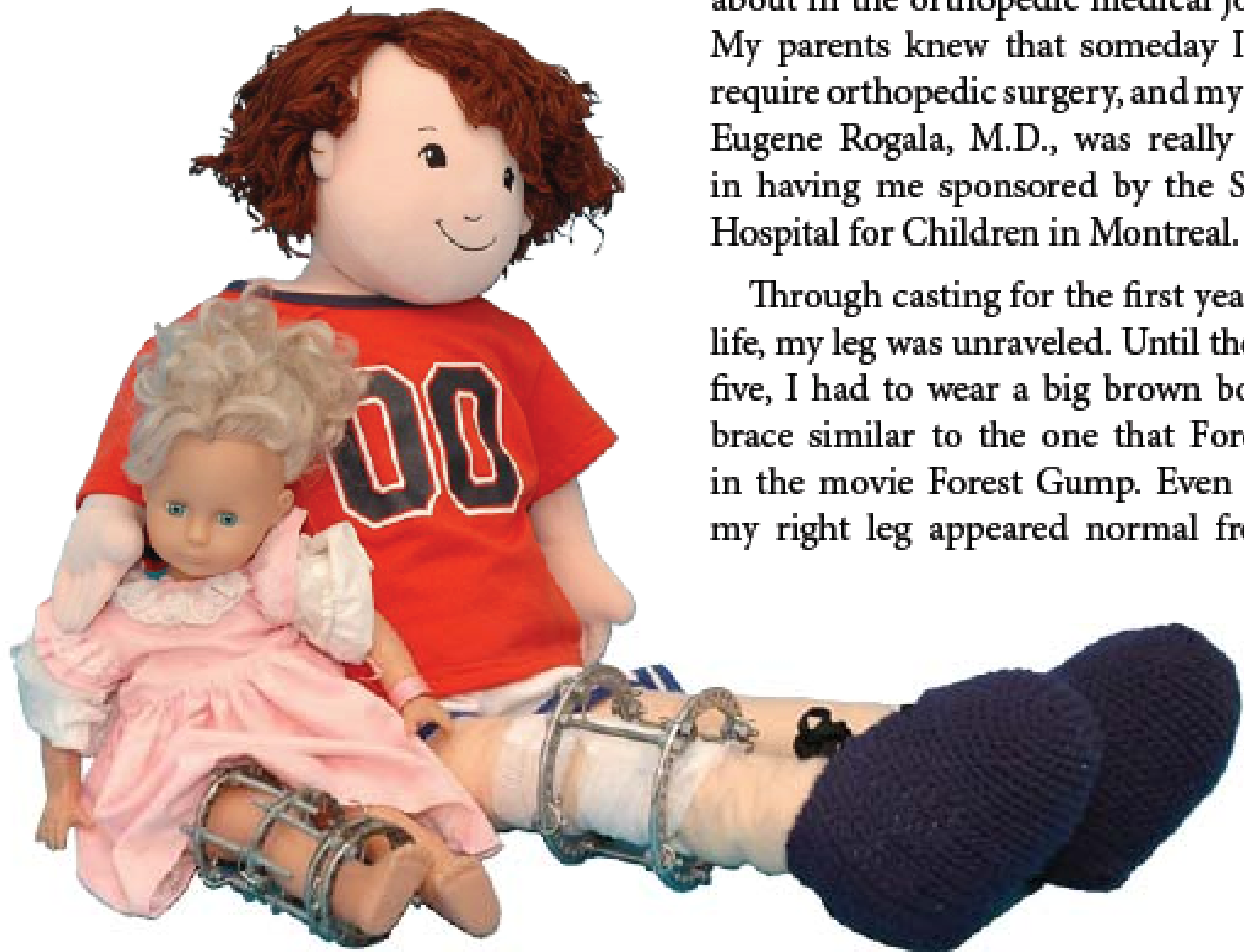








Can we lengthen fruits & vegetables?



about in the orthopedic medical journal. My parents knew that someday I would require orthopedic surgery, and my doctor, Eugene Rogala, M.D., was really helpful in having me sponsored by the Shri Hospital for Children in Montreal.

Through casting for the first year of life, my leg was unraveled. Until the age of five, I had to wear a big brown boot brace similar to the one that Forrest wore in the movie *Forrest Gump*. Even though my right leg appeared normal from