

Understanding Deformity Correction and TSF Principles

Advanced TSF Course, Memphis, TN; August 2-3, 2013

S. Robert Rozbruch, MD

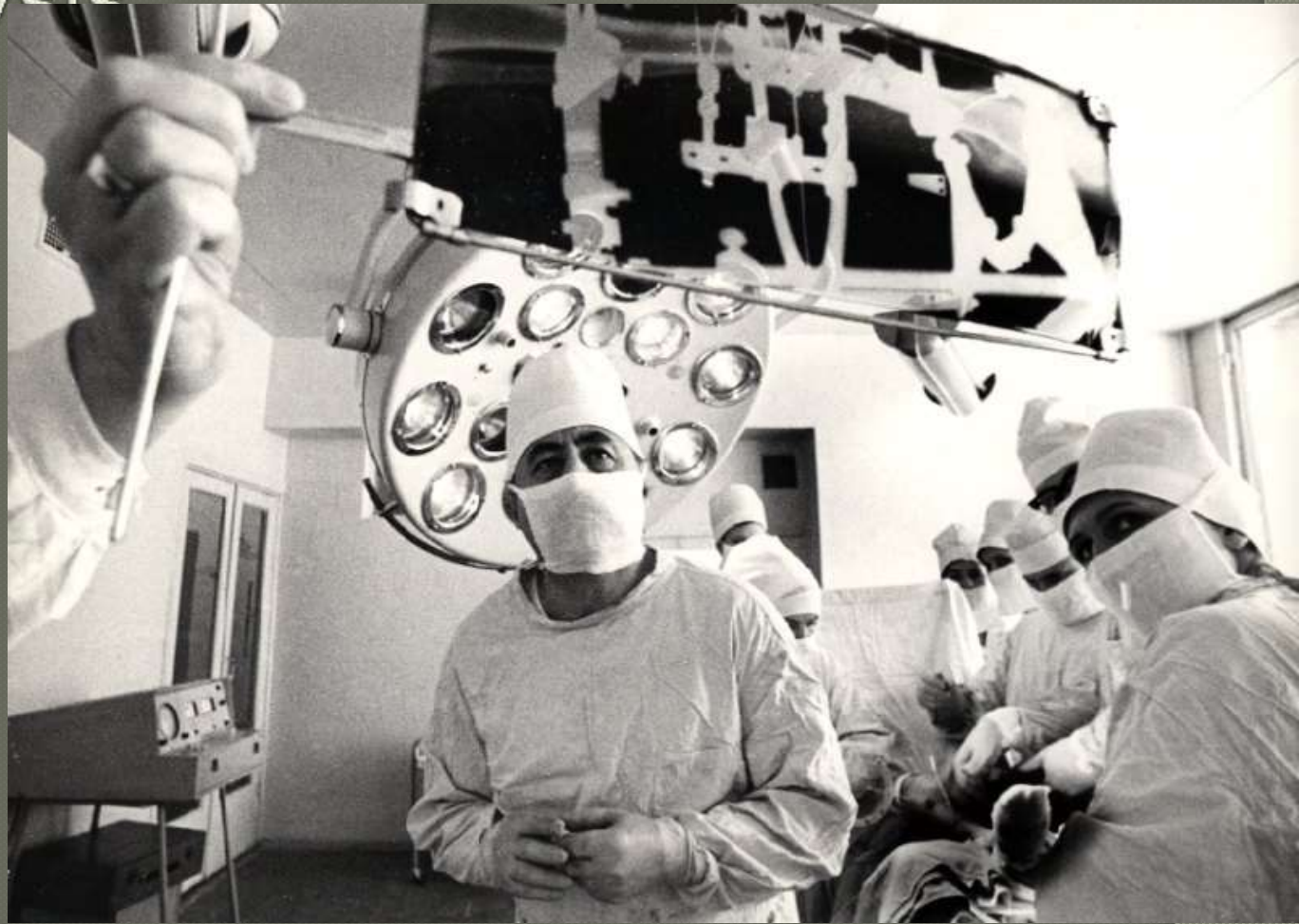
Chief, Limb Lengthening & Complex Reconstruction Service
Professor of Clinical Orthopedic Surgery



