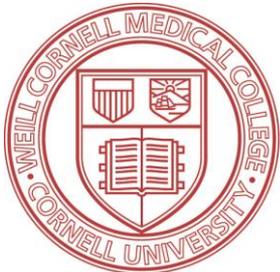


# Bone Surgery for Soft-Tissue Defects

**Masters of Disaster: Managing Osteomyelitis in the 21st Century Course**  
**Baltimore, Maryland**  
**August 25, 2016**

**S. Robert Rozbruch, MD**

Chief, Limb Lengthening & Complex Reconstruction Service  
**HOSPITAL FOR SPECIAL SURGERY**  
Professor of Clinical Orthopedic Surgery



LIMB .COM

The logo for Limb Lengthening.com, featuring the word "LENGTHENING" in blue capital letters, with a black rectangular frame around it that has vertical lines extending downwards from the top and upwards from the bottom, resembling a surgical frame or a measurement tool.

**HSS**

# Disclosures

- Smith and Nephew: consultant
- Stryker: consultant, royalties
- Nuvasive/ Ellipse: consultant

# Soft-tissue coverage

- Primary closure
- Delayed primary closure
- Flap coverage
  - Rotational
    - Gastrocnemius (proximal tibia)
    - Soleus (middle tibia)
  - Free Flap (microvascular)
- Delayed secondary closure

# Bone Defects

- Bone graft
- Free fibula graft
- Bone transport, ILIZAROV

## Difficult case

What do you do for the patient with a bone defect and soft-tissue defect that your *plastic surgeon says is not a candidate for a flap?*

# Ilizarov Strategies

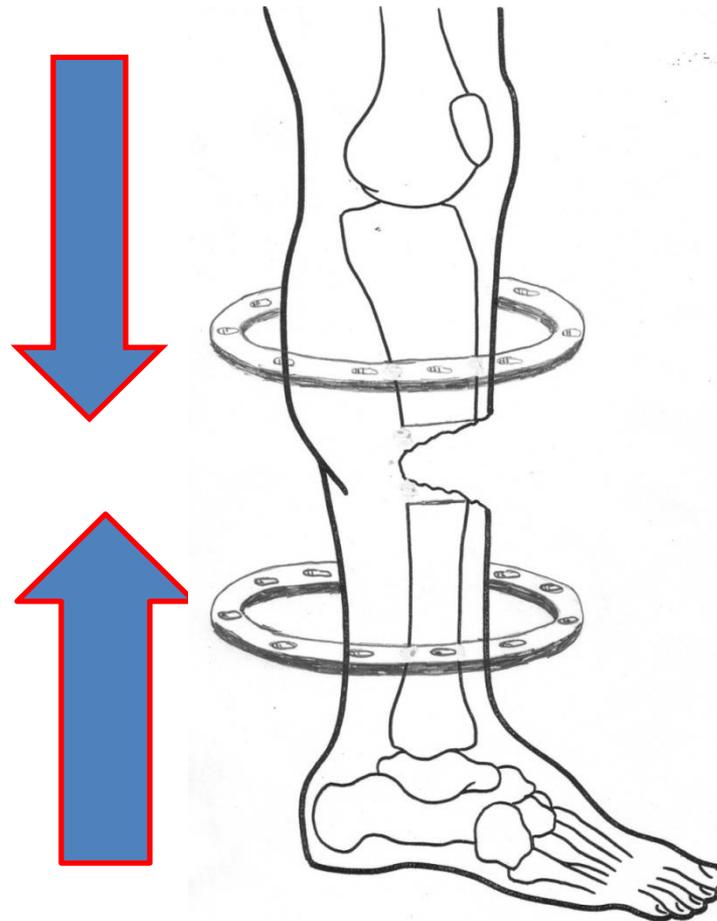
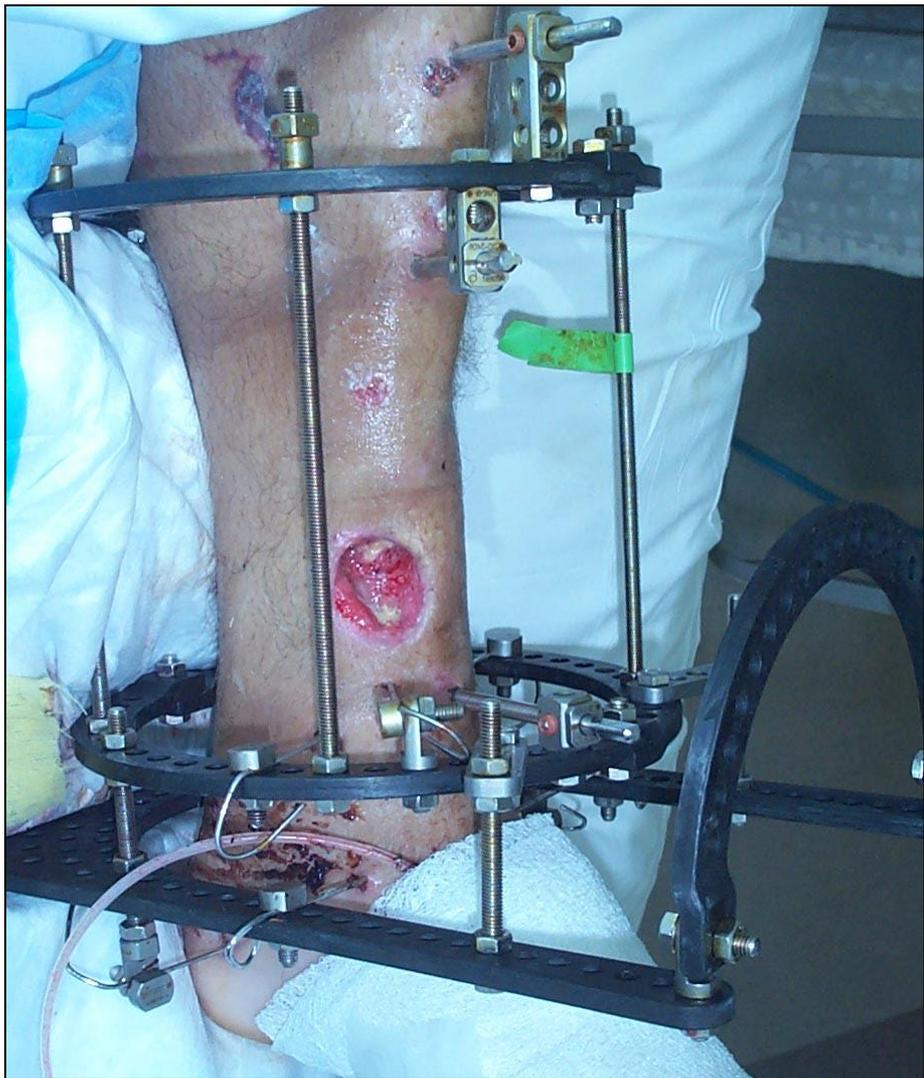
- Transport bone and soft-tissue
- Acute and / or gradual
- Wound care
  - VAC
- Nuts and bolts
  - Monofocal
  - Bifocal
  - Trifocal

# Options

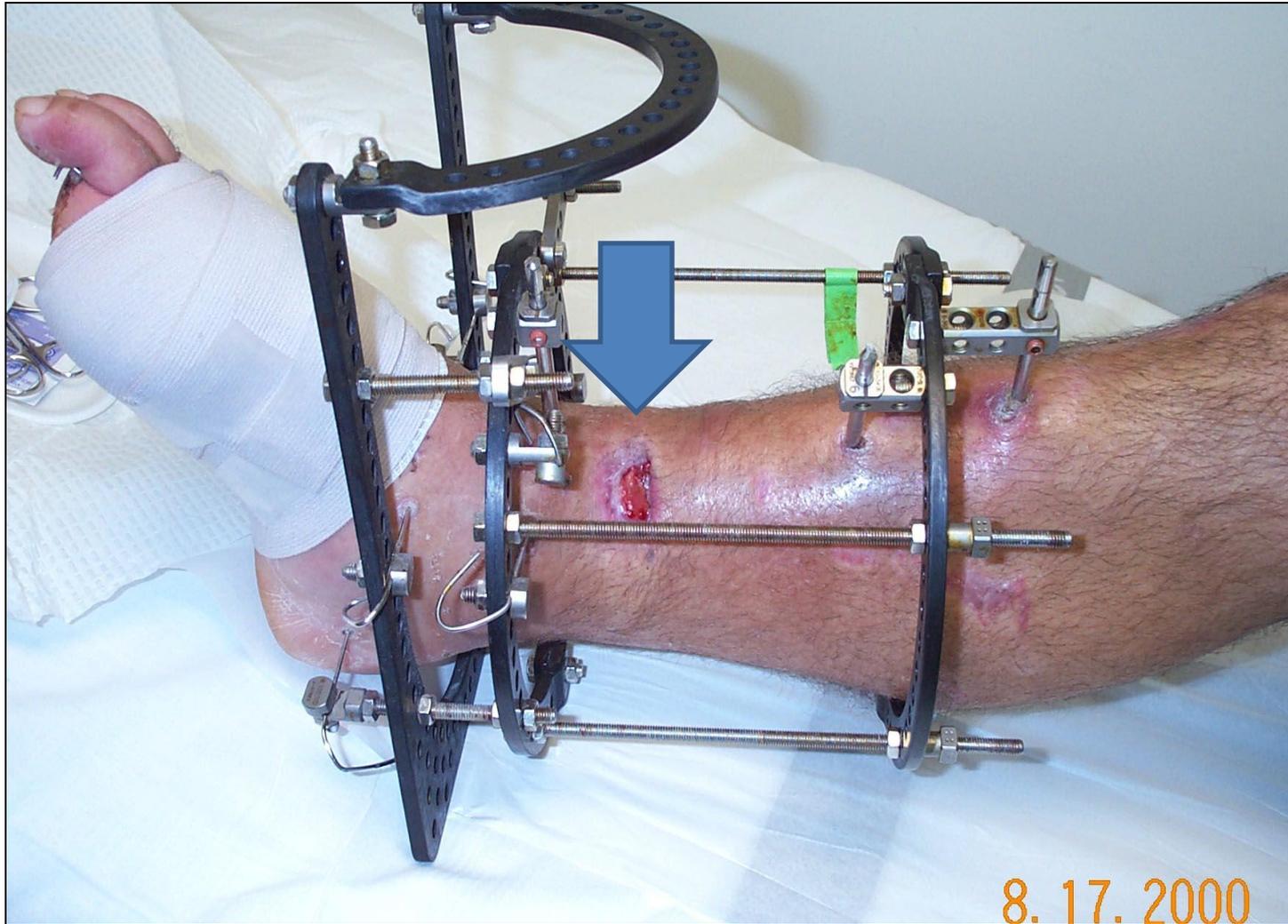
- Amputation
- This limb salvage technique



