

Ilizarov apparatus, Ilizarov method and modern external fixation

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<http://rniito.org>

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Objctives

- ExFix definition
- Short historical background, classification
- Ilizarov's Frame, Method, Discovery, and distraction osteogenesis
- Advantages and Disadvantages
- Indications and contraindications

External Fixation (ExFix)

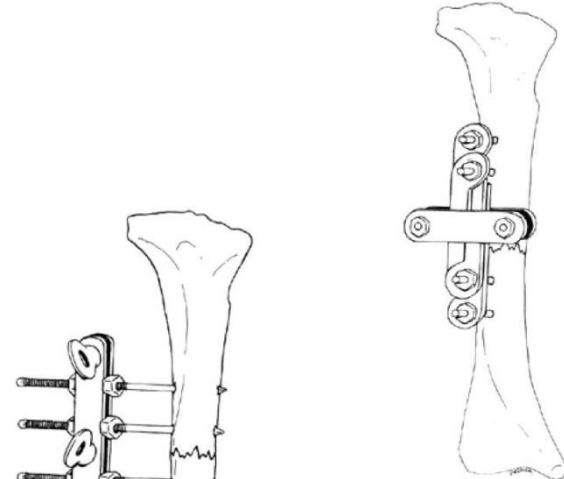
is a method for stabilization or manipulation of bone, joint, and soft tissue using osseous elements that traverse the soft tissue envelope and are linked by external connecting elements



External Fixation = Transosseous Osteosynthesis

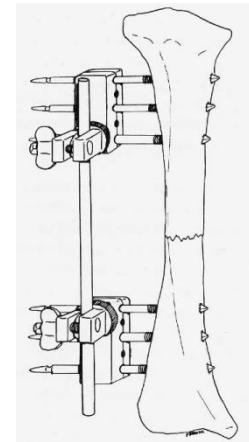


Malgaigne (1843)

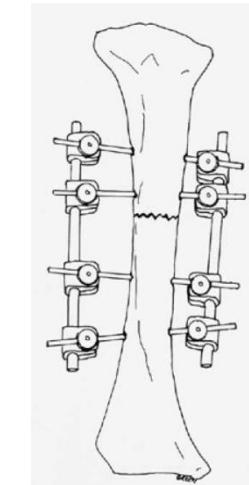


Parkhill (1897)

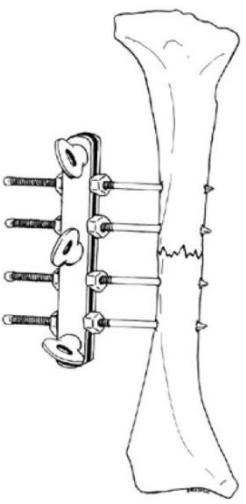
Lambotte (1902)



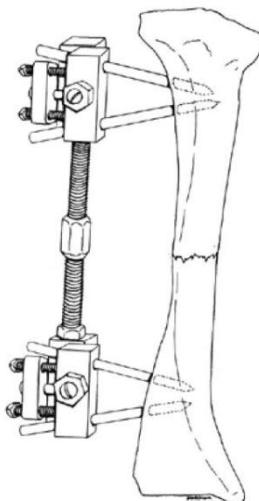
Bittner (1931)



Stader (1937)

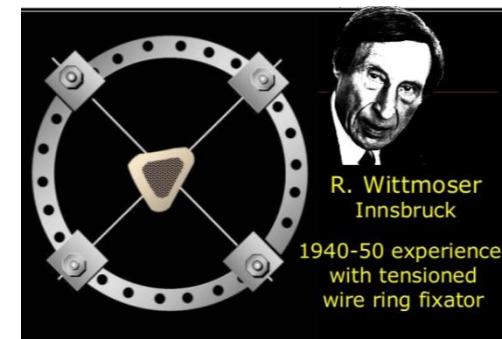
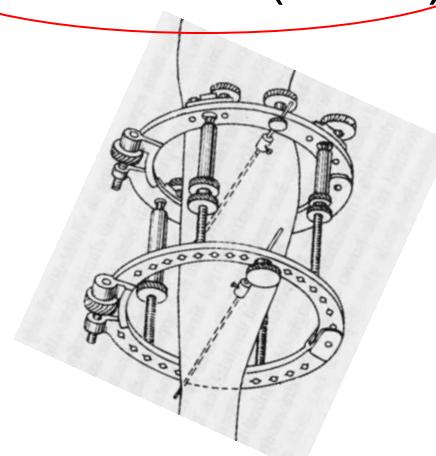


Anderson (1938)



Hoffmann (1938)

Wittmoser (1940)



R. Wittmoser
Innsbruck

1940-50 experience
with tensioned
wire ring fixator

Ilizarov innovations

1951: Frame



1954: the patent «the Method of healing of bone fractures and the device for realization of this method»

- minimal invasiveness
- bone marrow preservation
- stable fixation of bone fragments
- early restoration of limb function

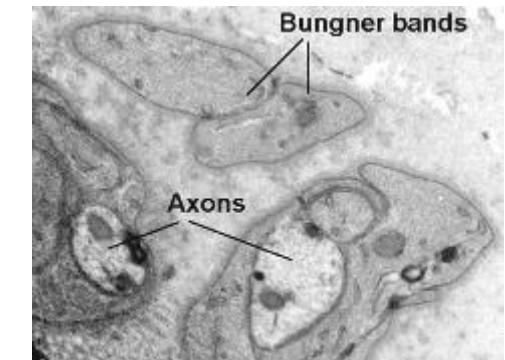
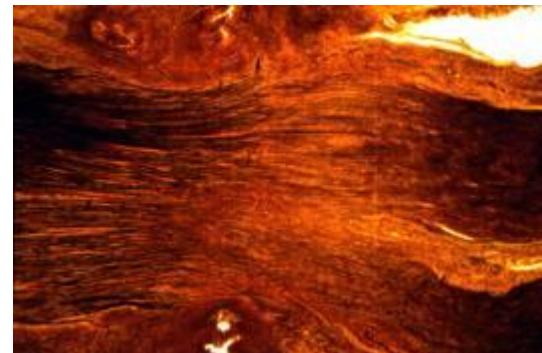
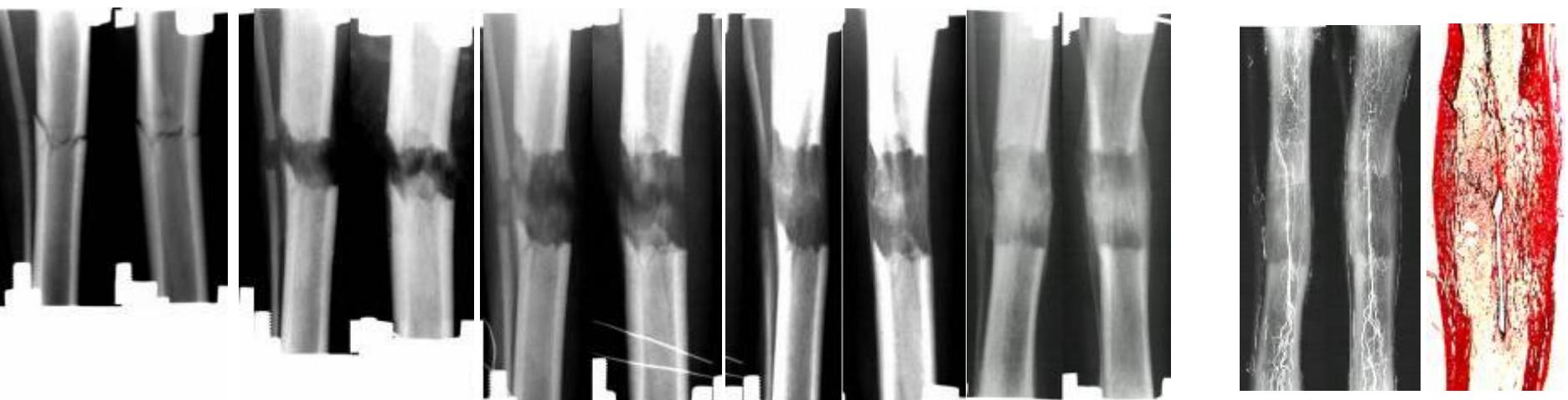
Forerunner of
AO Principles



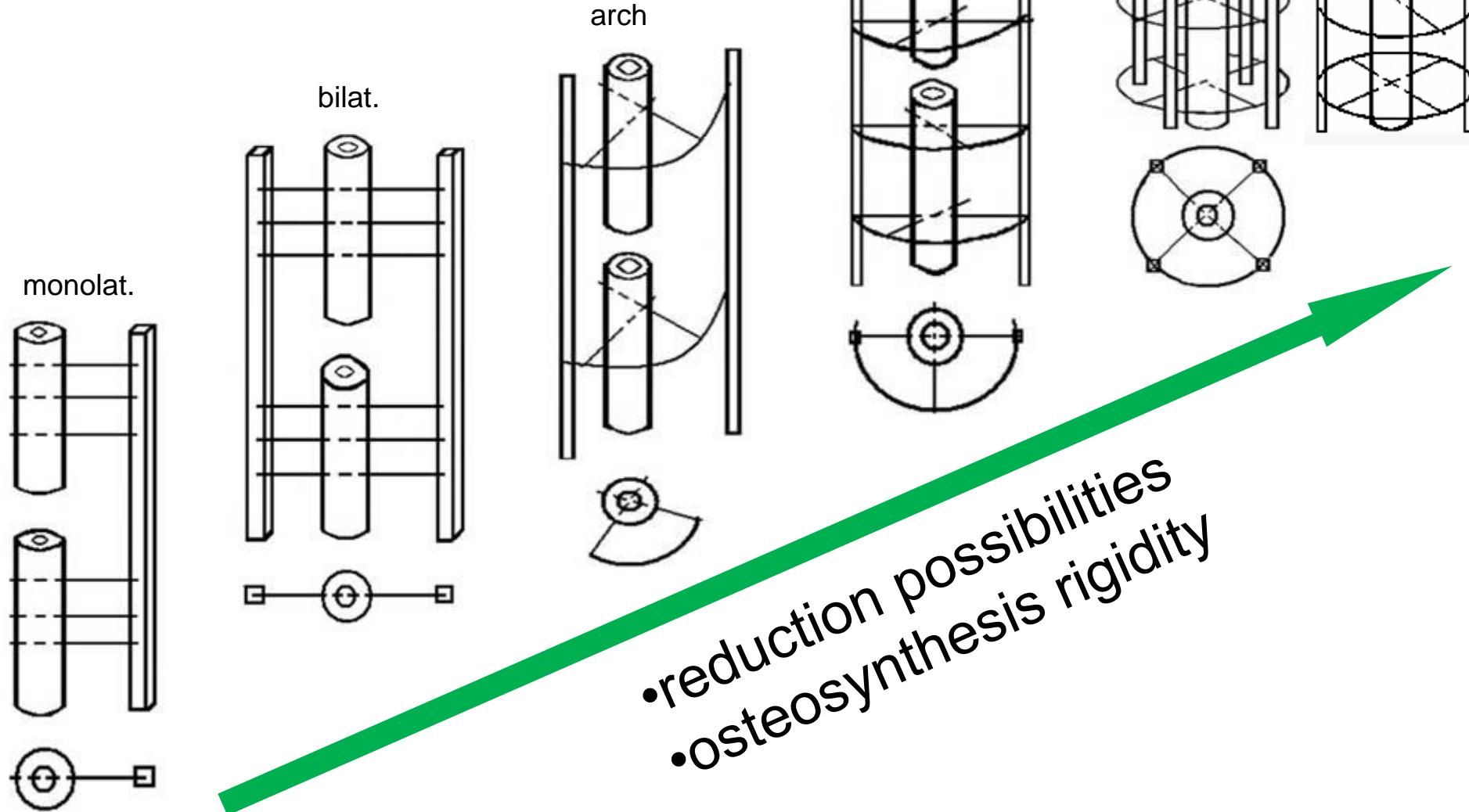
1988: the discovery “General biological property of tissues to answer the dosed distraction by growth and regeneration (Ilizarov Effect)”

Ilizarov discovery (USSR, #315)

“Tension-stress during gradual living tissue extension activates and maintains as a natural result active regeneration and growth of tissue structures during the entire process of this factor validity”



Principal types of external fixation devices



Benefits of external fixation

- The best biological decision: mini-invasive surgical technique, extra-focal fixation
- Advanced biomechanics: closed 3D reduction and full spectrum of stability
- Wide spectrum of effective indications
- Cost-effectiveness
- Easy for beginners (DCO) and indispensable for specialists (LLRS)
- The unique opportunity to study issues of bone and soft tissue regeneration in both the clinical and basic science settings

Disadvantages of external fixation

- Pin-tract infection and pin-induced joint stiffness
- Uncomfortable for both surgeon, patient and can take a lot of time
- The relative complexity of using external fixation devices, especially those of types IV–VI



Variety of indications



1. Fractures of all bones of the skeleton, including the pelvis, humerus, forearm, clavicle, femur, tibia, and foot/ankle:
 - Frames may be applied at any level: diaphyseal, epi-/metaphyseal, intraarticular.
 - Simple, comminuted, segmental fractures.
 - Open or closed fractures.
 - Fractures with the potential for soft-tissue contamination and infection.
2. Malunions/nonunions:
 - Delayed union and nonunion.
 - Malunions, traumatic deformities, soft-tissue or bony defects.
 - Infected malunions/nonunions.
3. Orthopaedic pathology:
 - Congenital deformities, bony defects, segmental bone resections for pathological conditions.
 - Infected orthopaedic pathology.
4. Joint pathology:
 - Malformations.
 - Contractures.
 - Dislocations.
5. Dysplasia or degenerative disease.