LIMB **LENGTHENING**.COM



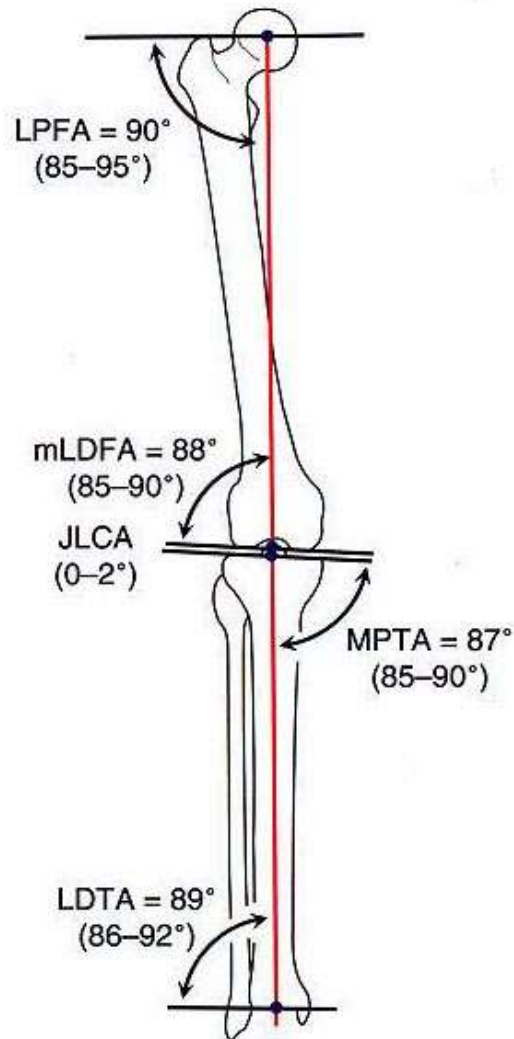
Radiographic analysis



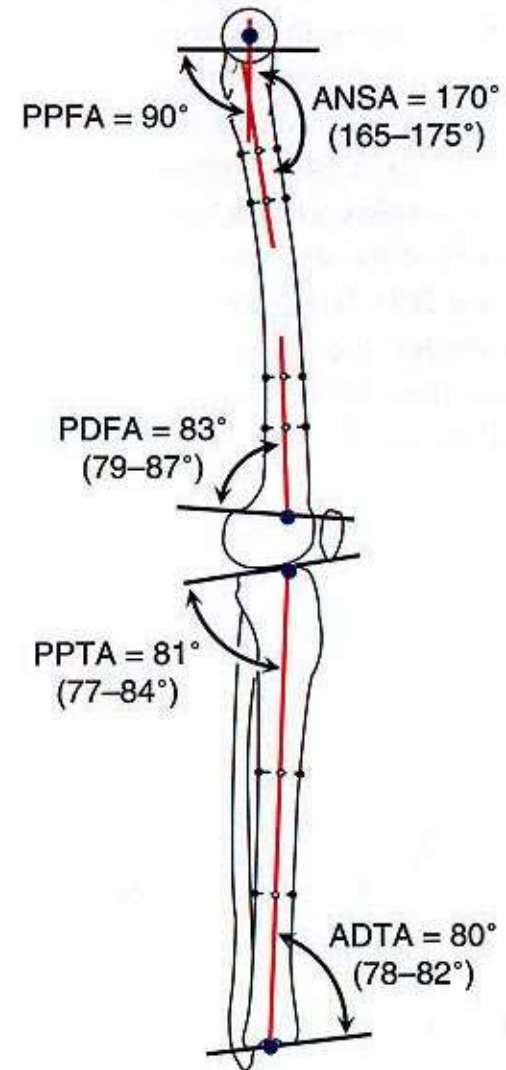
Normal alignment parameters

a.