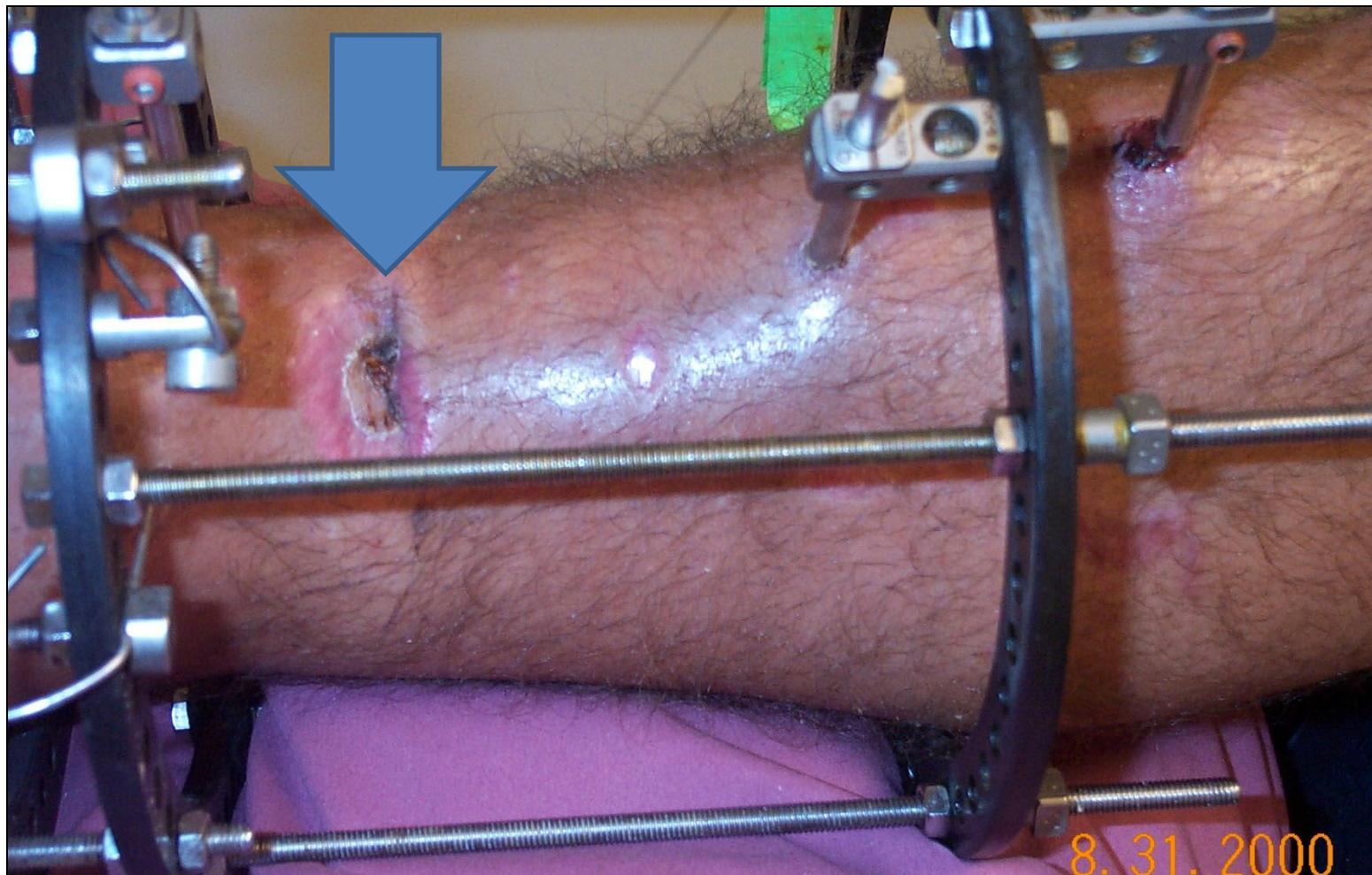
# Monofocal approach



4 weeks Later



7 Weeks Later



12 weeks Later



# Post-Op X-Rays



4 weeks



3 months



4 months



# 8 months post injury



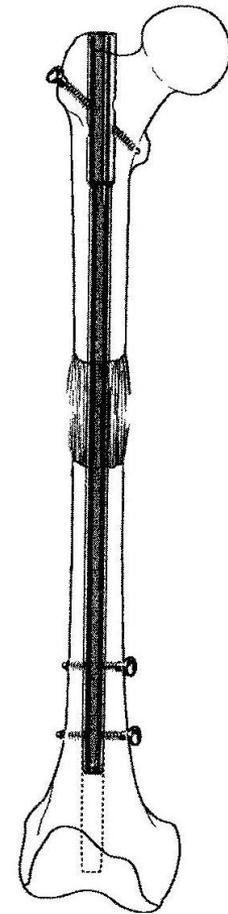
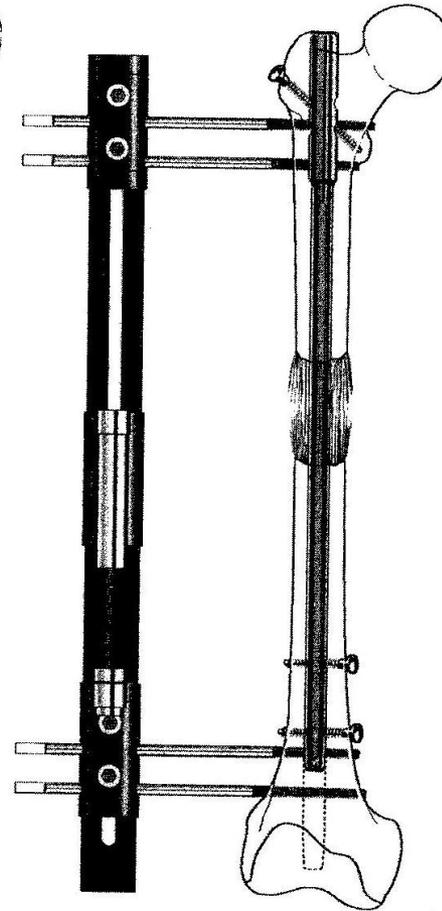
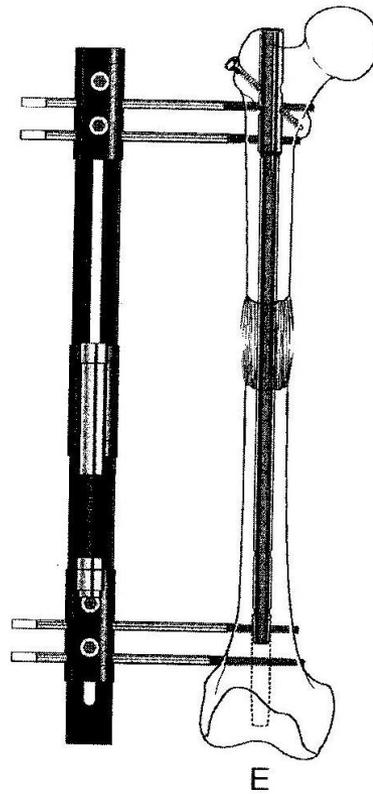
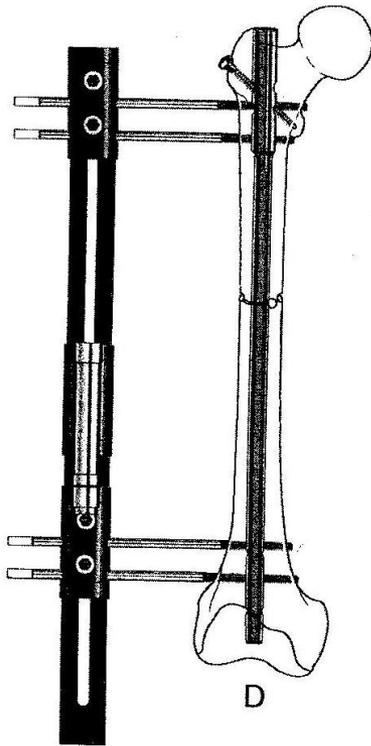
# Follow Up