External Fixation treatment

Temporary

*Consecutive ExFix
and IntFix:*

- DCO
- EFAN & EFAP



Integrated

*Combined
ExFix
and IntFix:
- LON & LOP*



Definitive



External Fixation treatment

Temporary

Consecutive ExFix
and IntFix:

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Integrated

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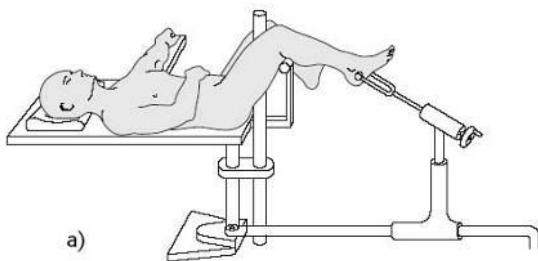
Definitive



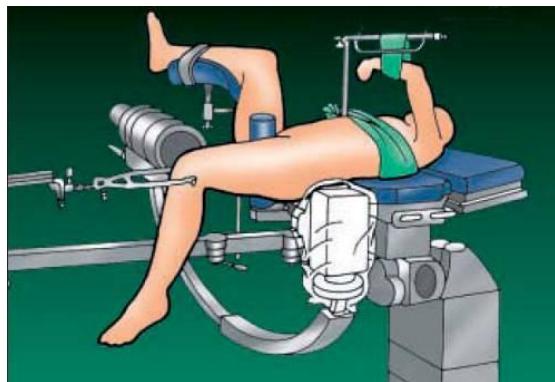
Temporary ExFix: acute trauma

Fracture reduction

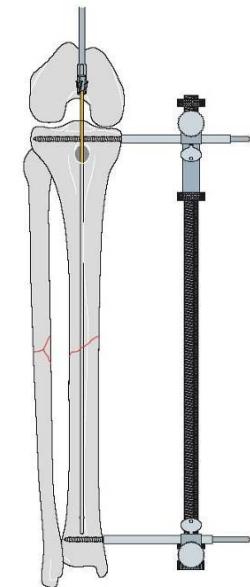
conventional technique



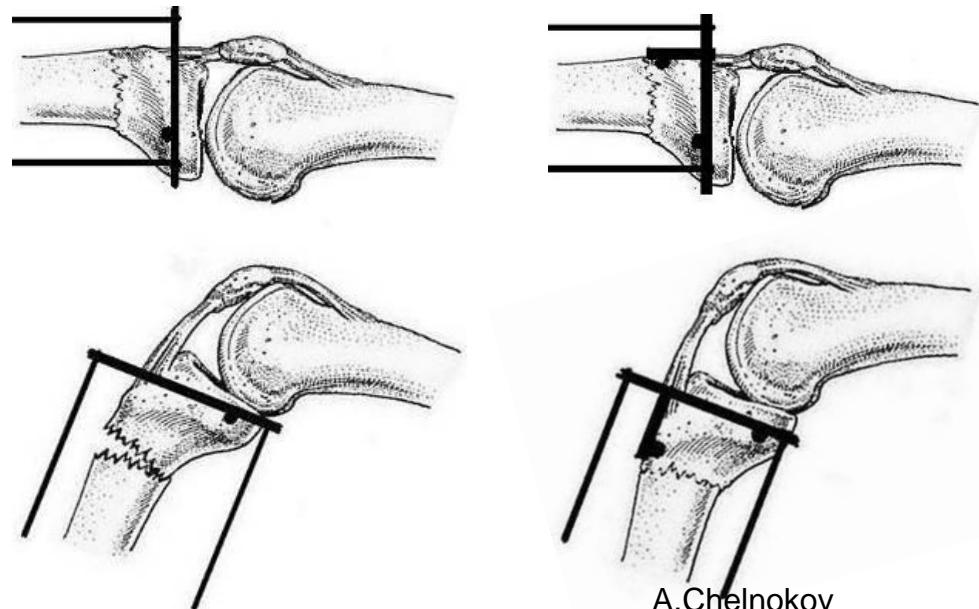
a)



distractors

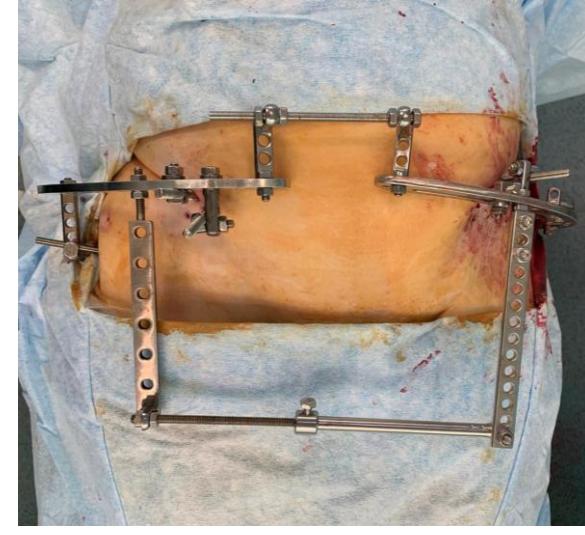
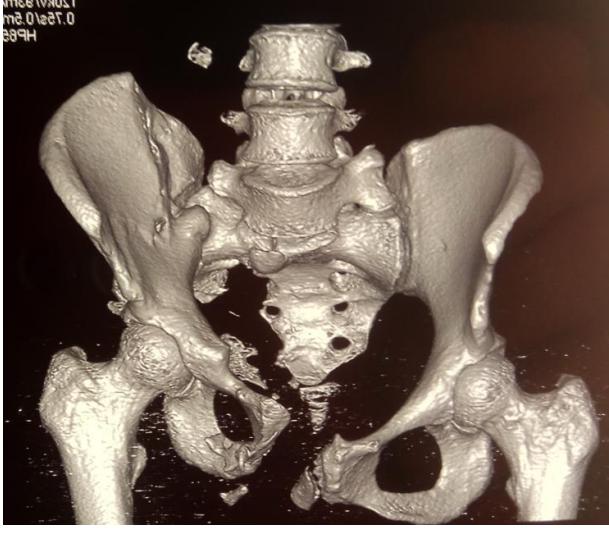


Temporary ExFix: EFAN

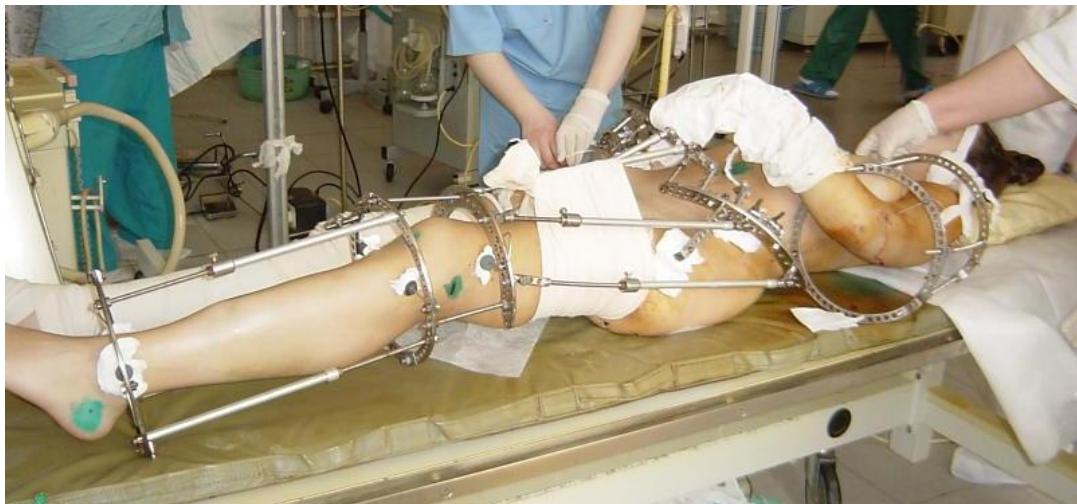


A.Chelnokov

Temporary ExFix: EFAP



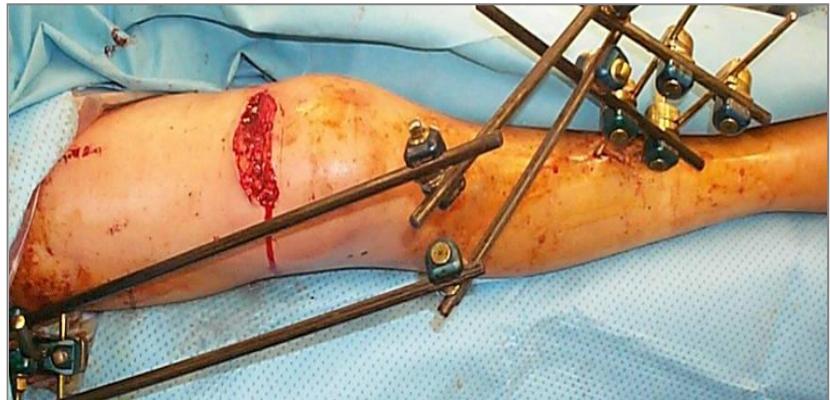
Temporary ExFix: DCO



Temporary ExFix: “Soft Tissue DCO”

Soft tissue optimization staged protocol:

1st stage: Temporary fixation (24 hours)
Spanning

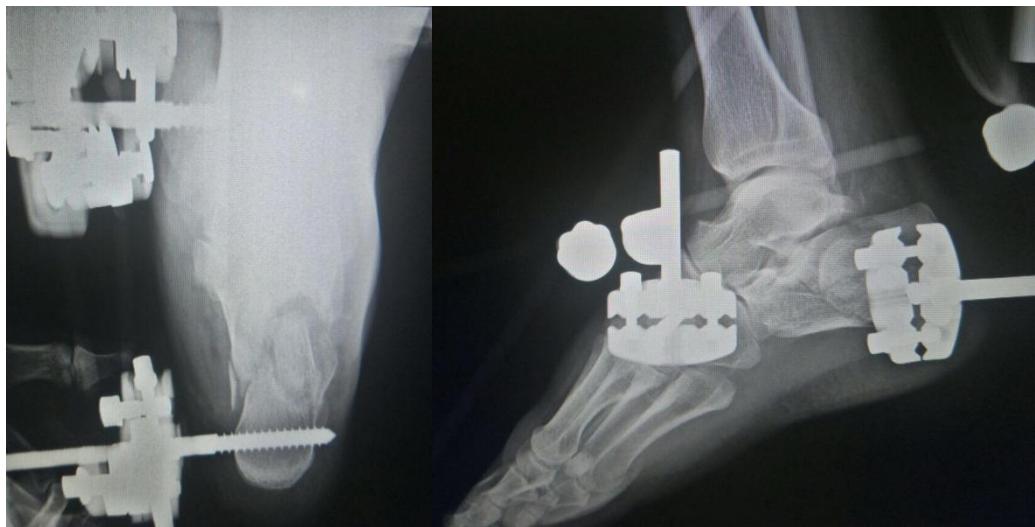
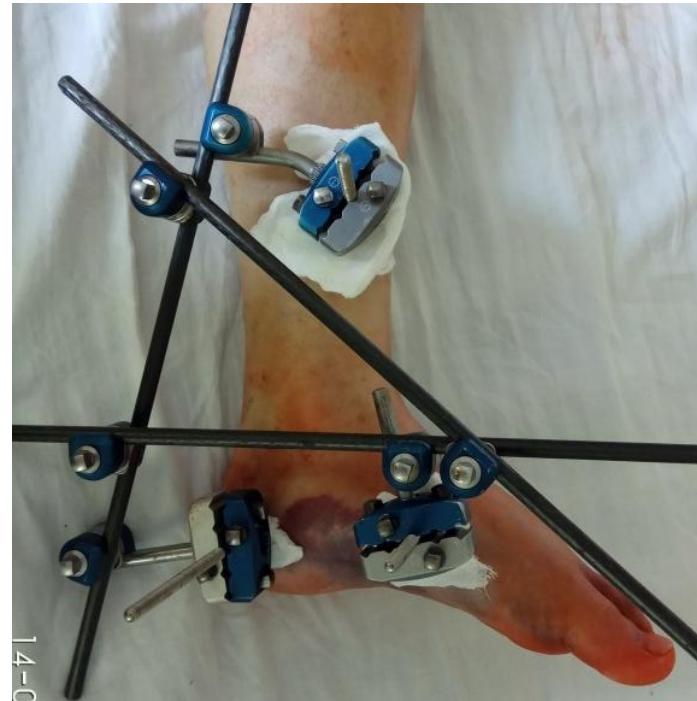


2nd stage: Interim (7-14 days)
•resolution of edema
•“wrinkle” sign
•epithelialized fracture blisters

3rd stage: Definitive *Internal Fixation*.



Temporary ExFix: “Soft Tissue DCO”

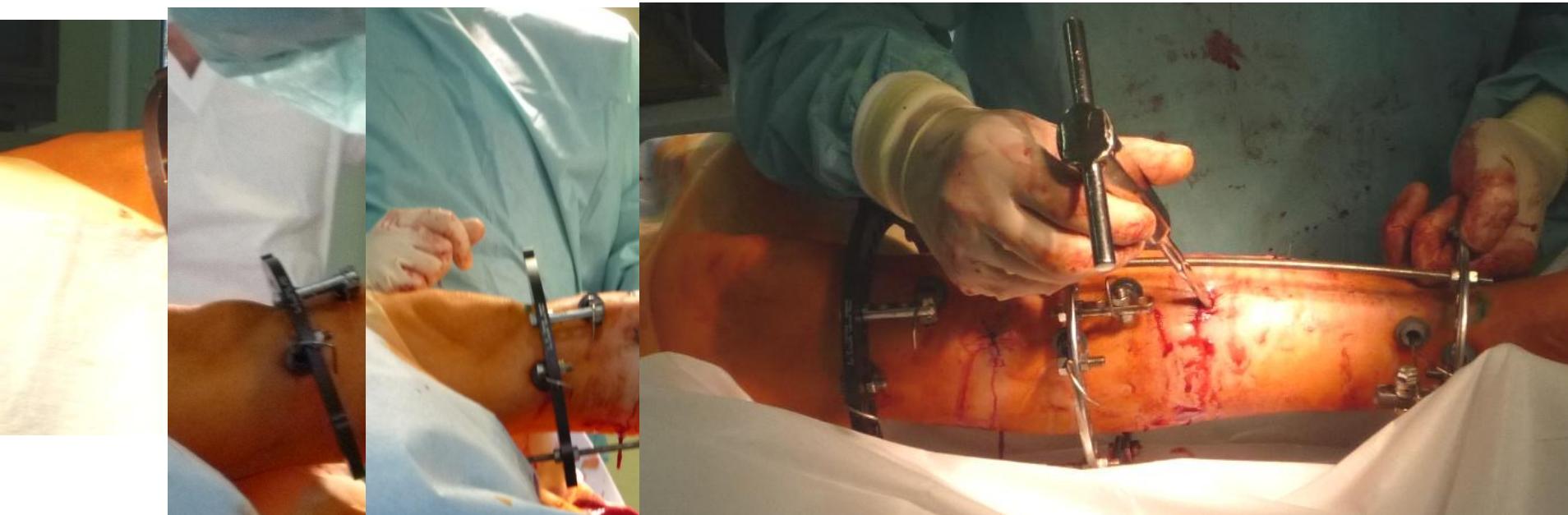


Temporary ExFix: “Soft Tissue DCO”