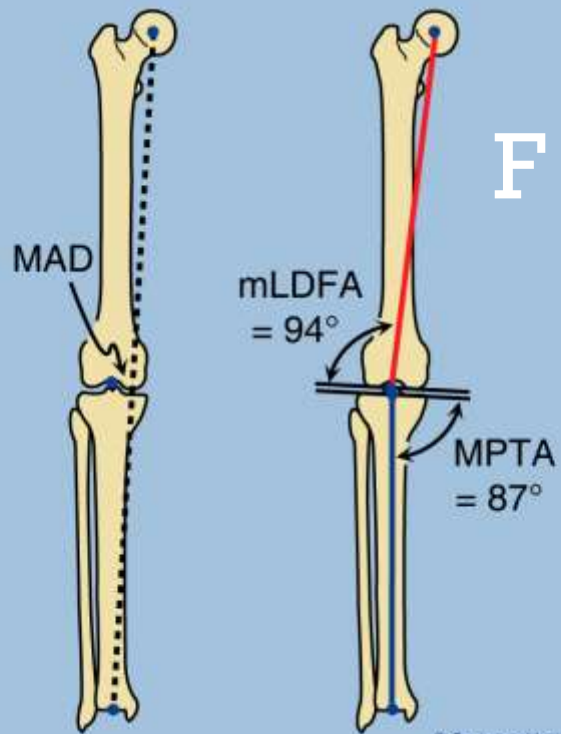
Mechanical



Sagittal



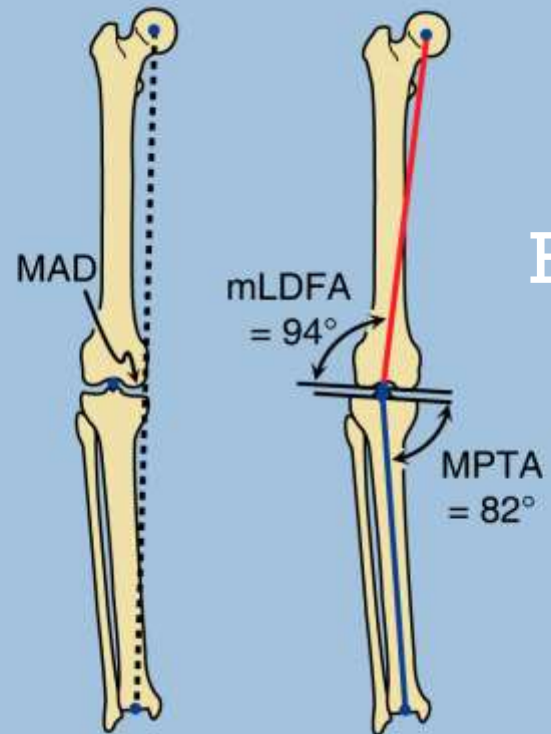
2-04a



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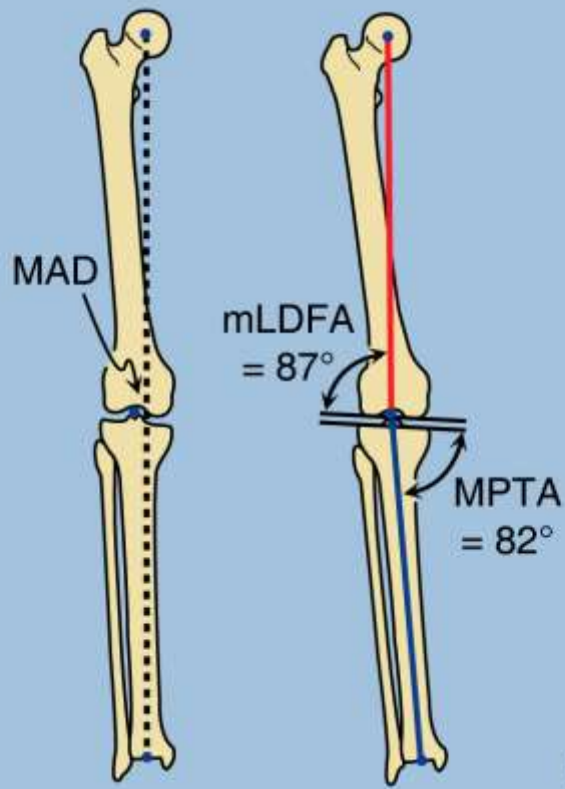
What is the source of deformity