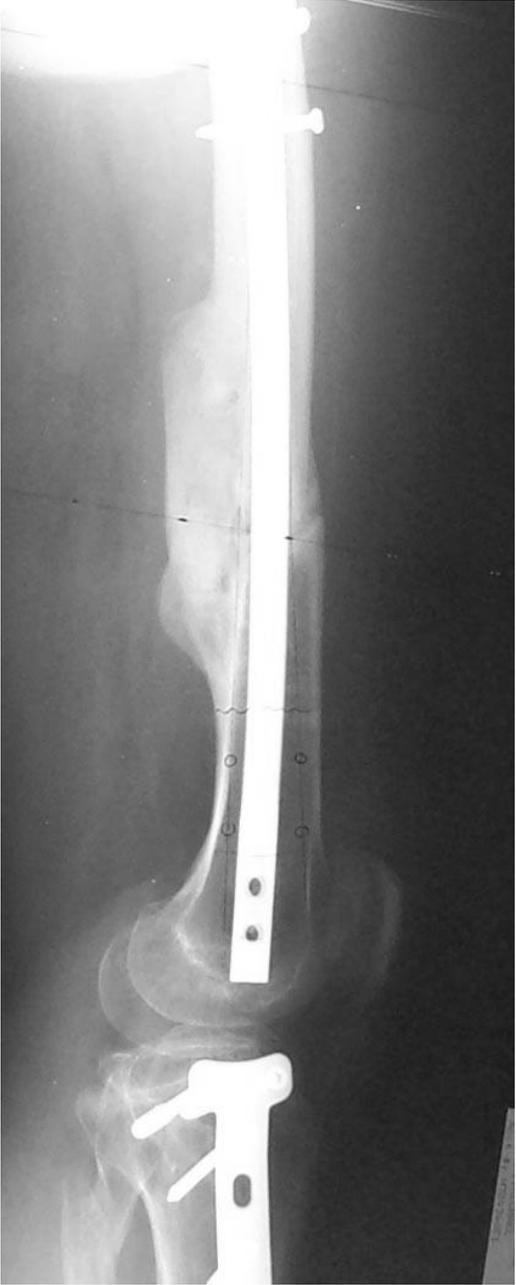


1 inch LLD  
Subsequently had  
A femoral  
Lengthening  
(LON)



# Lengthening over Nail (LON)

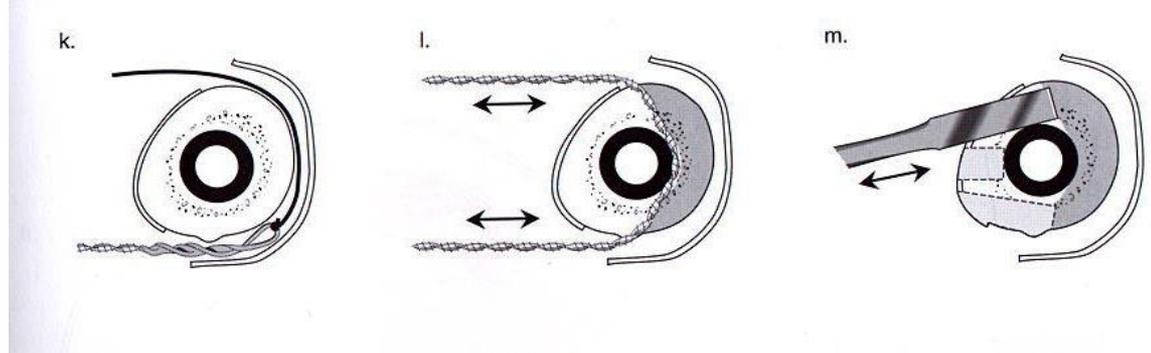




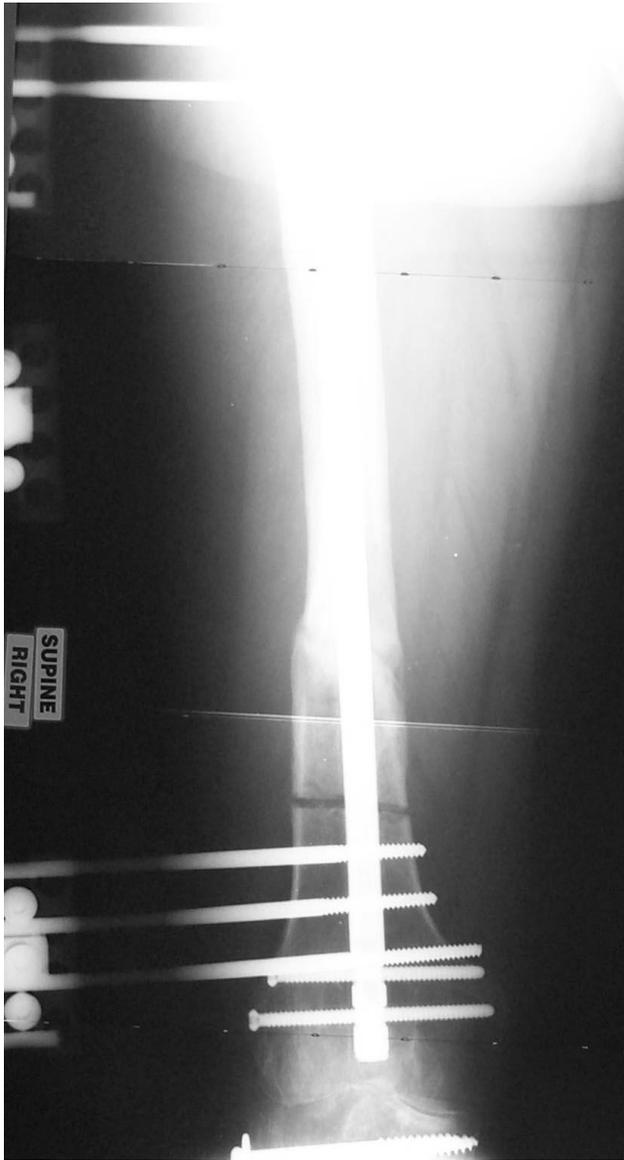
# Combination Technique

- Gigli saw for far cortex
- Osteotome for near cortex
- LON when nail already in place

- Proximal femur
- Distal femur
- Proximal tibia



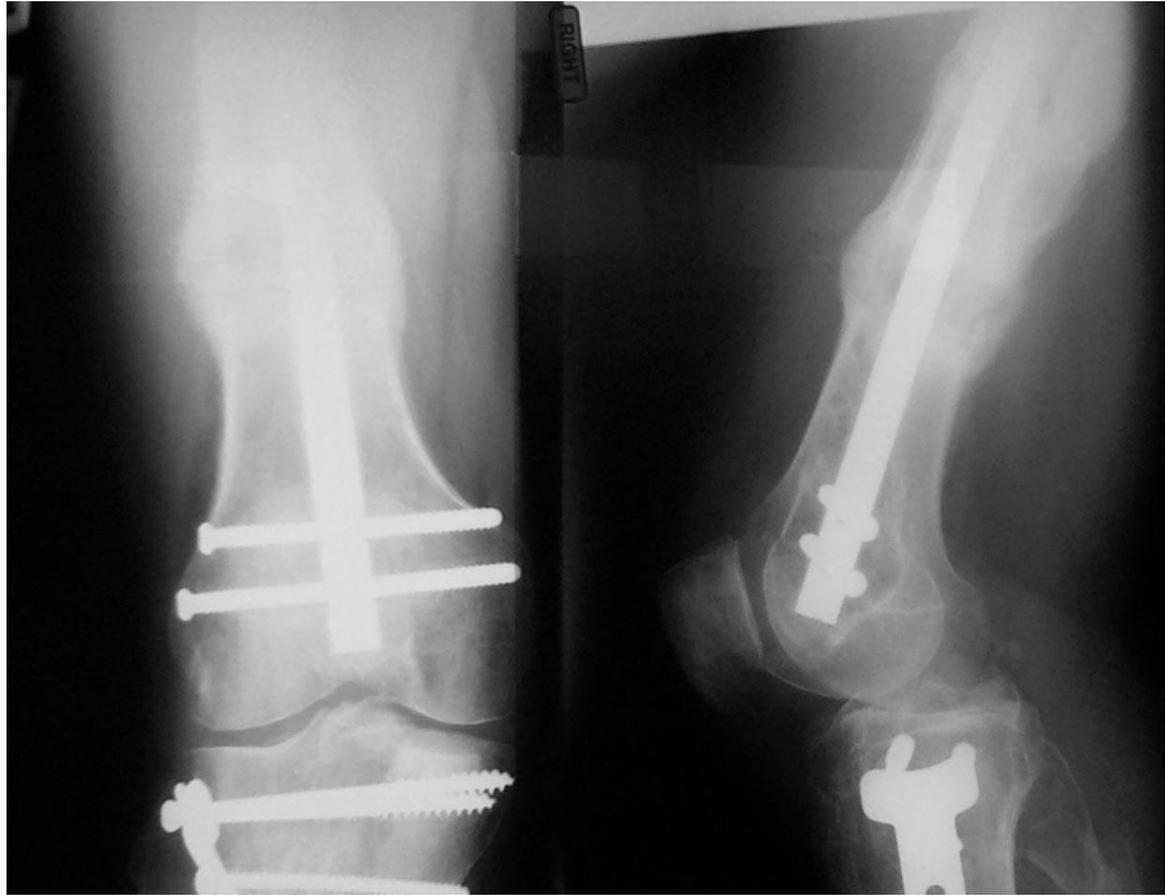
2 weeks postop



1 month



2 months



# Limb Salvage of Charcot arthropathy/ osteomyelitis with complex ankle arthrodesis

Clin Orthop Relat Res  
DOI 10.1007/s11999-012-2470-9

Clinical Orthopaedics  
and Related Research  
Publication of The Journal of Bone and Joint Surgery