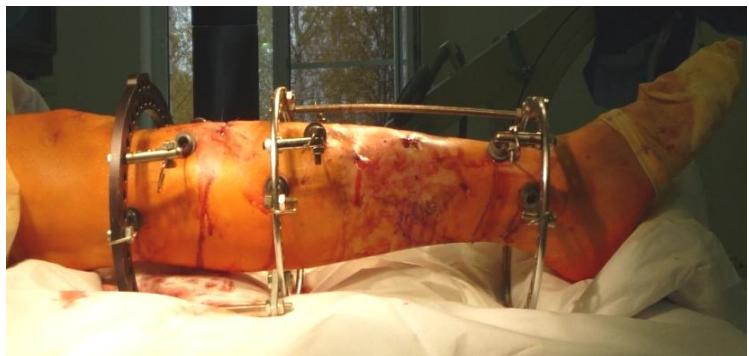


Temporary ExFix: orthopedic surgery

External Fixation Assisted Nailing (EFAN)



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External Fixation Assisted Nailing (EFAN)



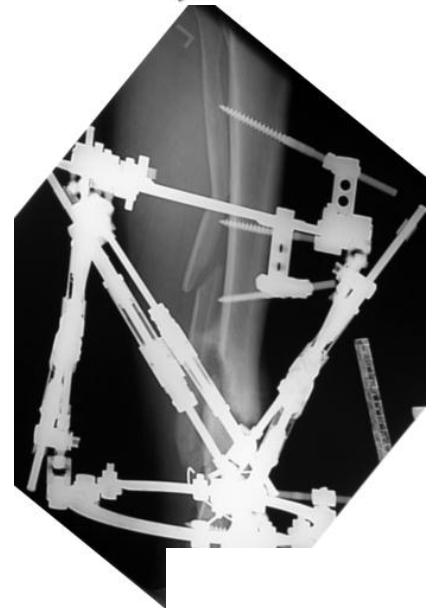
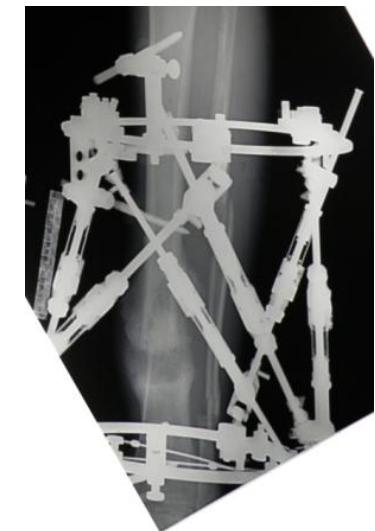
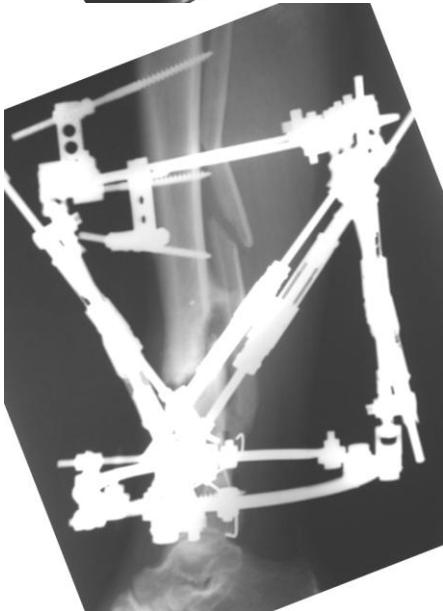
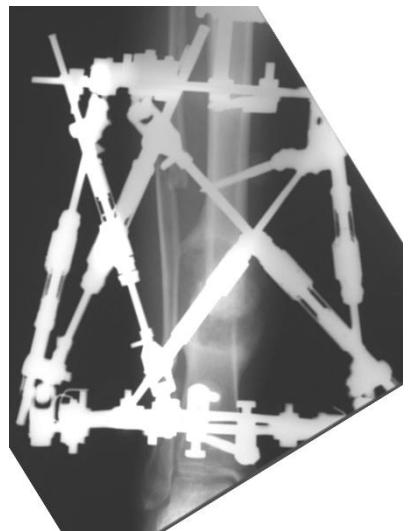
Sequential External Fixation and Nailing (SEFAN)



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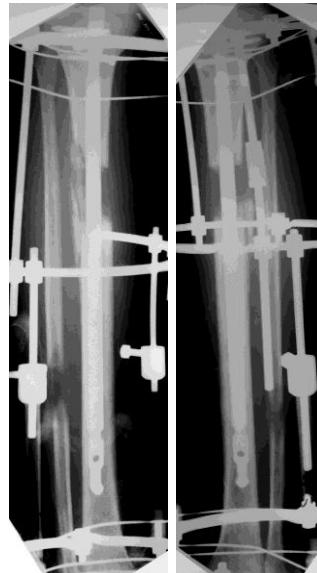
Sequential External Fixation and Nailing (SEFAN)



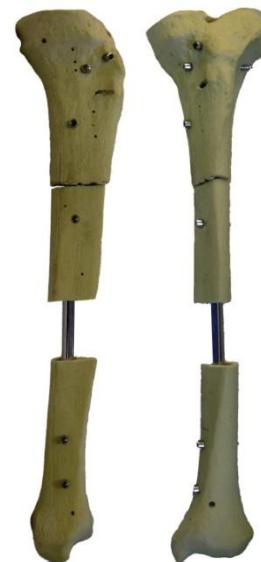
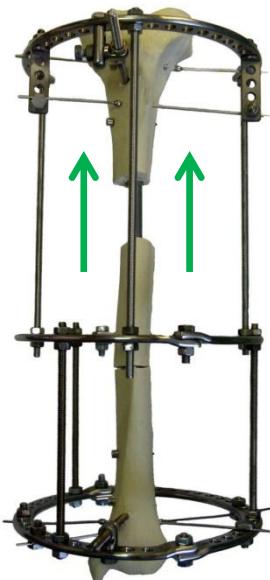
Lower leg lengthening Over the Nail (LON)



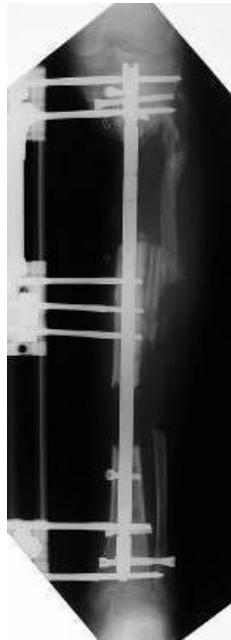
Cosmetic lower legs LON



BTOP



BTOP



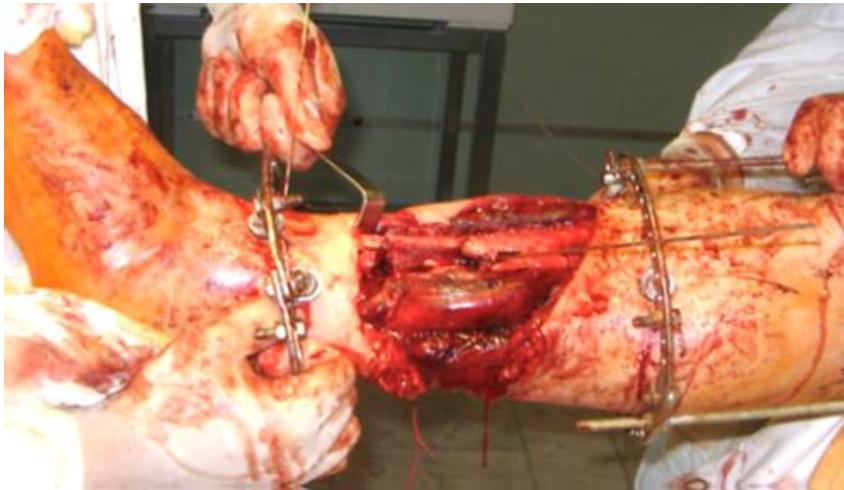
Definitive ExFix

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Prevention of complications / indications for reconstruction

Acute trauma. G&A 3B



44 yo. Pedestrian accident



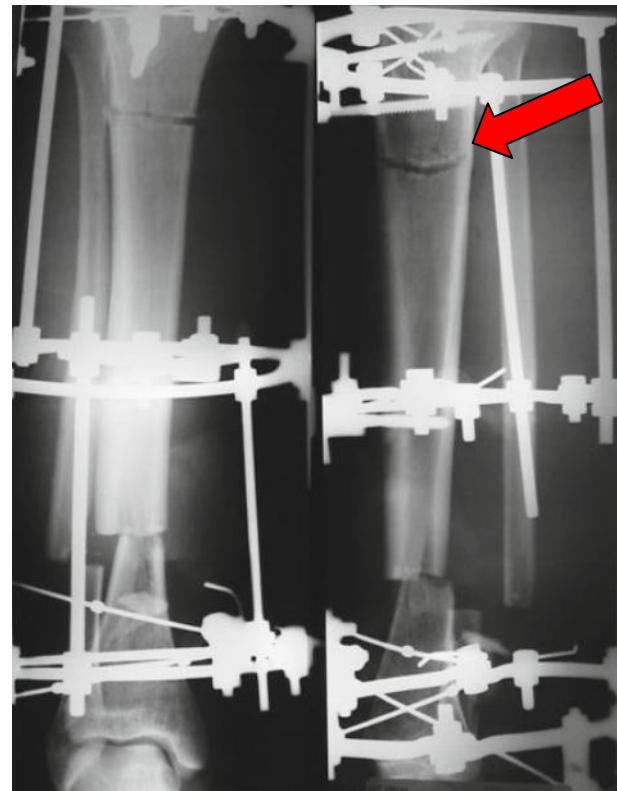
Prevention of complications / indications for reconstruction