2-04c



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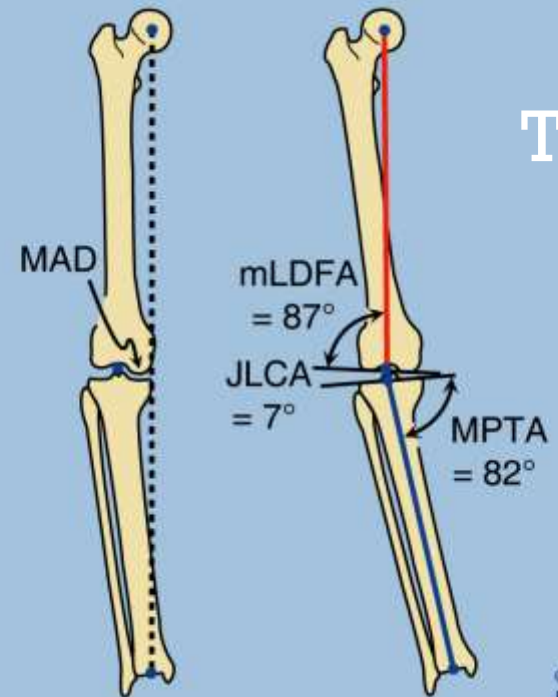
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T

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2-04d



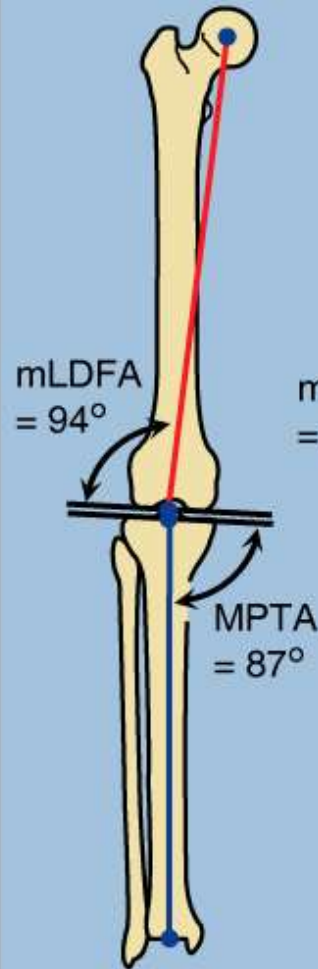
T+JLC

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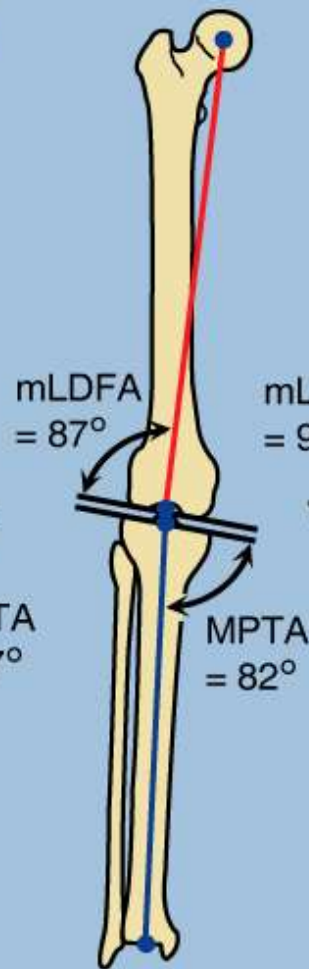
Malalignment
source