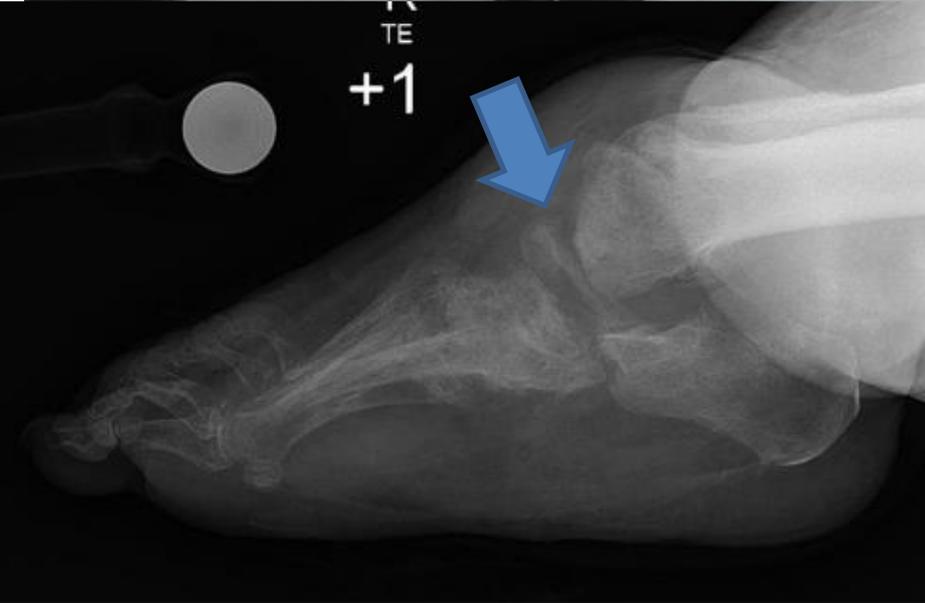
CLINICAL RESEARCH

## Complex Ankle Arthrodesis Using the Ilizarov Method Yields High Rate of Fusion

Austin T. Fragomen MD, Eugene Borst BA,  
Lindsay Schachter BS, Stephen Lyman PhD,  
S. Robert Rozbruch MD

Received: 25 October 2011 / Accepted: 22 June 2012  
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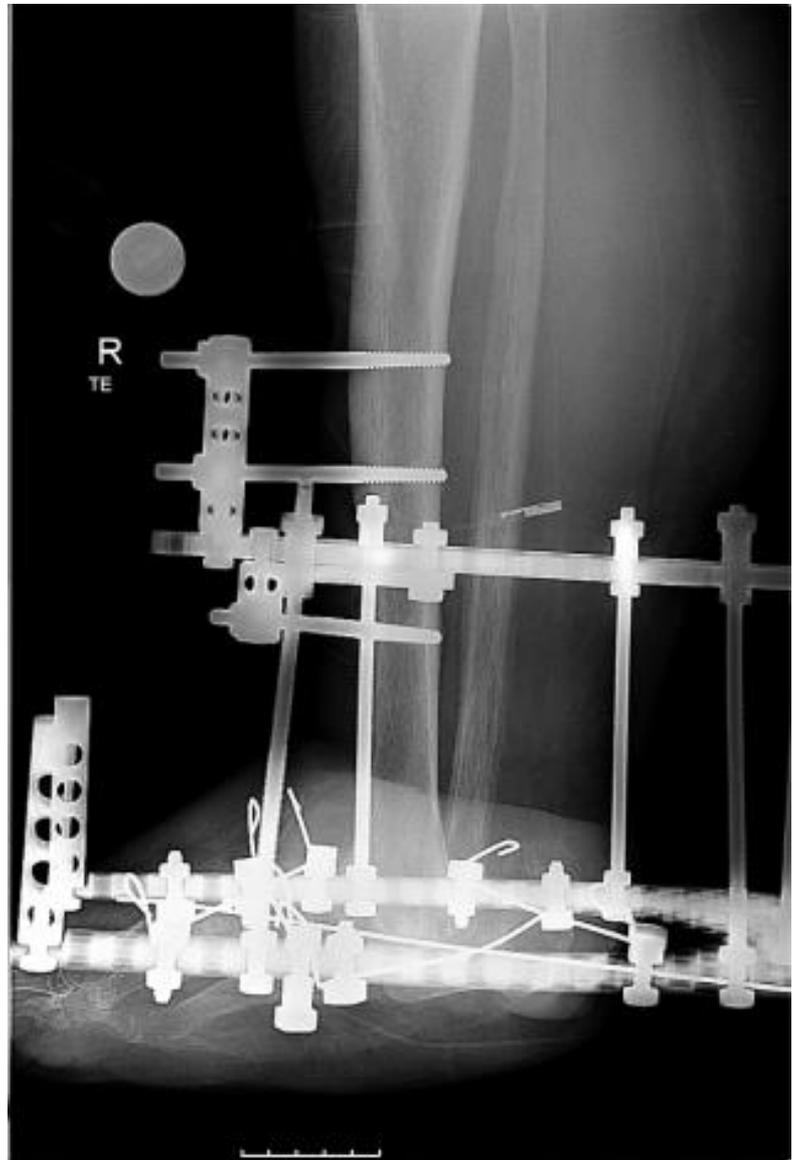
Before: Infected, ulcer

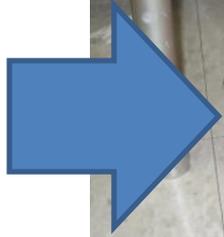


JURIE, A

RE

VIEWS





After: Solid Tibio-calcaneal fusion  
& eradication of infection



# Temporary Intentional Leg Shortening and Deformation to Facilitate Wound Closure Using the Ilizarov/Taylor Spatial Frame

Shane J. Nho, MD, David L. Helfet, MD, and S. Robert Rozbruch, MD

**Summary:** Infected tibial nonunions with bone loss pose an extremely challenging problem for the orthopaedic surgeon. A comprehensive approach that addresses the infection, bone quality, and overlying soft-tissue integrity must be considered for a successful outcome. Acute shortening with an Ilizarov frame has been shown to be helpful in the treatment of open tibia fractures with simultaneous bone and soft-tissue loss. Cases in which the soft-tissue defect considerably exceeds bone loss may require an Ilizarov frame along with a concomitant soft-tissue procedure; however, there are a number of potential difficulties with vascularized pedicle flaps and free tissue flaps, including anastomotic complications, partial flap necrosis, and flap failure. The technique described in this report involves acute shortening and temporary bony deformation with the Ilizarov apparatus to facilitate wound closure and does not require a concomitant soft-tissue reconstructive procedure. Once the wound is healed, osseous deformity and length are gradually corrected by distraction osteogenesis with the Ilizarov/Taylor Spatial frame.

**Key Words:** Ilizarov, Taylor Spatial frame, nonunion, acute shortening, deformity correction, wound closure

*J Orthop Trauma* 2006;20:419-424

The Ilizarov method has been described alone or in combination with soft-tissue reconstruction for the management of open tibia fractures, limb shortening, deformity, joint contractures, and infections. Shortening with bifocal compression-distraction has been successfully used in the treatment of open tibia fractures with primary wound closure or delayed primary wound closure.<sup>1-3</sup> The technique is called bifocal because there are 2 segments with activity. One segment (the defect) is

undergoing compression/shortening, and 1 segment (the bony regenerate) is undergoing distraction/lengthening to maintain the length of the limb. Bone defects < 3 cm can usually be acutely shortened, and defects of > 3 cm should usually be gradually shortened.<sup>1</sup> Acute shortening is easier and safer to accomplish in the acute rather than chronic situation. Acute shortening of > 3 cm may be safe if the vascular physical examination does not change. Bifocal compression-distraction not only leads to solid osseous union but also corrects limb length discrepancy, deformity, joint contractures, and infection throughout the treatment period. The Ilizarov method does not eliminate or "correct" the infection solely because it is applied to the bone. Removal of the dead bone, sequestrum, debridement, irrigation, local, and systemic antibiotics, etc., all contribute to the elimination of the infection from the bone. It does supply stability as an adjunct to the whole process. Additionally, the absence of internal fixation may be safer in the setting of active or history of infection.

In the present article, the authors present the technique of acute shortening and intentional temporary bony deformation to facilitate wound closure, thereby avoiding a soft-tissue flap, along with an illustrative case example. With the leg stabilized in the Ilizarov/Taylor Spatial frame (TSF; Smith & Nephew, Inc., Memphis, TN), the wound was allowed to completely heal in the deformed position. The deformed leg was gradually corrected until anatomic reduction of the bony fragments was achieved, and through a second tibial osteotomy, the leg was lengthened to correct the leg length discrepancy (LLD). The TSF, which is particularly useful for this technique, is an evolution of the Ilizarov frame that allows simultaneous correction of length, angulation, translation, and rotation about a virtual axis.<sup>4-6</sup> With the TSF, a crooked frame mounted on a deformed bone can be used to gradually correct the leg deformity.<sup>4</sup>

## SURGICAL TECHNIQUE

Surgery is usually performed under regional anesthesia. Preoperative antibiotics are withheld until after intraoperative cultures are obtained. Bony edges are debrided with the goal of removing all dead bone. The bony edges are cut flat and perpendicular to the axis of the tibia with a power saw cooled with saline. An equal-sized segment of the fibula must be removed at about the

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From the Limb Lengthening and Deformity Service, Orthopaedic Trauma Service, Hospital for Special Surgery, Weill Medical College of Cornell University, New York, New York, 10021.