Acute shortening



Prevention of complications / indications for reconstruction

Acute shortening and osteotomy

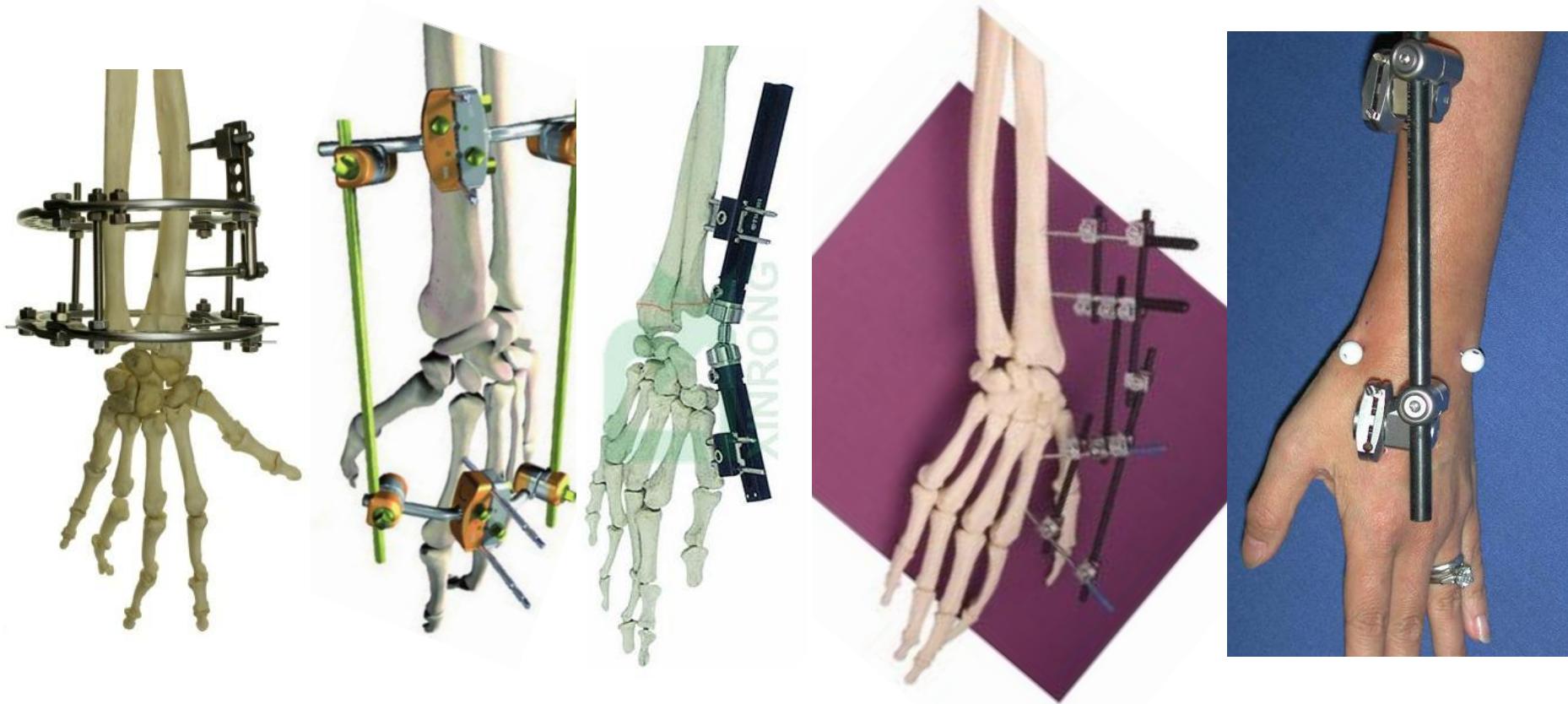


Prevention of complications / indications for reconstruction

Result



“Special” localizations: 23-



- Hayes AJ, Duffy PJ, McQueen MM (2008) Bridging and non-bridging external fixation in the treatment of unstable fractures of the distal radius: a retrospective study of 588 patients. *Acta Orthop* 79(4): 540-547.
- Payandeh JB, McKee MD (2007) External fixation of distal radius fractures. *Orthop Clin North Am* 38(2): 187-192.
- Vamshi Krishna Chilakamary, Maheshwar Lakkireddy, Kiran Kumar Koppolu, Shivaprasad Rapur. Osteosynthesis in Distal Radius Fractures with Conventional Bridging External Fixator; Tips and Tricks for Getting Them Right. *J Clin Diagn Res*. 2016 Jan; 10(1): RC05–RC08.
- Solomin L. The Basic Principles of External Skeletal Fixation Using the Ilizarov and Other Devices. 2012.
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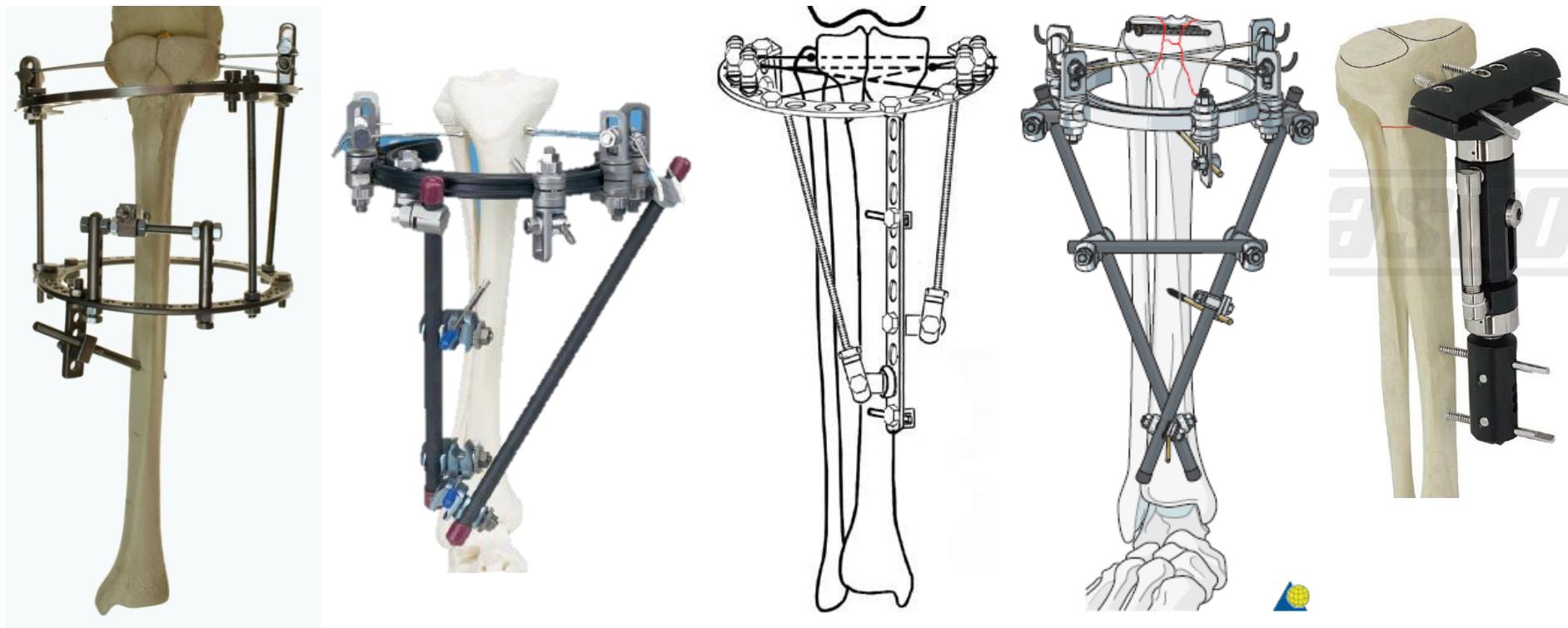
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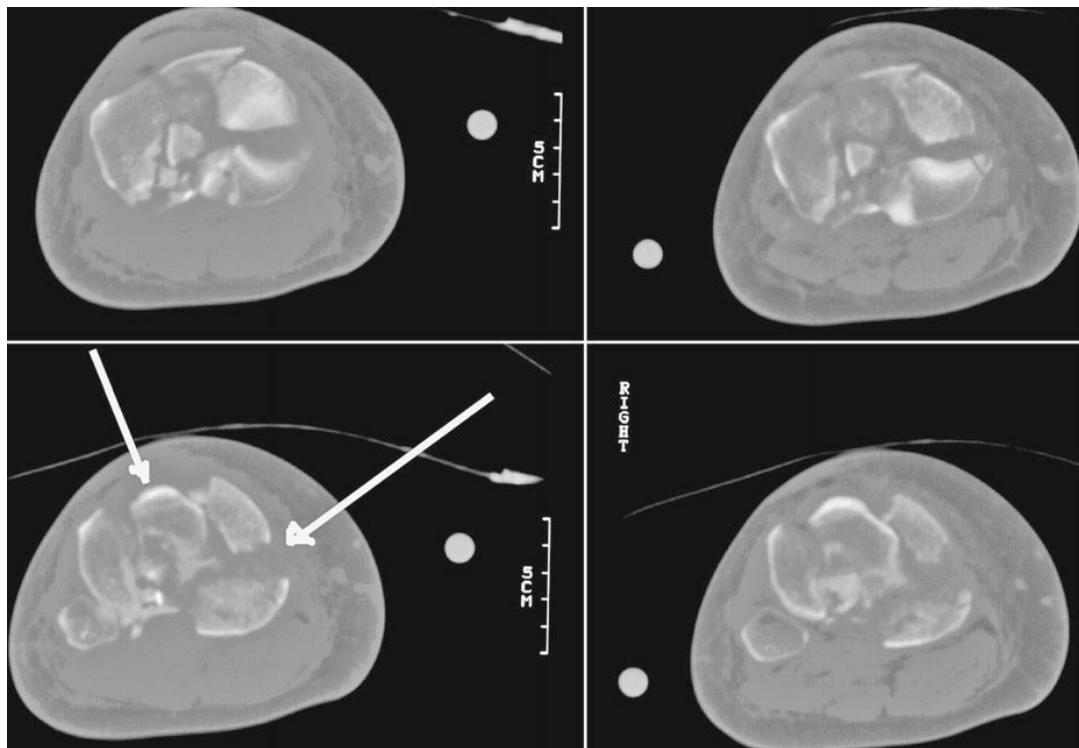


“Special” localizations: 41-

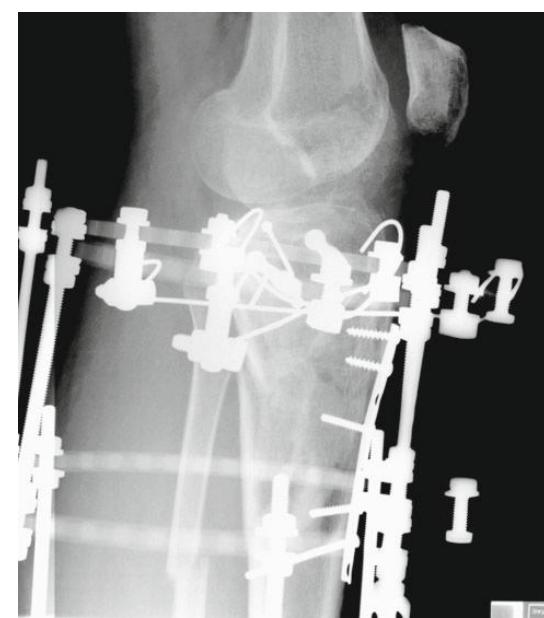
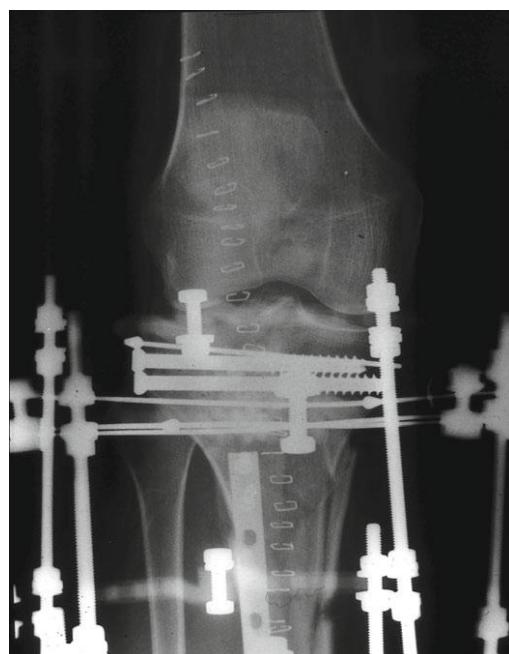
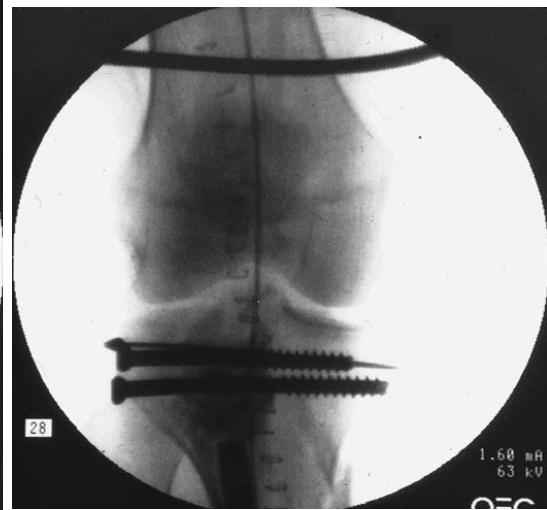
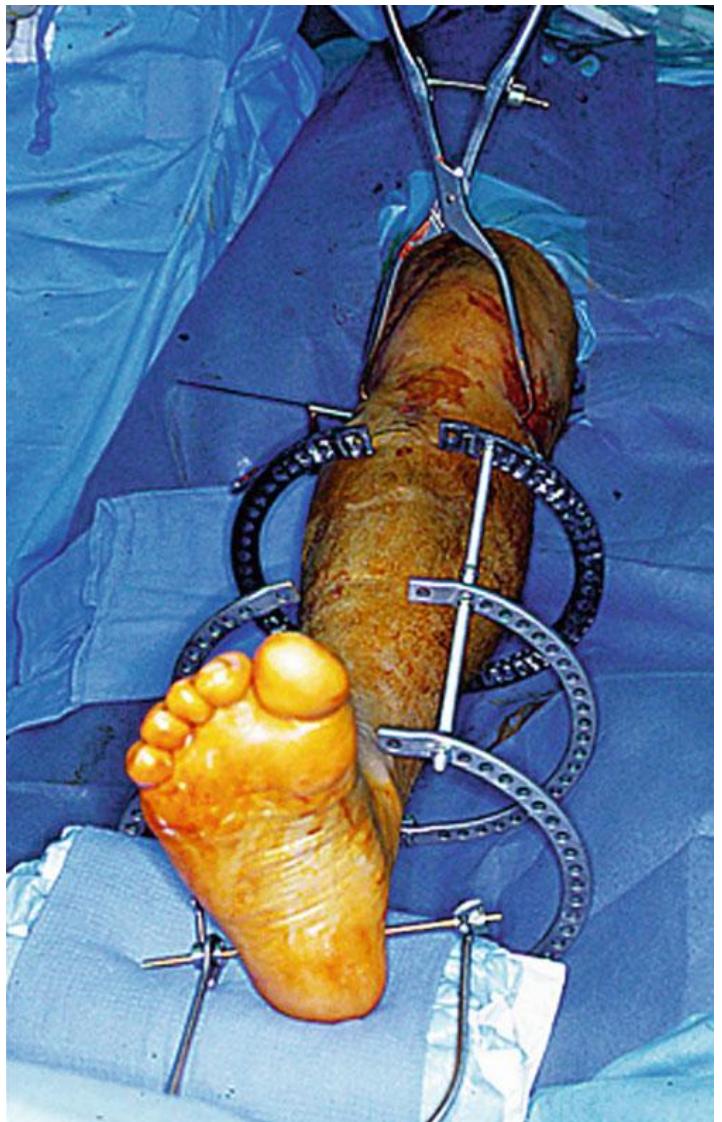


- Hybrid External Fixation of Proximal Tibia Fractures: Biomechanical Analysis of Four Commercial Systems / M. Voor; V. Antoci; B. Kam; C. Roberts // Orthopedics- 2007.-Vol. 30, Issue 12
- Solomin L. The Basic Principles of External Skeletal Fixation Using the Ilizarov and Other Devices. 2012.
- Babis GC, Evangelopoulos DS, Kontovazenis P, Nikolopoulos K, Soucacos PN. High energy tibial plateau fractures treated with hybrid external fixation. *J OrthopSurg Res.* 2011;6:35-41.
- Zeman J, Matejka J. Use of a hybrid external fixator for treatment of tibial fractures. *Acta Chir Orthop Traumatol Cech.* 2005;72:337-43.

“Special” localizations: 41-



“Special” localizations: 41-



“Special” localizations: 43- and 44-

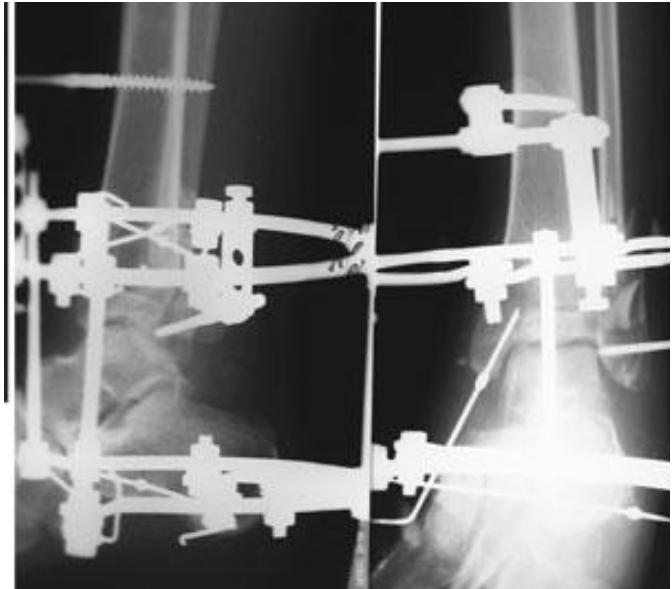


- Cheung KY, Wong MS, Choi SH. Hybrid configuration of the AO/ASIF pinless external fixator in the treatment of compound fractures of distal tibial shafts. Kong J Orthop Surg. 2001;5(1):58–63.
- Nebu Jacob, Amit Amin, Nikolaos Giotakis, Badri Narayan, Selvadurai Nayagam, Alex J. Trompeter. Management of high-energy tibial pilon fractures. Strategies Trauma Limb Reconstr. 2015 Nov; 10(3): 137–147.
- Sharma H., Nunn T. Conversion of open tibial IIIb to IIIa fractures using intentional temporary deformation and the Taylor Spatial Frame. Strategies Trauma Limb Reconstr. 2013 Aug; 8(2): 133–140.
- Solomin L. The Basic Principles of External Skeletal Fixation Using the Ilizarov and Other Devices. 2012.