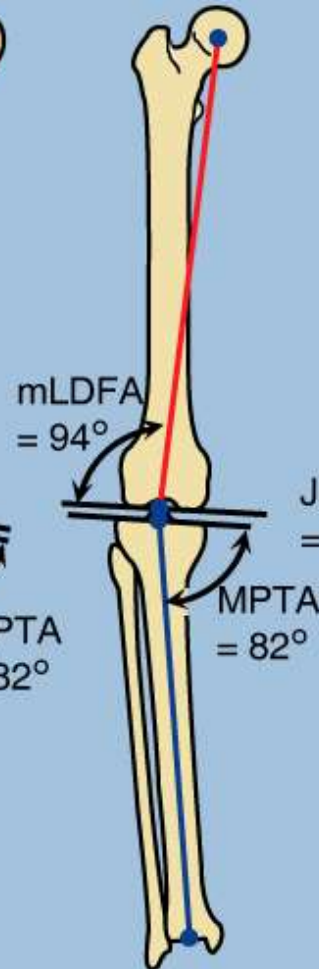
Femur



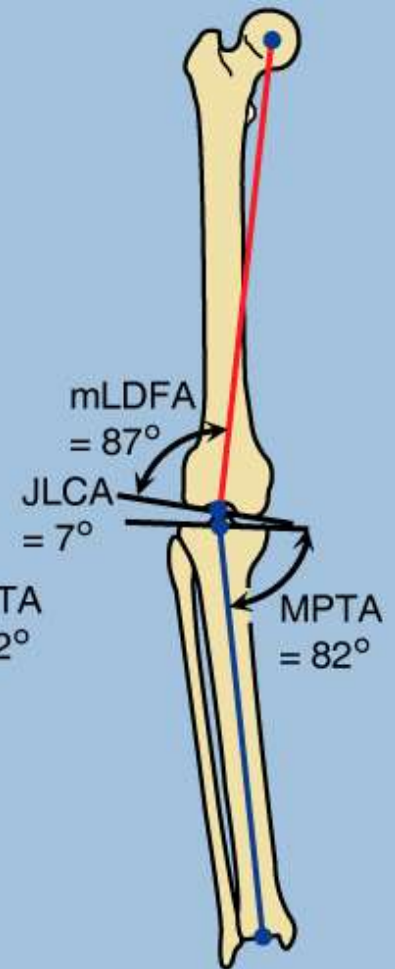
Tibia



Femur + Tibia

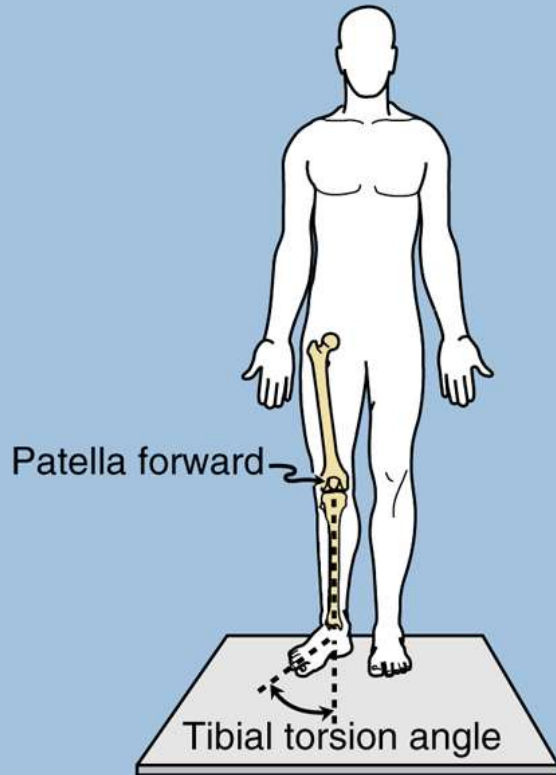


16-13a
Tibia + LCL