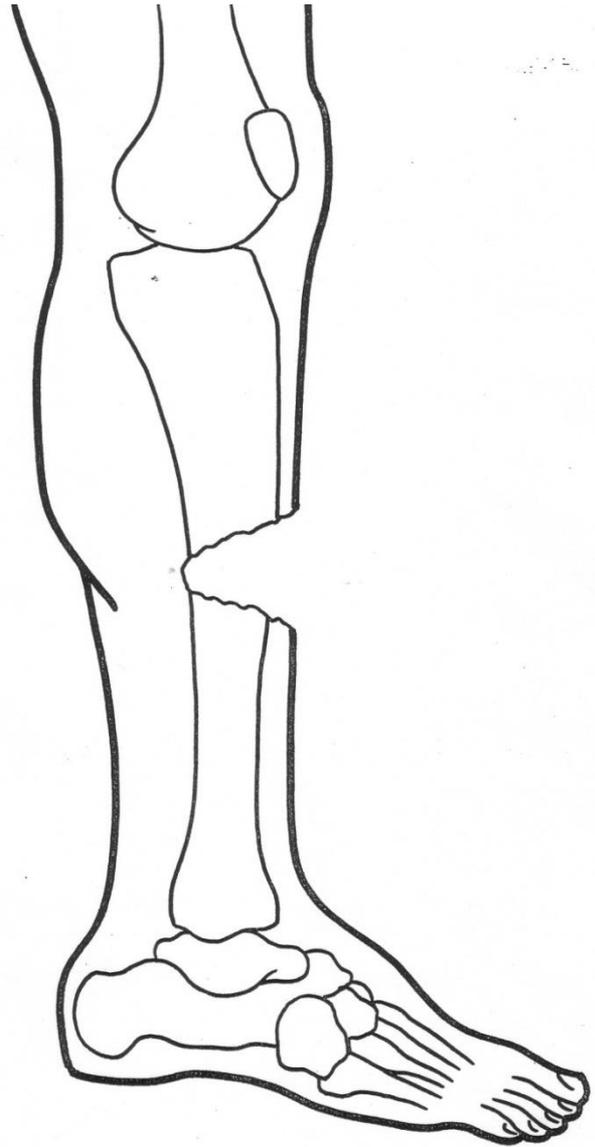
No authors received financial support for the research or preparation of the manuscript.

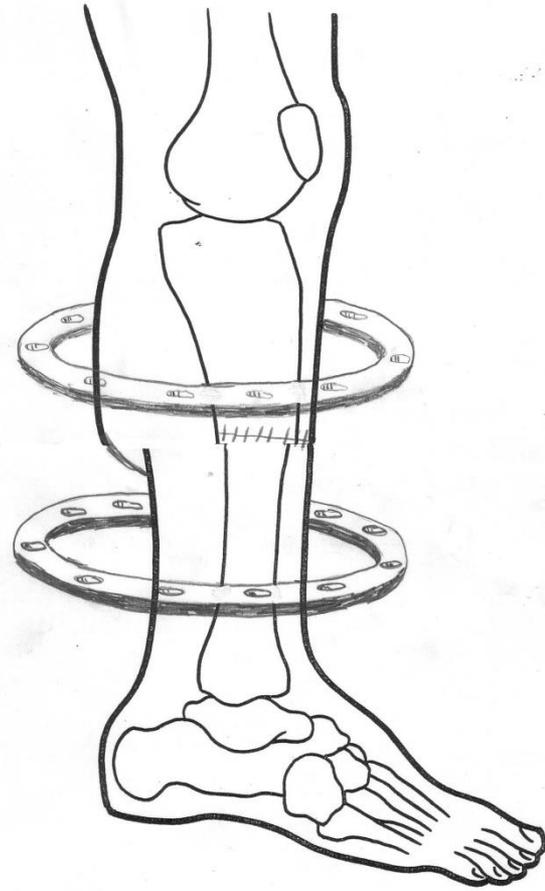
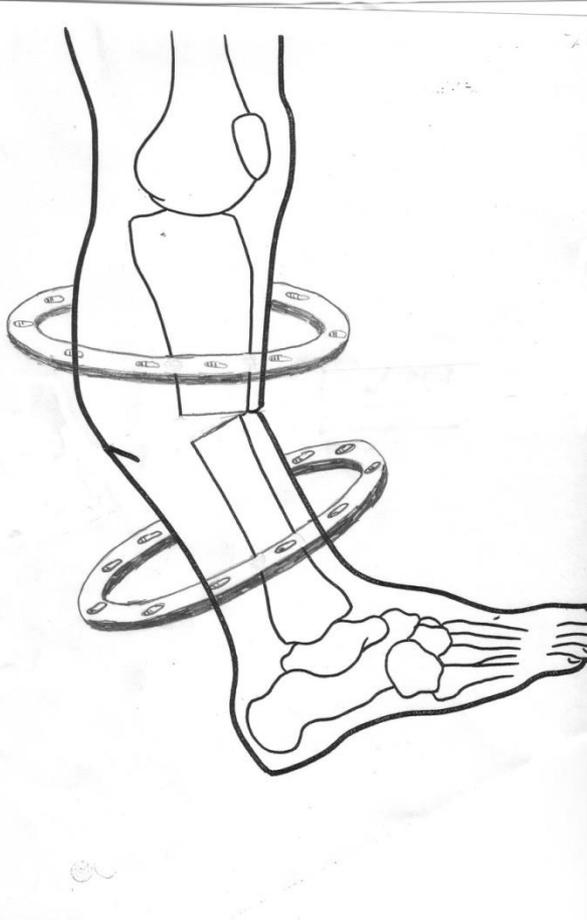
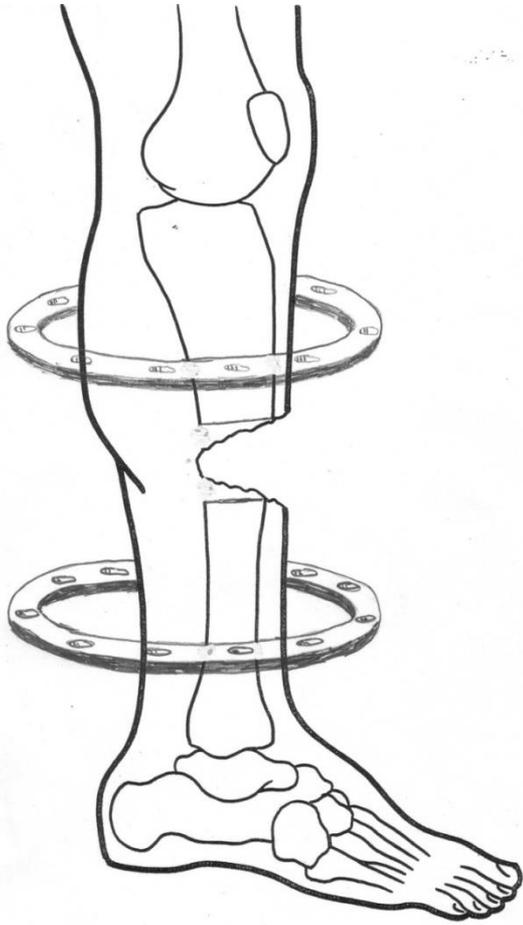
The device that are the subject of this manuscript are FDA approved. Reprints: S. Robert Rozbruch, MD, The Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021 (e-mail: RozbruchSR@hss.nyu).

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# Infected nonunion, bone loss, soft-tissue defect