“Special” localizations: 43- and 44-

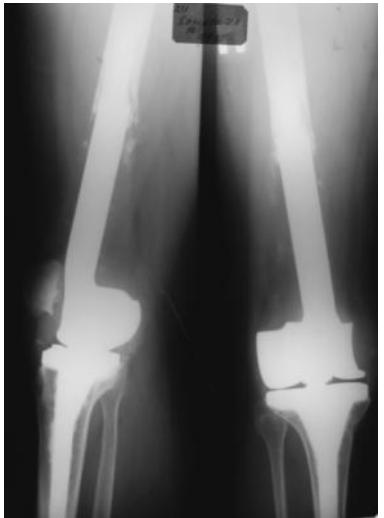


“Special” localizations: 43- and 44-



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In 1985 sarcoma resection

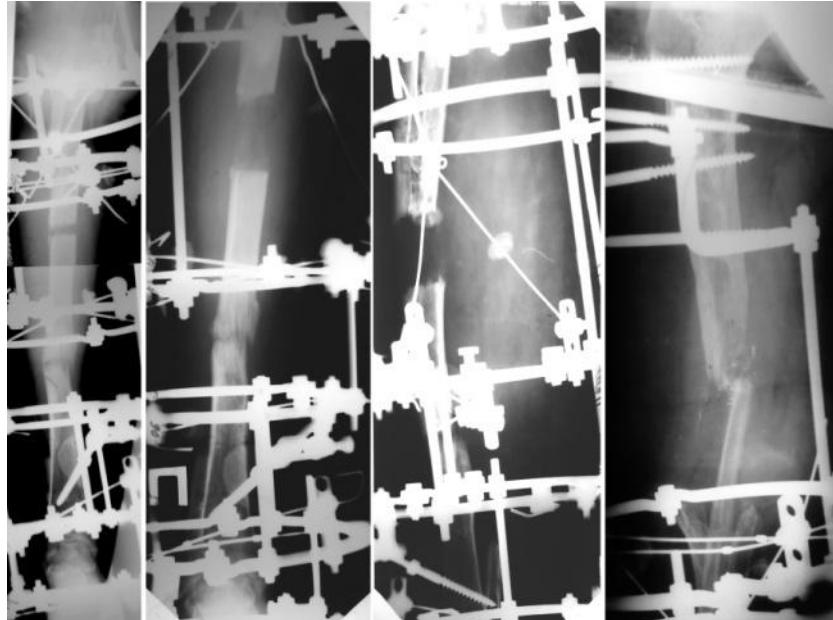


Preoperative Problem List:

- Shortening of the right lower extremity 12 cm
- Bone defect forming the knee joint 18 cm,
- Chronic osteomyelitis of the right low extremity
- Multiple scars
- Neuropathy of right peroneal nerve and secondary equines-varus deformity of the foot

Ilizarov reconstruction

Step 1



120 days – 9 cm

+

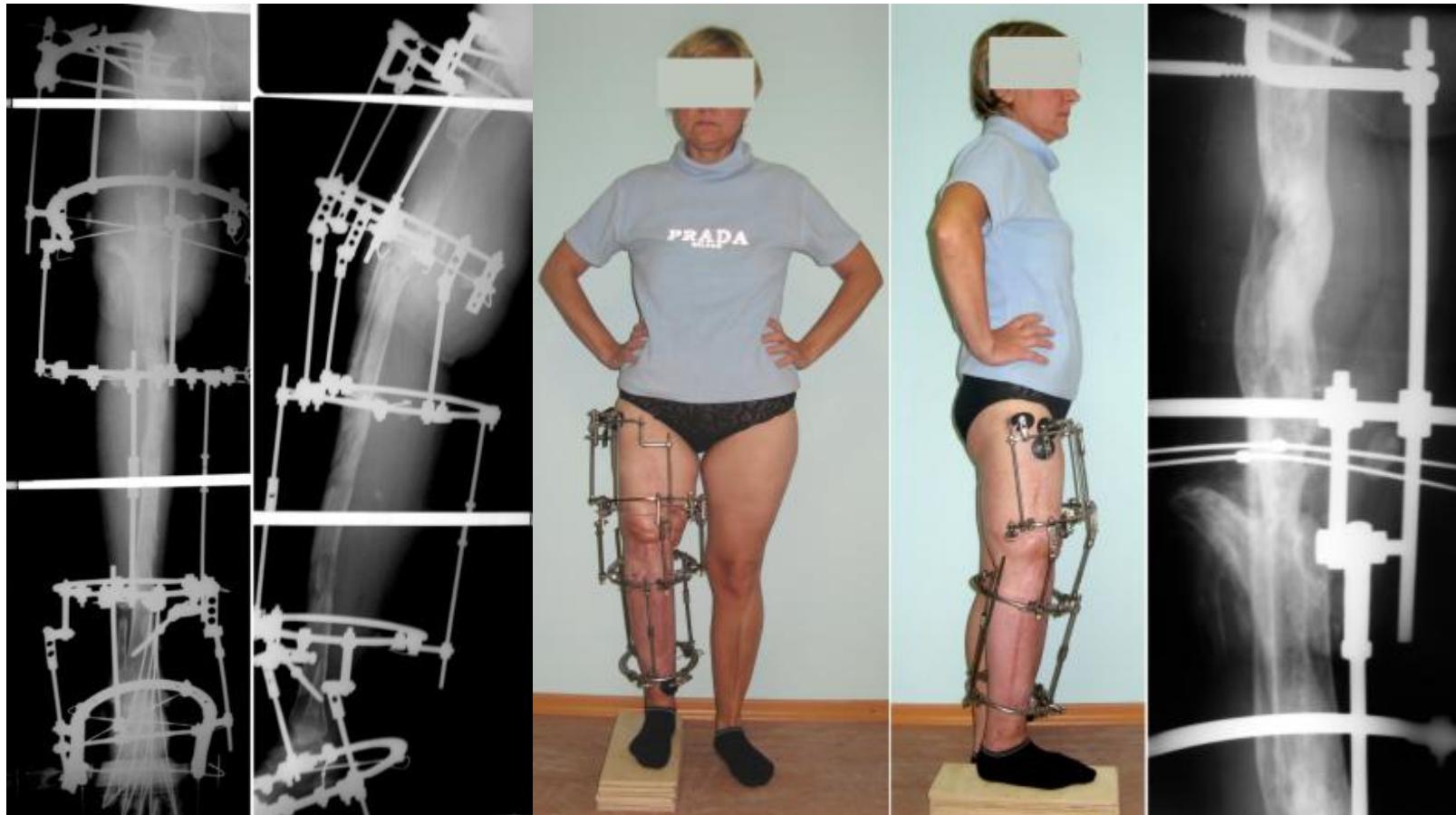
120 days – 7 cm



Ilizarov reconstruction

Step 2

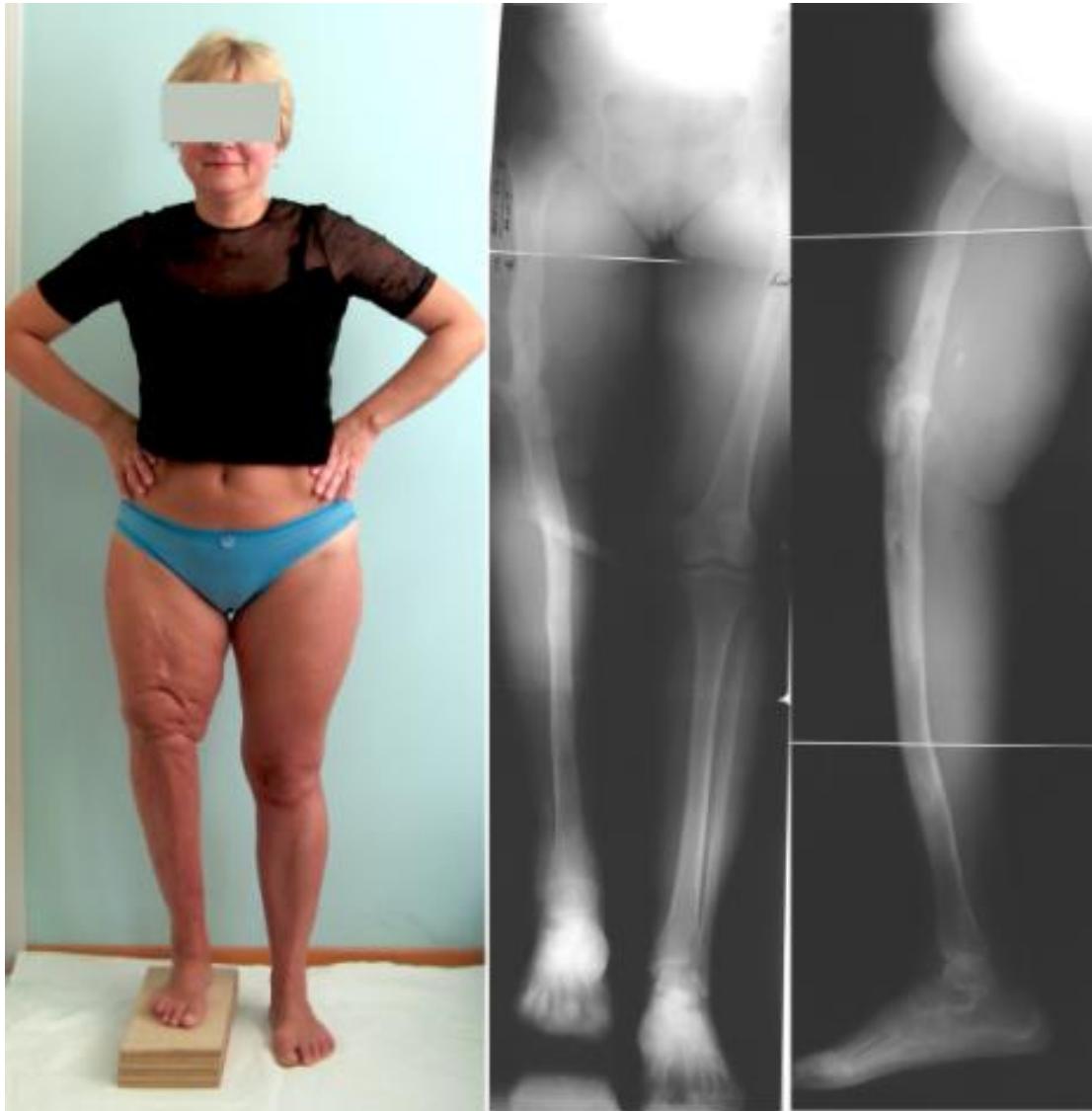
17 months – 8 cm



Ilizarov reconstruction

Step 2

17 months – 8 cm



Ilizarov reconstruction

Step 3

(in 2 years)

110 days – 7 cm



8 months

Ilizarov reconstruction: Result

ExFix **43** months

Total **67** month (- 12 months)



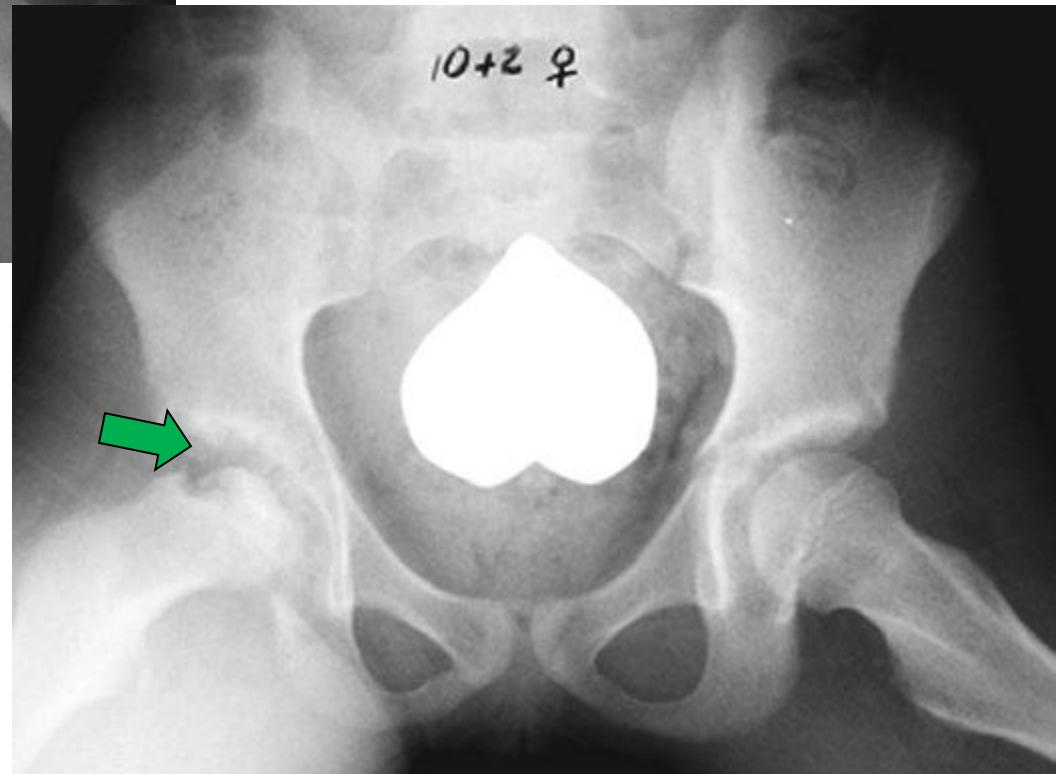
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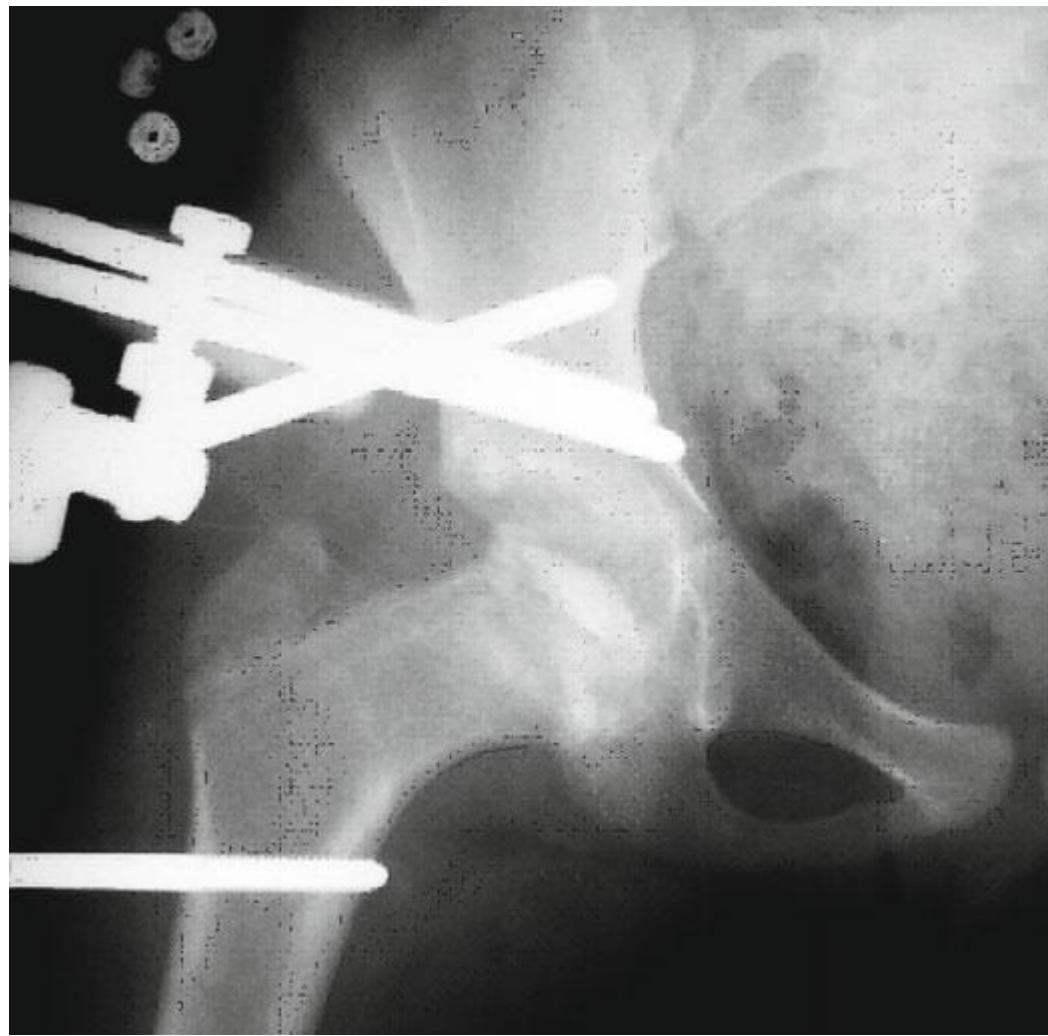
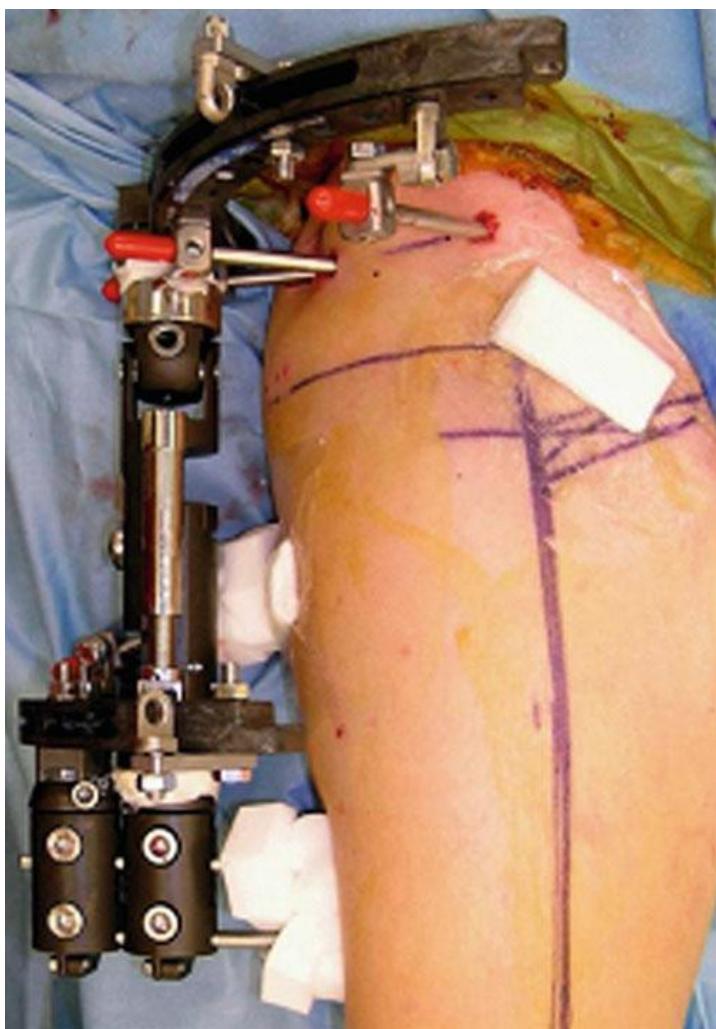
Pelvic support osteotomy



Arthrodiatasis



Arthrodiatasis



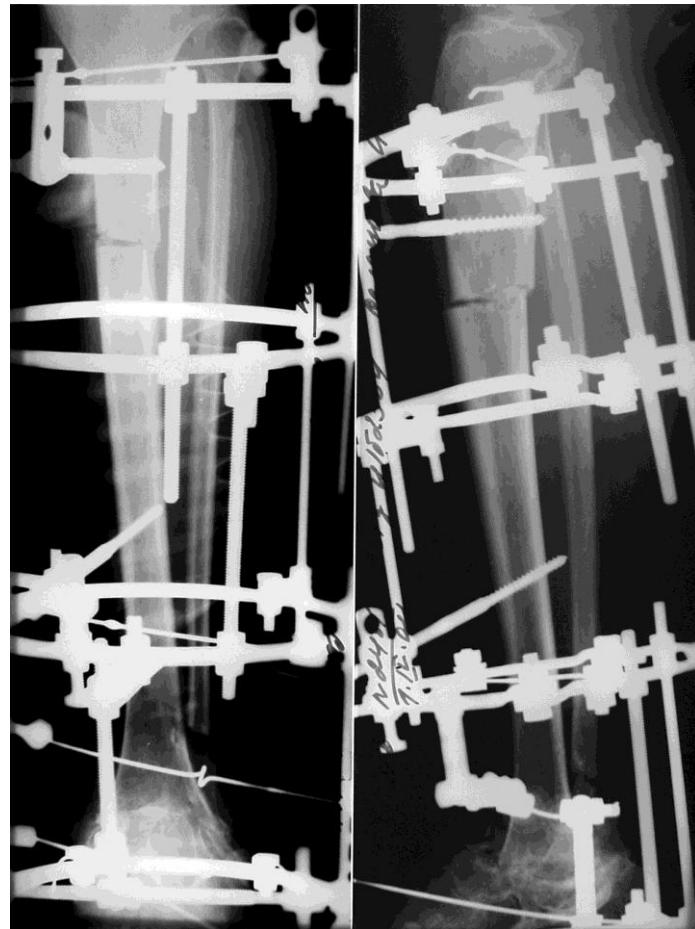
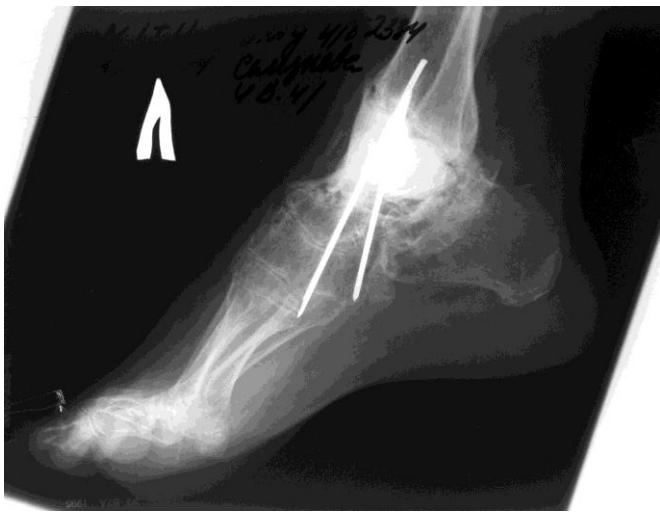
W.D. Terrell

Arthrodiatasis: result

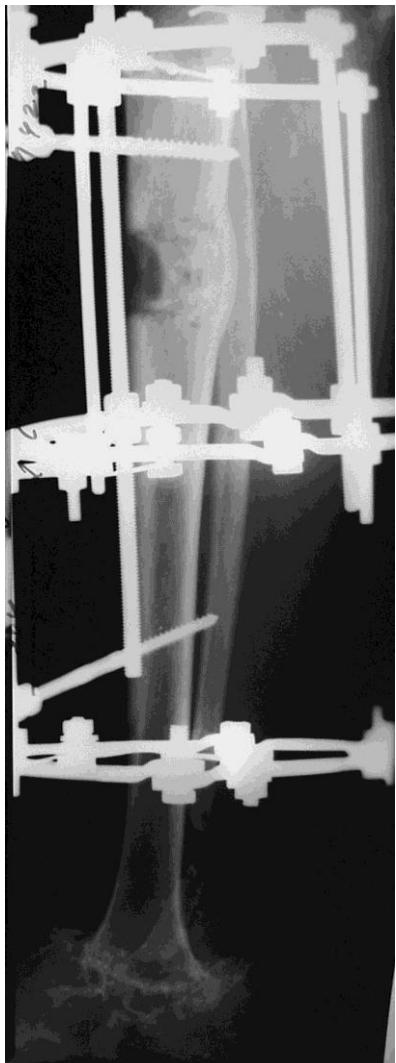


W.D. Terrell

Fusion and lengthening



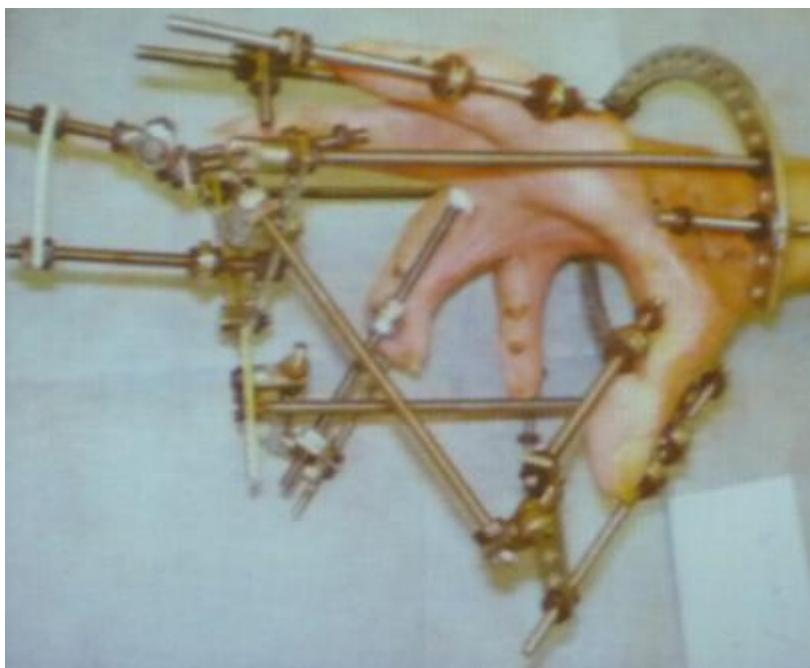
Fusion and lengthening



Definitive ExFix

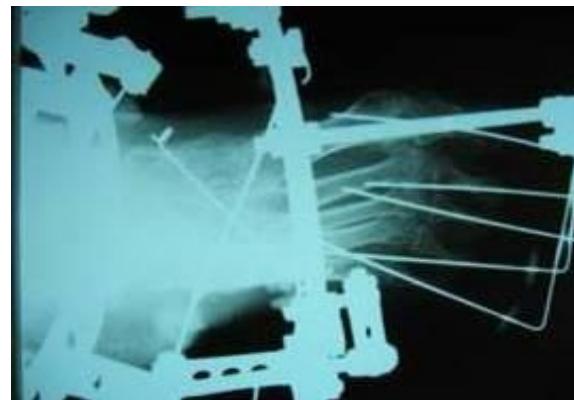
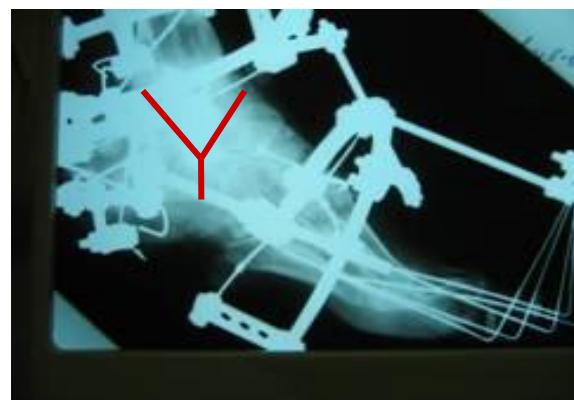
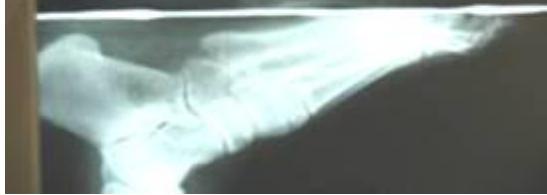
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Hand



V. Shevtsov

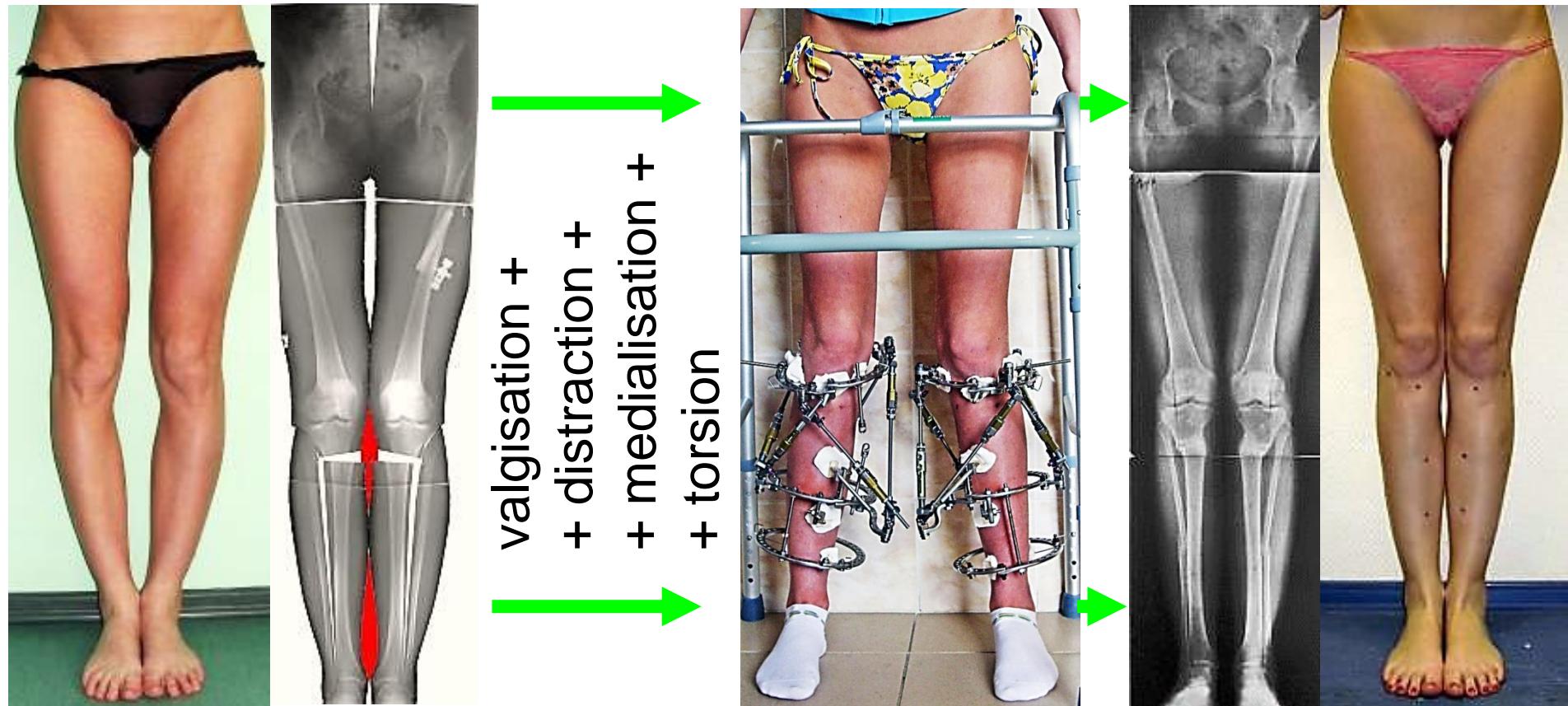
Foot



Definitive ExFix

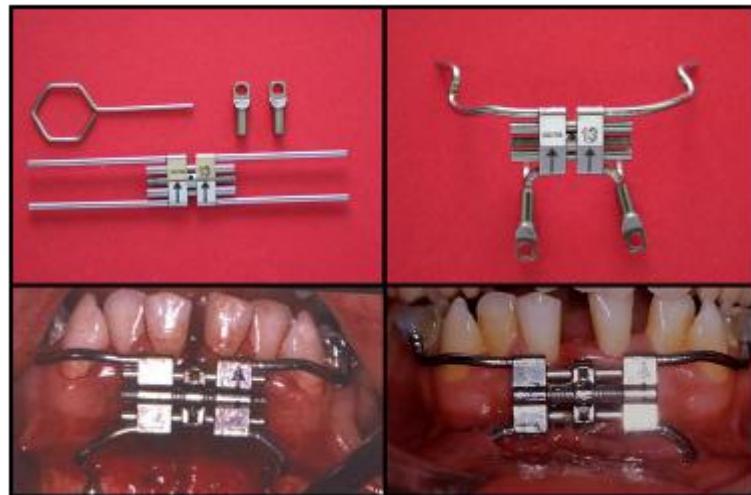
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5. Other