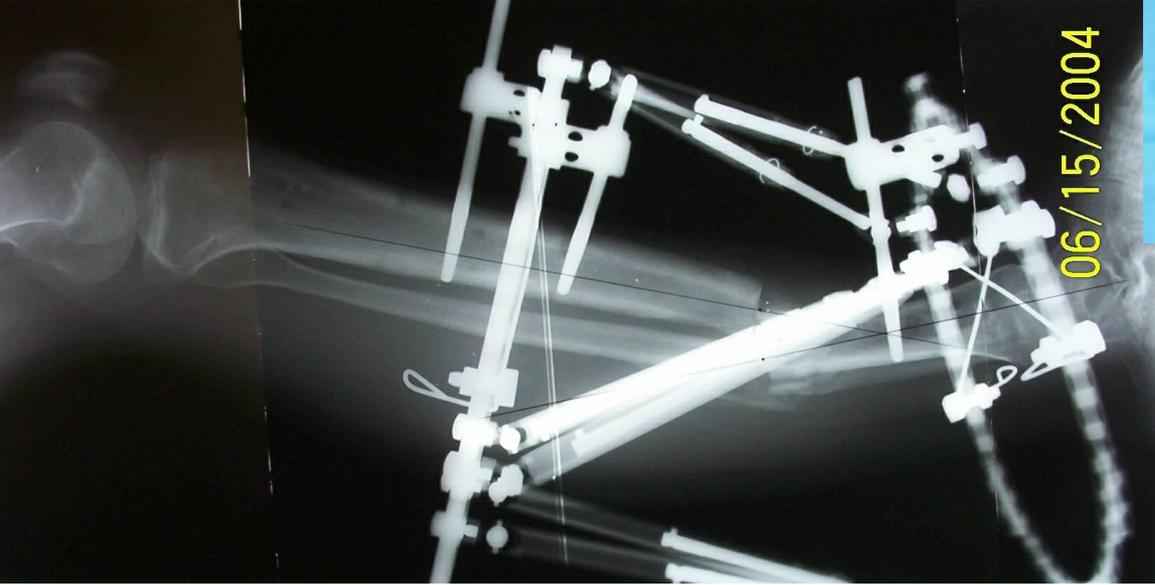




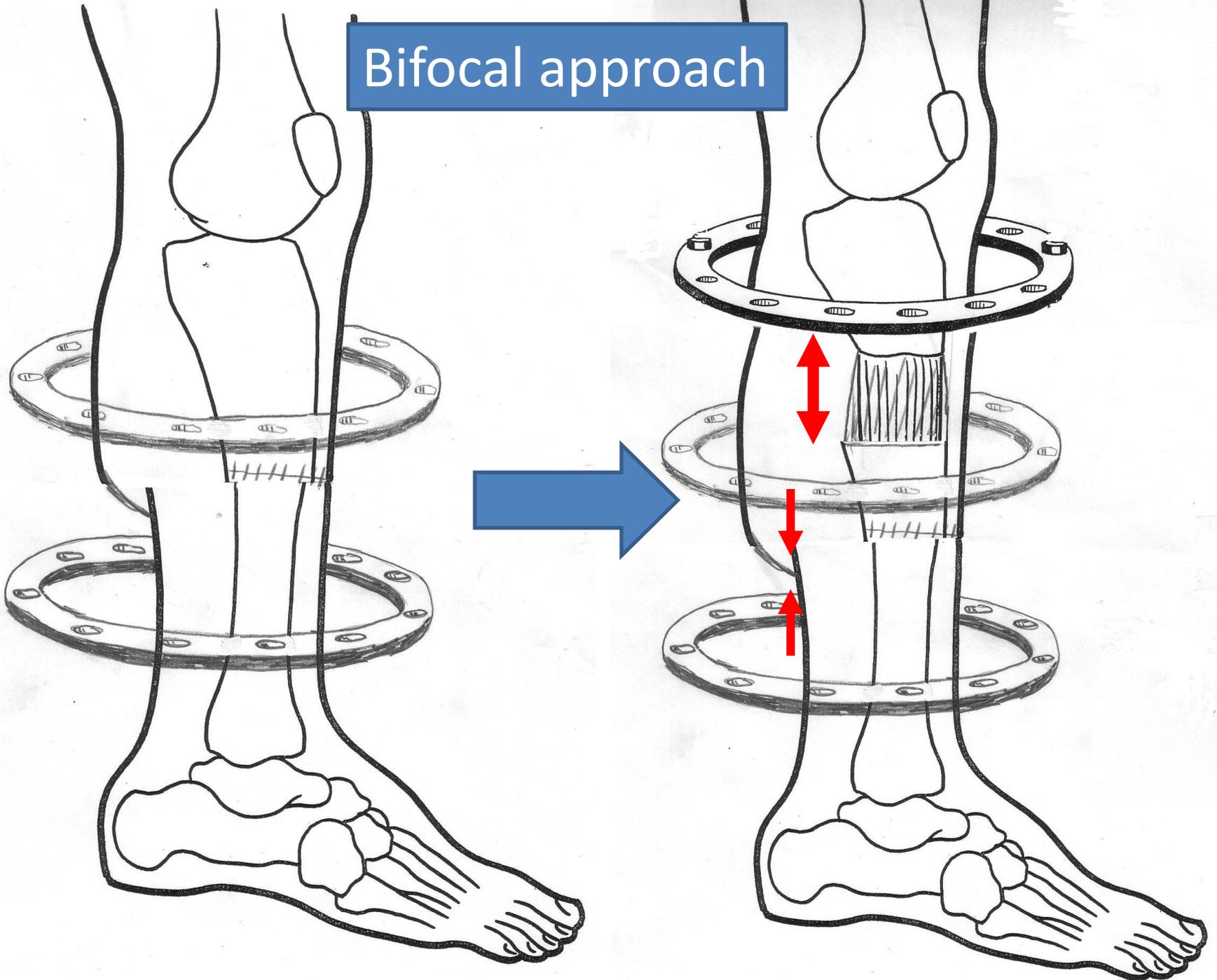


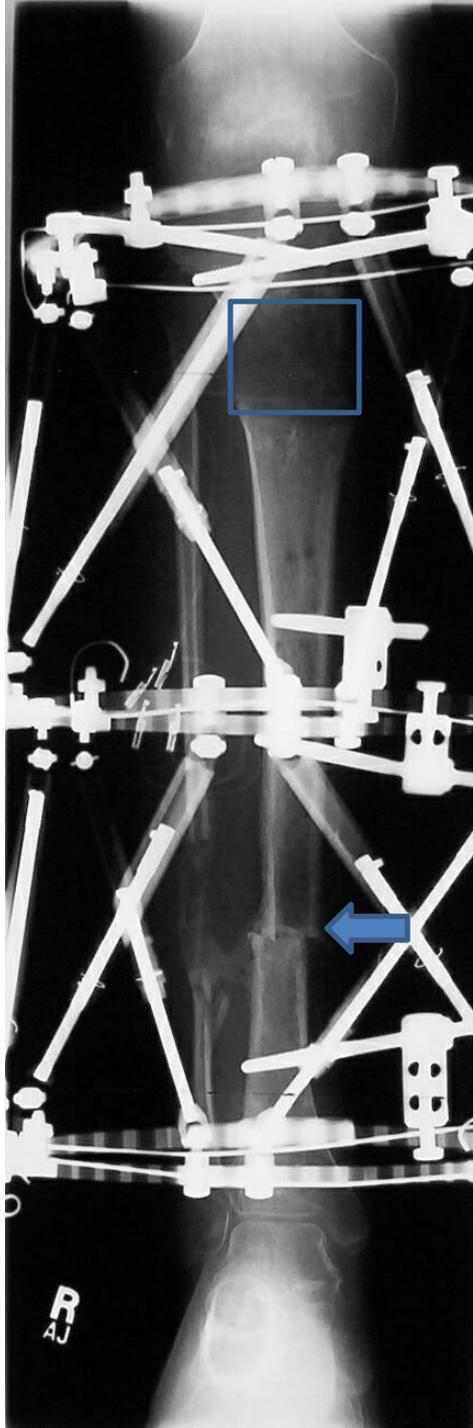


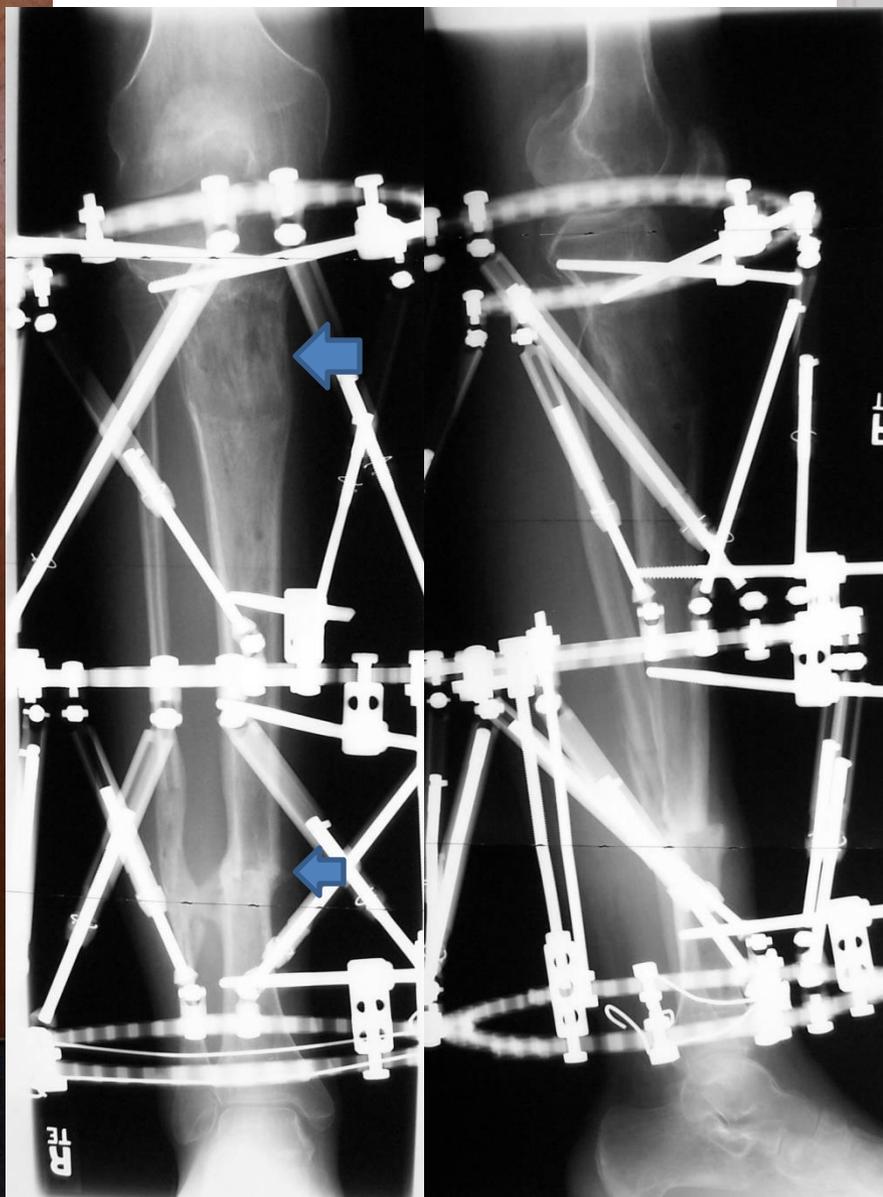
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# Bifocal approach

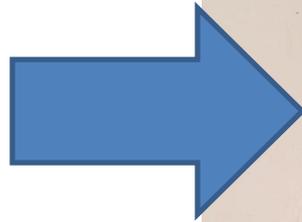












# Trifocal technique

## Simultaneous Treatment of Tibial Bone and Soft-tissue Defects With the Ilizarov Method

S. Robert Rozbruch, MD,\* Adam M. Weitzman, BA,† J. Tracey Watson, MD,‡  
Paul Freudigman, MD,§ Howard V. Katz, MD,|| and Svetlana Ilizarov, MD\*

Rozbruch et al

**Objectives:** To evaluate the potential for limb salvage using the Ilizarov method to simultaneously treat bone and soft-tissue defects of the leg without flap coverage.

**Design:** Retrospective study.

**Setting:** Level I trauma centers at 4 academic university medical centers.

**Patients/Participants:** Twenty-five patients with bone and soft-tissue defects associated with tibial fractures and nonunions. The average soft-tissue and bone defect after debridement was 10.1 (range, 2–25) cm and 6 (range, 2–14) cm respectively. Patients were not candidates for flap coverage and the treatment was a preamputation limb salvage undertaking in all cases.

**Intervention:** Ilizarov and Taylor Spatial Frames used to gradually close the bone and soft-tissue defects simultaneously by using monofocal shortening or bifocal or trifocal bone transport.

**Main Outcome Measurements:** Bone union, soft-tissue closure, resolution or prevention of infection, restoration of leg length equality, alignment, limb salvage.