Aesthetic Surgery



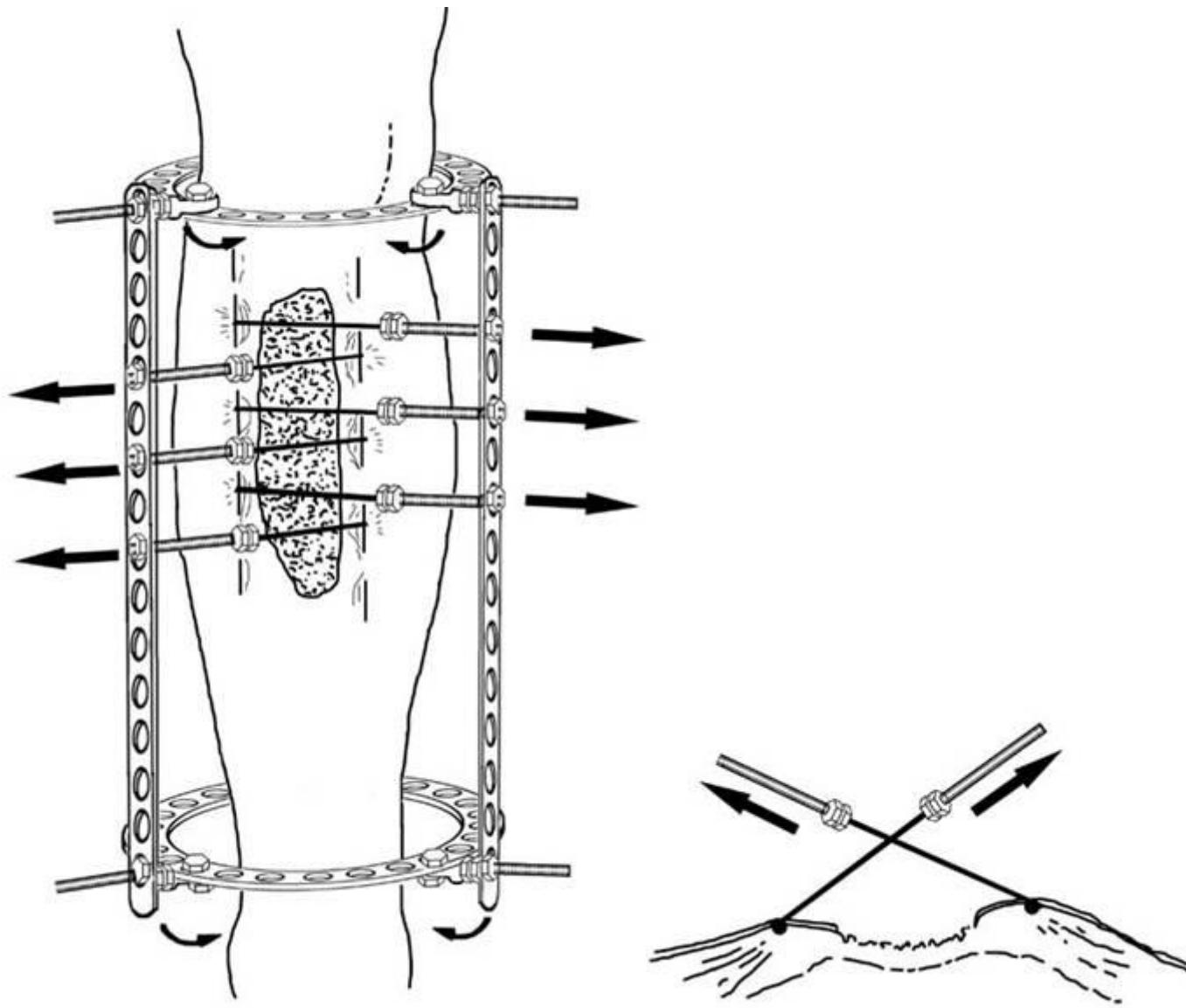
Kulesh PN Application of Ortho-SUV Frame for correction of lower limb shape / PN Kulesh, LN Solomin, VA Vilensky // 8th International ASAMI Conference. India, Goa. 2014 – Scientific Program and Abstract Book. – P. 97.

Jaws

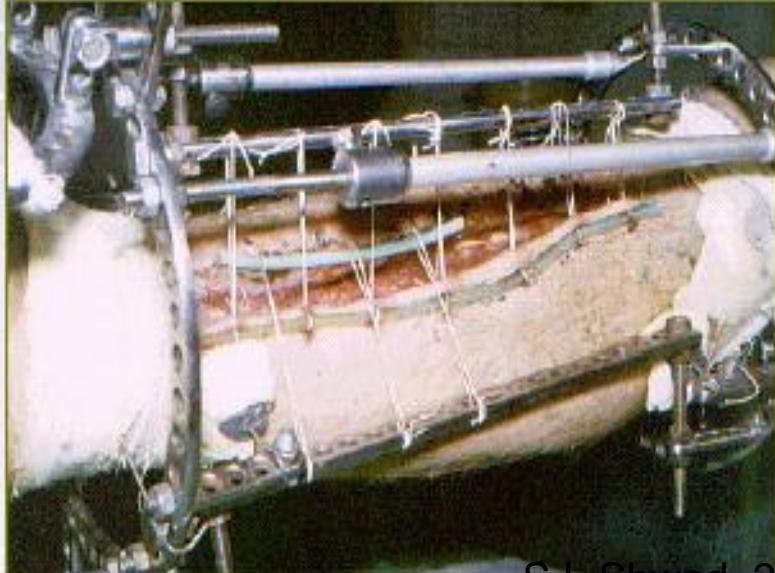
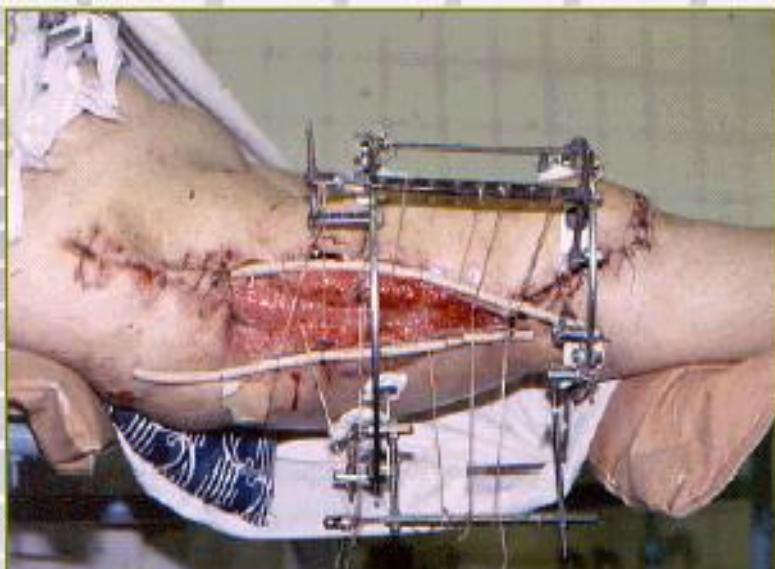
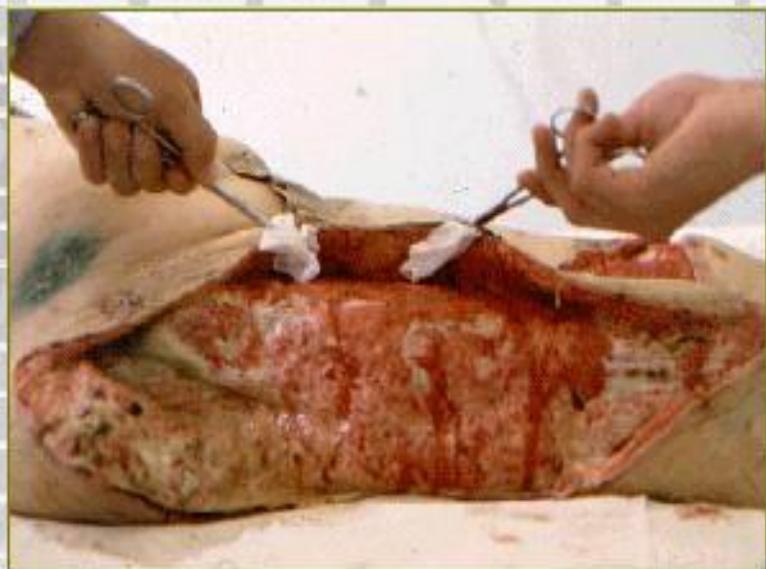


M. Orhan

Skin growing

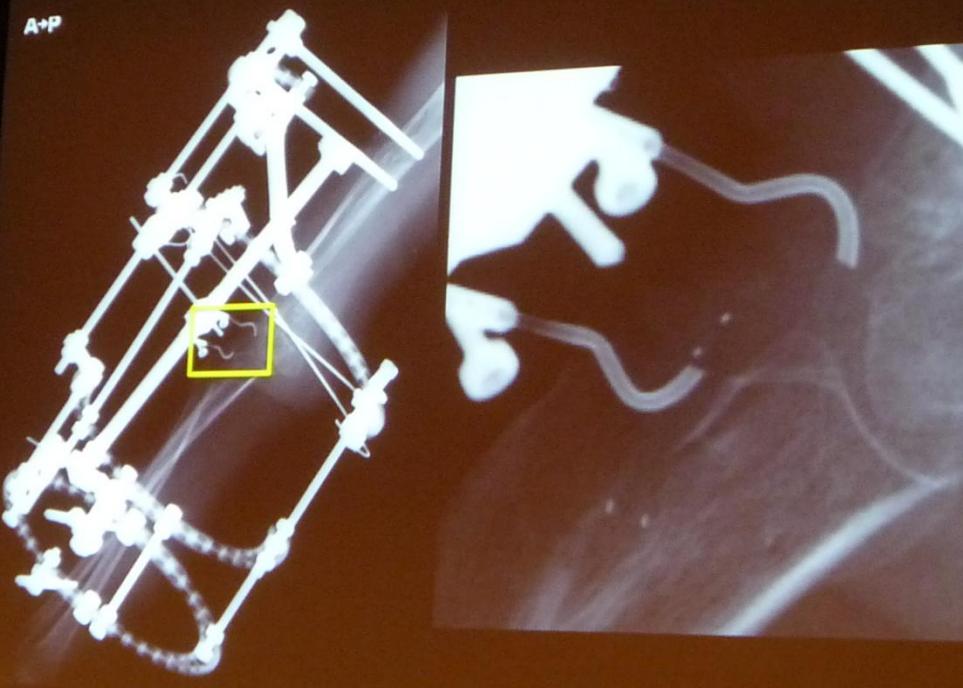
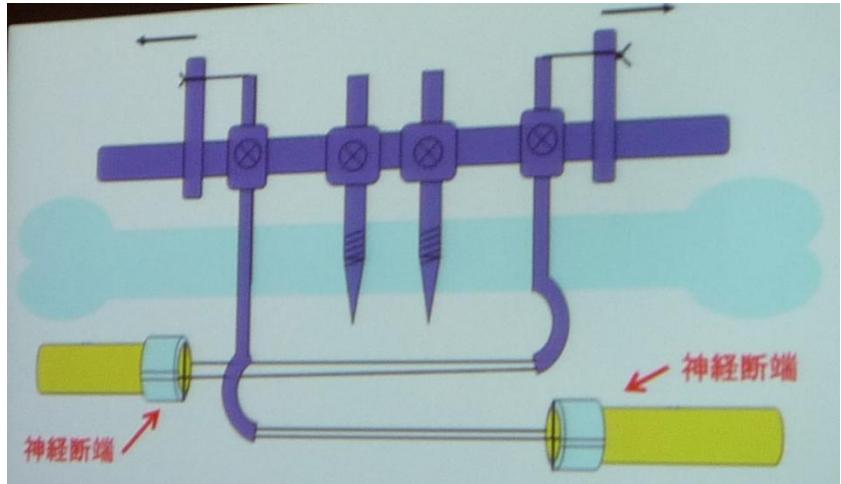


Skin growing



S.I. Shwed, 2004

Nerve growing



JORIM-2014

神経伸長器を用い神経両断端を縫合可能距離まで
緩徐伸長、両断端を新鮮化し端々縫合

Soft tissue protection



Soft tissue protection



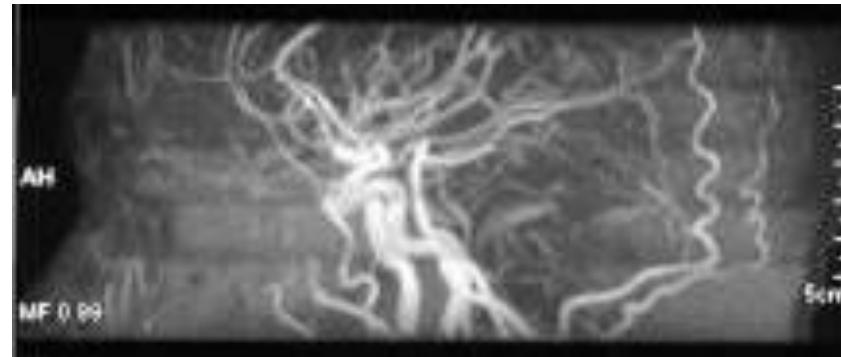
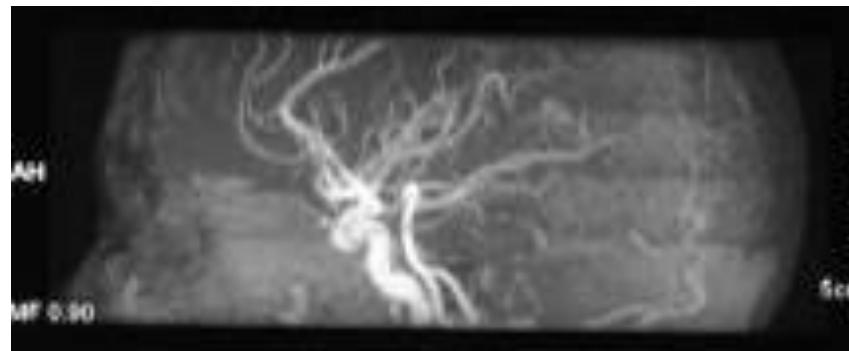
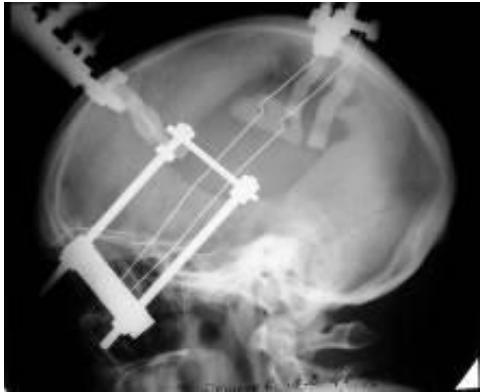
Soft tissue protection



Soft tissue protection



Ischemic disorders



O. Prudnikova

Contraindications

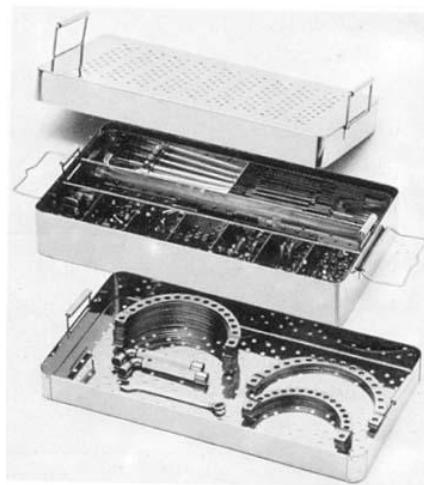
- Patients in whom no **wires and pins can be inserted** (due to a bone or soft tissue disease, pre-existing internal fixation that prohibits proper wire or pin placement)
- Patient who would otherwise benefit from **nonoperative management** (compromised immune system, HIV-positive patients)
- Impossibility of constant skilled **monitoring** of the patient during the fixation period
- **Non compliant patient** who would not be able to ensure proper frame care. Patients who for social and physical reasons are not suitable for an External Fixator
 - inability of the patient to follow postoperative recommendations.
 - ability to monitor external fixation and fracture healing postoperatively because of social or compliance issues, or the and advice because of age-related issues, psychoemotional status, alcohol or narcotic abuse, or any factor that may inhibit a patient's judgment regarding the care and management of an external fixator

Theoretical basis

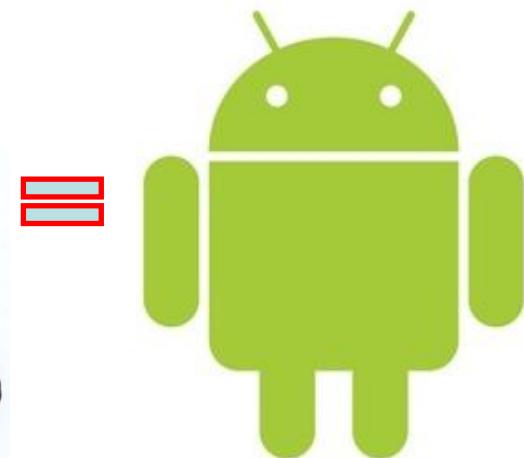
Ilizarov
method

Ilizarov
discovery

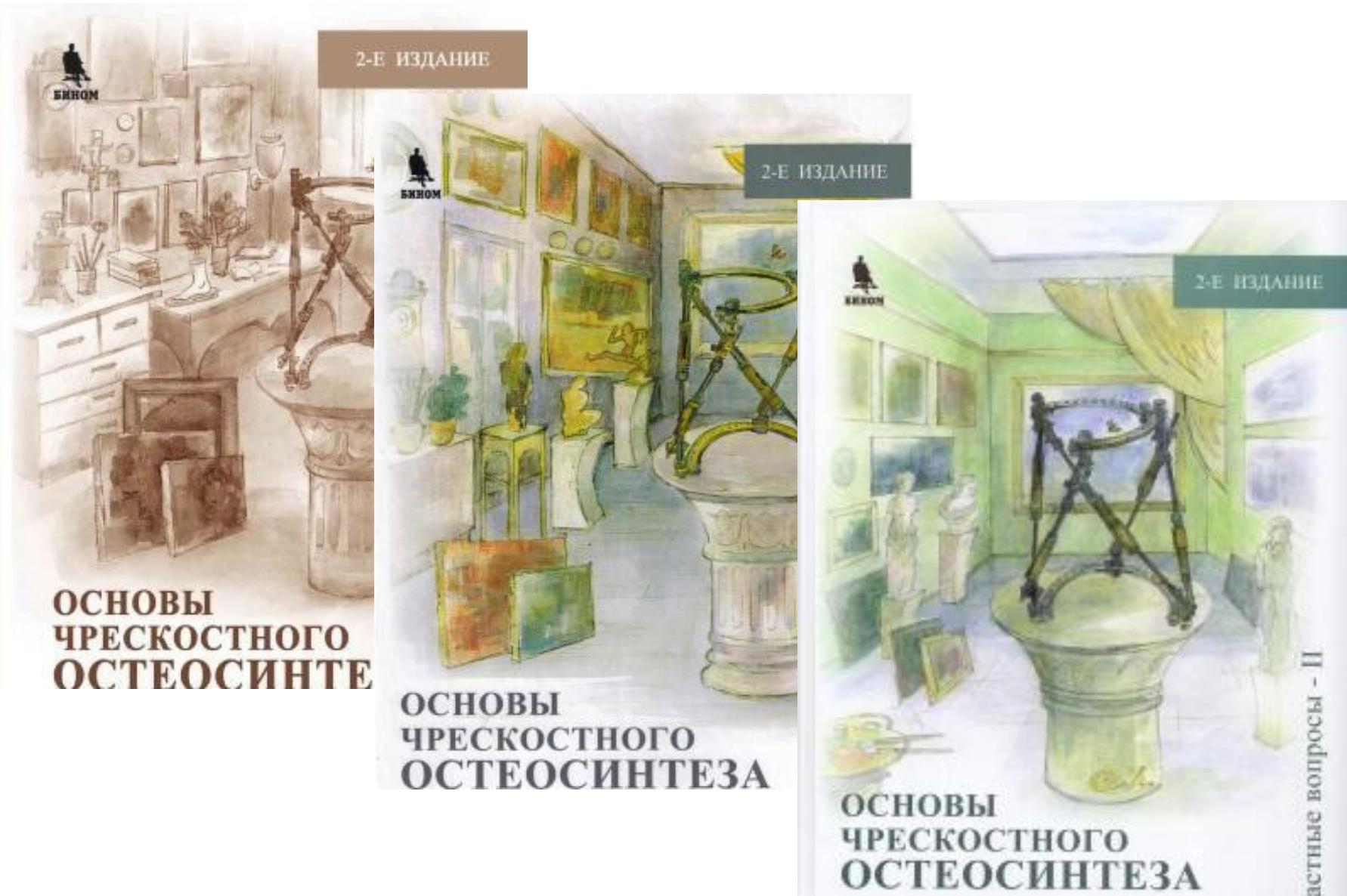
Equipment



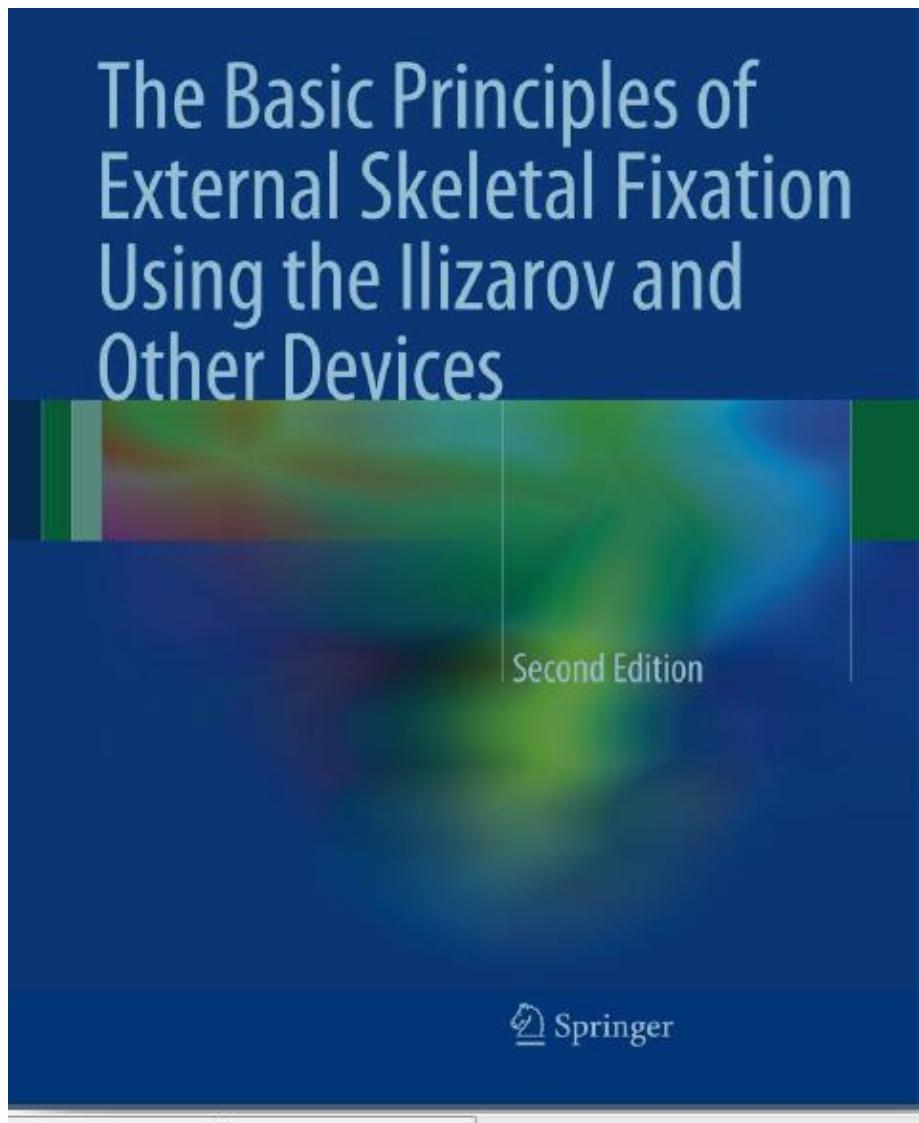
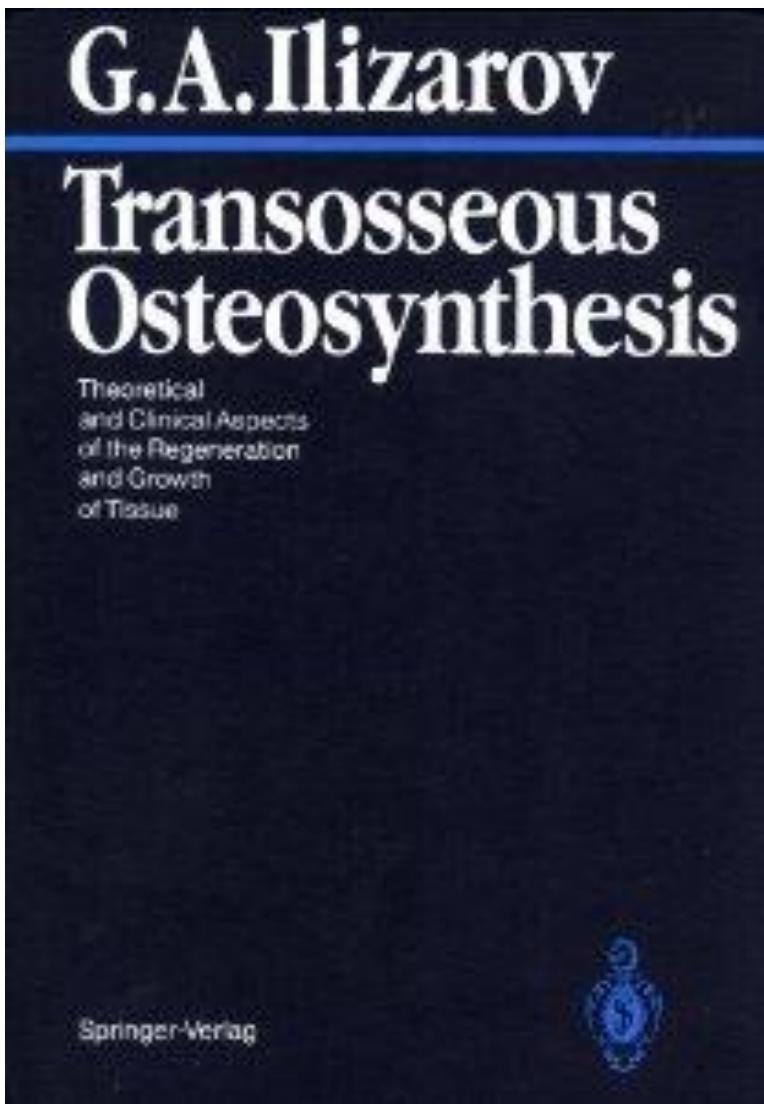
What is it?



Recommended literature



Recommended literature





Удачи!