**Results:** The average time of compression and distraction was 19.7 (range, 5–70) weeks, and time to soft-tissue closure was 14.7 (range, 3–41) weeks. Bony union occurred in 24 patients (96%). The average time in the frame was 43.2 (range, 10–82) weeks. Lengthening at another site was performed in 15 patients. The average amount of bone lengthening was 5.6 (range, 2–11) cm. Final leg length discrepancy (LLD) averaged 1.2 (range, 0–5) cm. Use of the trifocal approach resulted in less time in the

frame for treatment of large bone and soft-tissue defects. There were no recurrences of osteomyelitis at the nonunion site. All wounds were closed. There were no amputations. All limbs were salvaged.

**Conclusions:** The Ilizarov method can be successfully used to reconstruct the leg with tibial bone loss and an accompanying soft-tissue defect. This limb salvage method can be used in patients who are not believed to be candidates for flap coverage. One also may consider using this technique to avoid the need for a flap. Gradual closure of the defect is accomplished resulting in bony union and soft-tissue closure. Lengthening can be performed at another site. A trifocal approach should be considered for large defects (> 6 cm). Advances in technique and frame design should help prevent residual deformity.

**Key Words:** Ilizarov, tibia, wound, nonunion, bone defect, Taylor spatial frame

(*J Orthop Trauma* 2006;20:197–205)

Tibial diaphyseal fractures are among the most common types of open fracture and > 50% are classified as high-energy Gustilo-Anderson type III fractures.<sup>1–3</sup> Management of these fractures is further complicated by accompanied vascular and soft-tissue injury, putting these limbs at risk for infection, bone loss, and even amputation.<sup>4–7</sup> Even if bony union is achieved, these difficulties may still lead to impaired function of the treated limb and result in poor functional outcome from limb length discrepancy, deformity, and joint contractures.<sup>8</sup>

The Ilizarov method has been used successfully in the treatment of tibial fractures, nonunions, and malunions, deformity, and shortening.<sup>8–12</sup> The dynamic frame enables gradual lengthening, deformity correction, and nonunion or delayed union compression while remaining minimally invasive.<sup>5,11,13–16</sup> The Ilizarov method of intercalary bone transport has been used to deal with tibial bone loss and achieve limb salvage.<sup>8,17,18</sup>

The soft-tissue damage found in these fractures and wound management often are the main factors affecting outcome.<sup>6,19,20</sup> The preferred treatment of these wounds during tibial fixation is early application of a local flap if the defect is in the proximal two-thirds of the tibia or a free muscle flap if it is in the distal one-third.<sup>21–23</sup> Local flaps can, however, be suboptimal because the tissue that

Accepted for publication October 4, 2005.

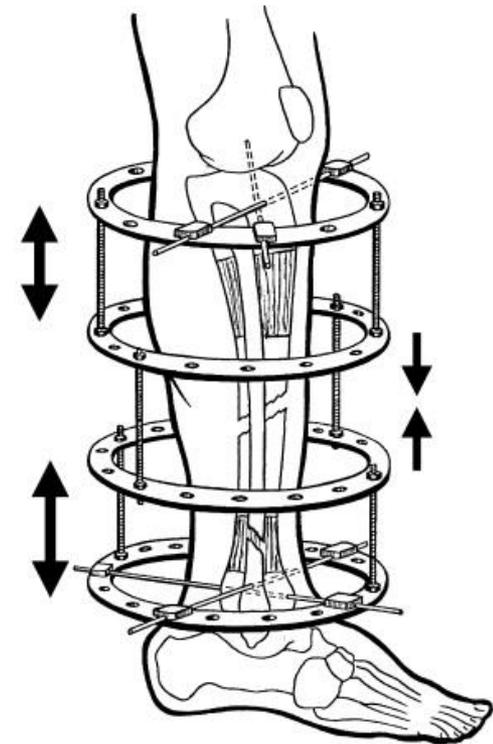
From the \*Hospital for Special Surgery, New York, NY; †Weill Medical College of Cornell University, New York, NY; ‡St. Louis University School of Medicine, St. Louis, MO; §Baylor School of Medicine, Waco, TX; and ||Beth Israel Medical Center, New York, NY. The lead author receives research and educational support from Smith and Nephew.

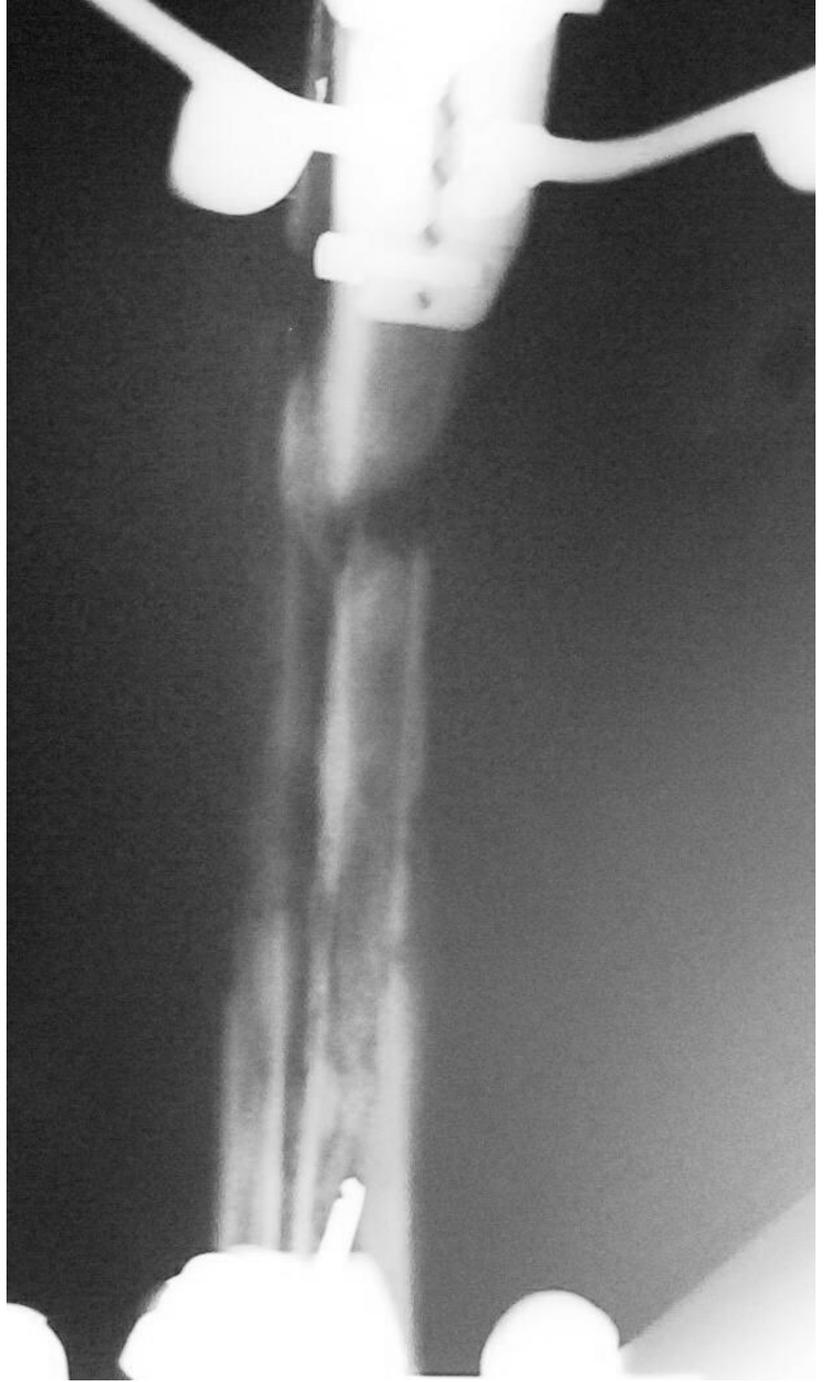
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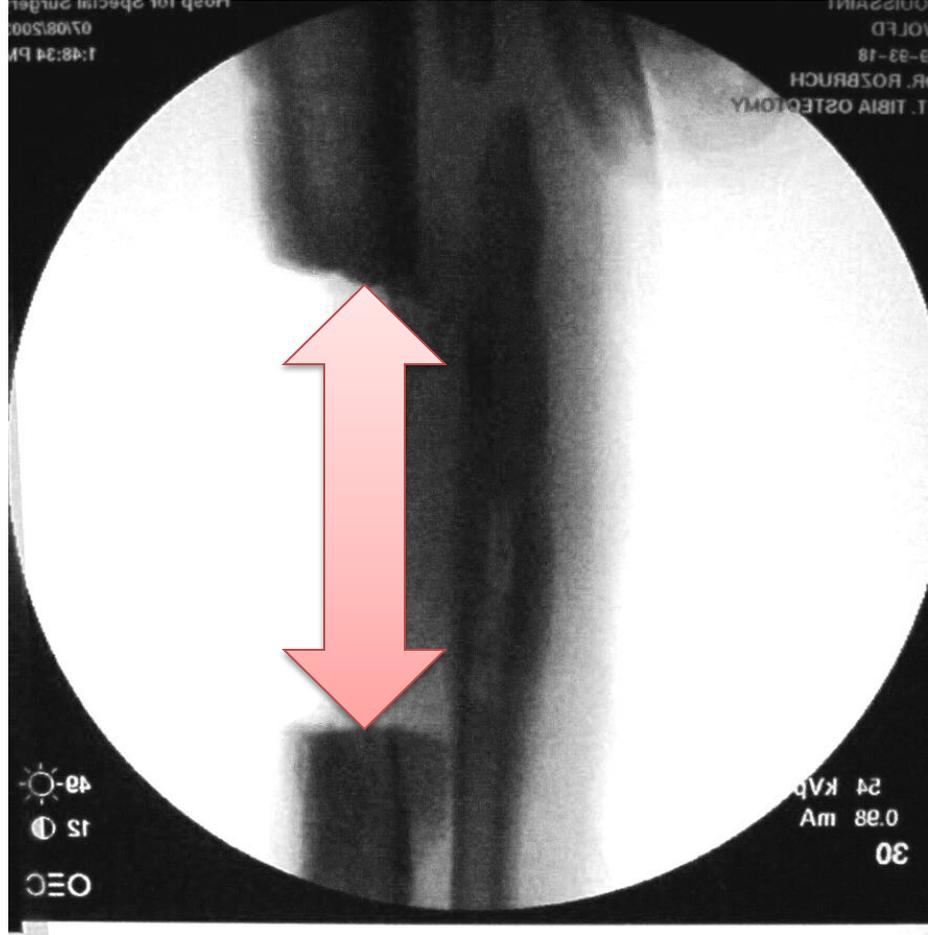
This study was not supported by a research grant. The devices that are the subject of this manuscript are FDA-approved (The Ilizarov and the Taylor Spatial Frame; Smith & Nephew, Memphis, TN, and the V.A.C.; Kinetic Concepts, Inc., San Antonio, TX).

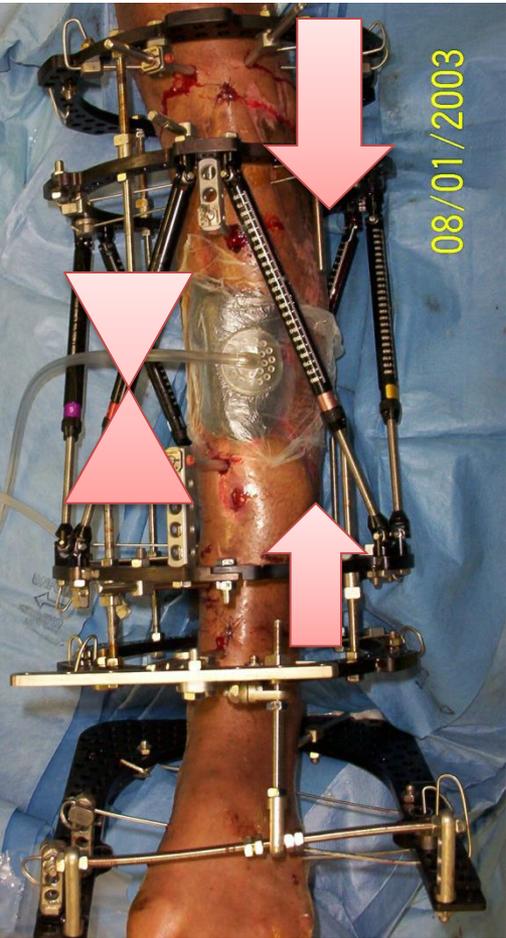
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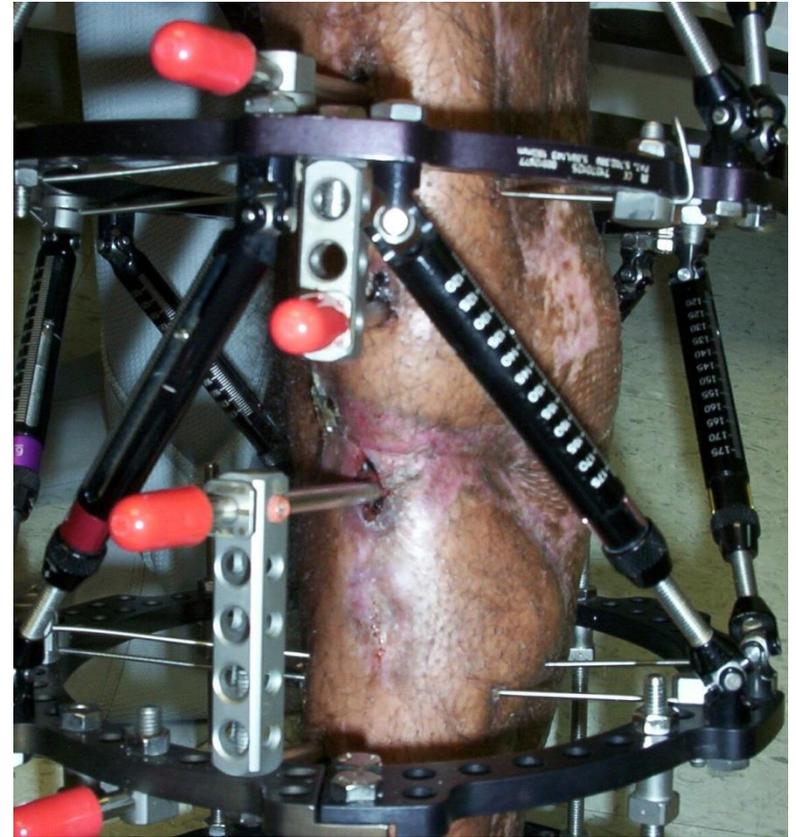
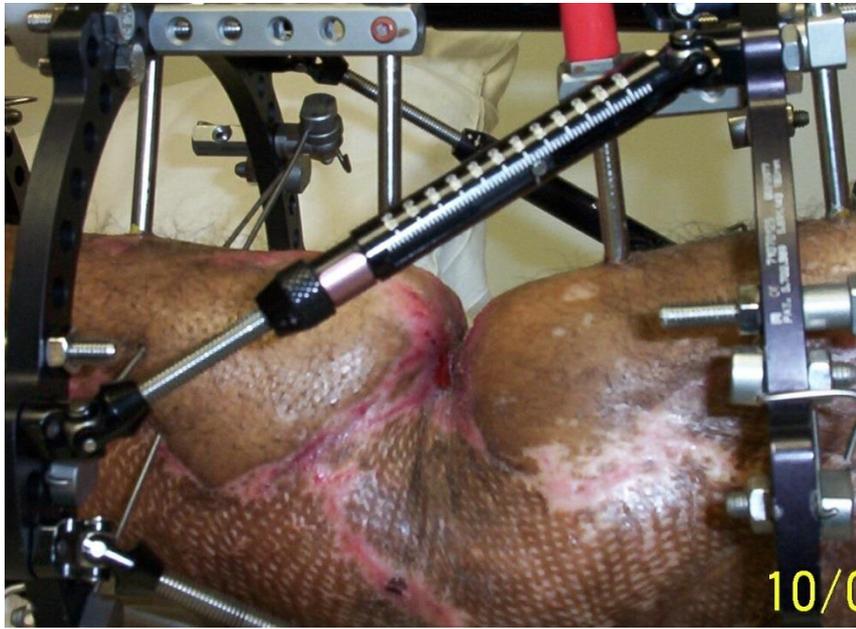
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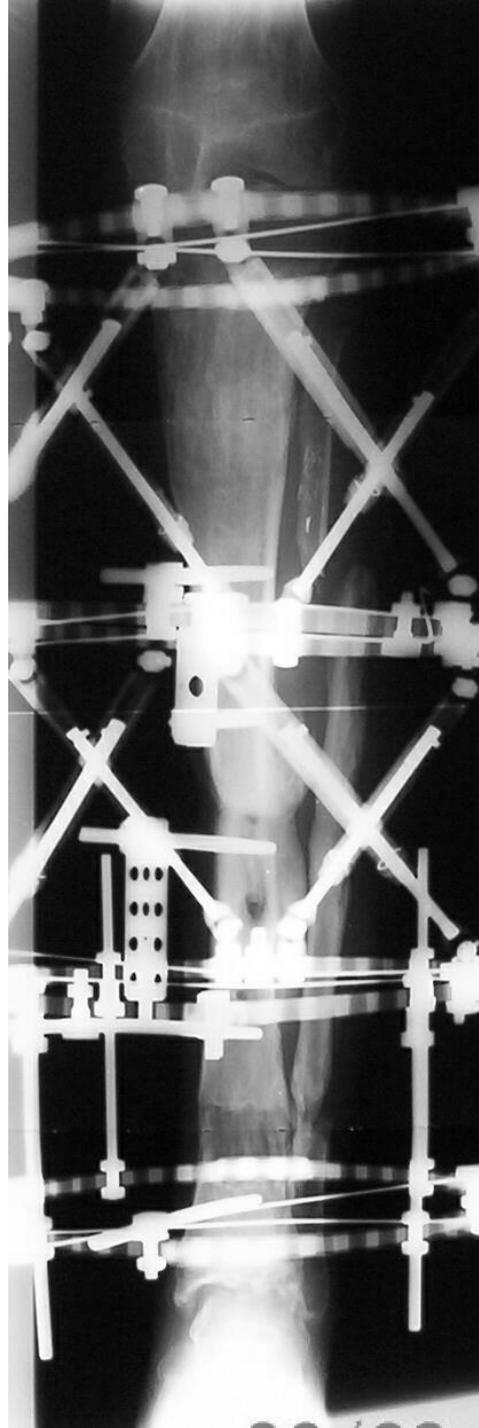












# 10 year follow-up



# W. H. Auden, Poet 1907-1973

- “Healing is not science but the intuitive art of wooing nature”
- Debride dead bone and create environment for healing



2016

3 Volumes

1. Pediatric Deformity
2. Trauma  
Foot and Ankle
3. Adult Reconstruction  
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Limb Lengthening and  
Reconstruction Surgery  
Case Atlas Vol. 1

S. ROBERT ROZBRUCH  
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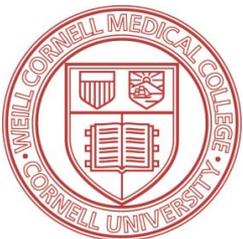
# Limb Lengthening and Reconstruction Surgery Case Atlas

*Volume 1*



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# Thank You



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