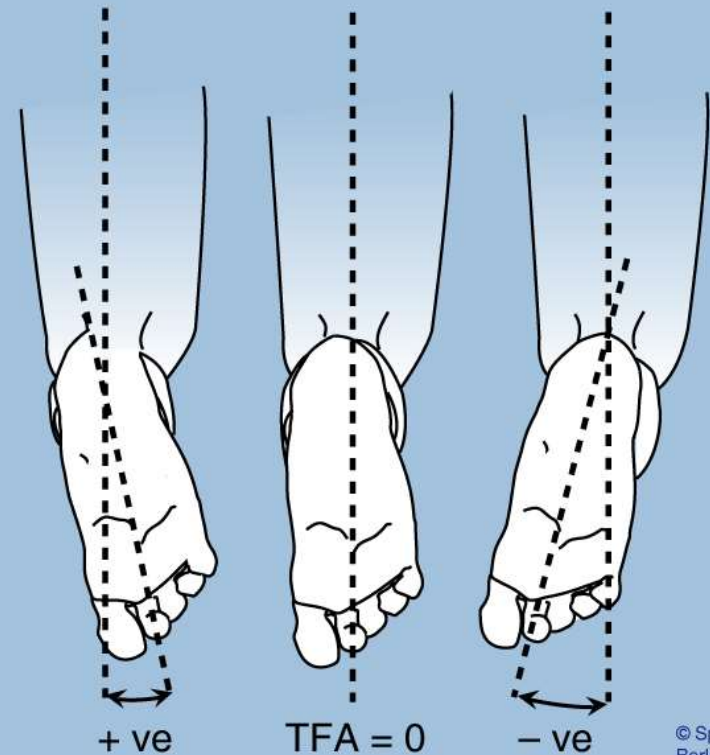
Rotational deformity -tibia

9-03c



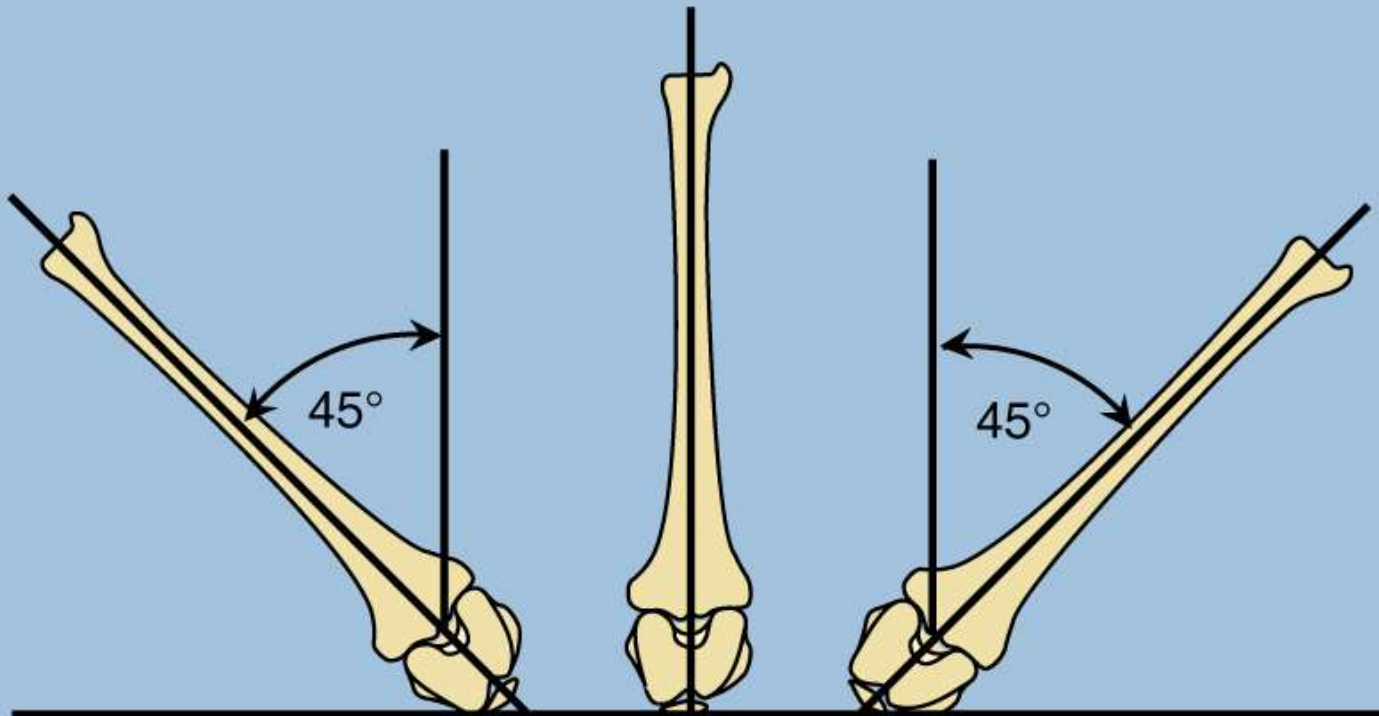
©
Bt

9-03a

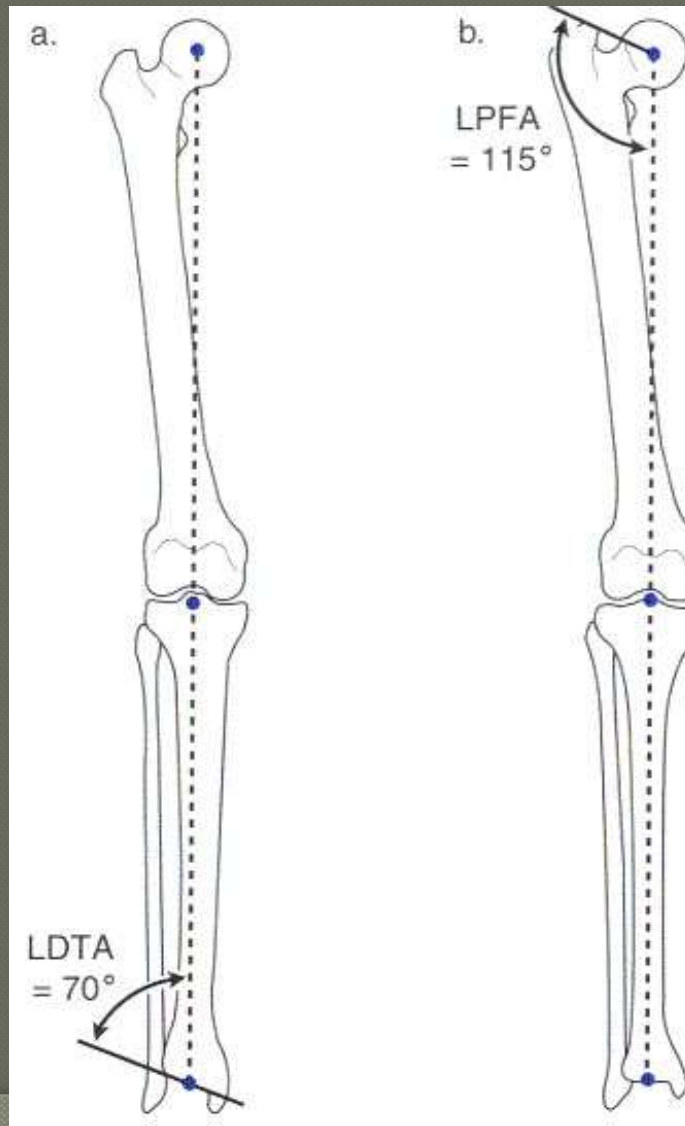


Rotational deformity-femur

9-04a



Hip and ankle deformities do not affect MAD much



Physical Exam

- Large Varus deformity
- Mild Procurvatum deformity
- 5'8" tall, 155 lbs.



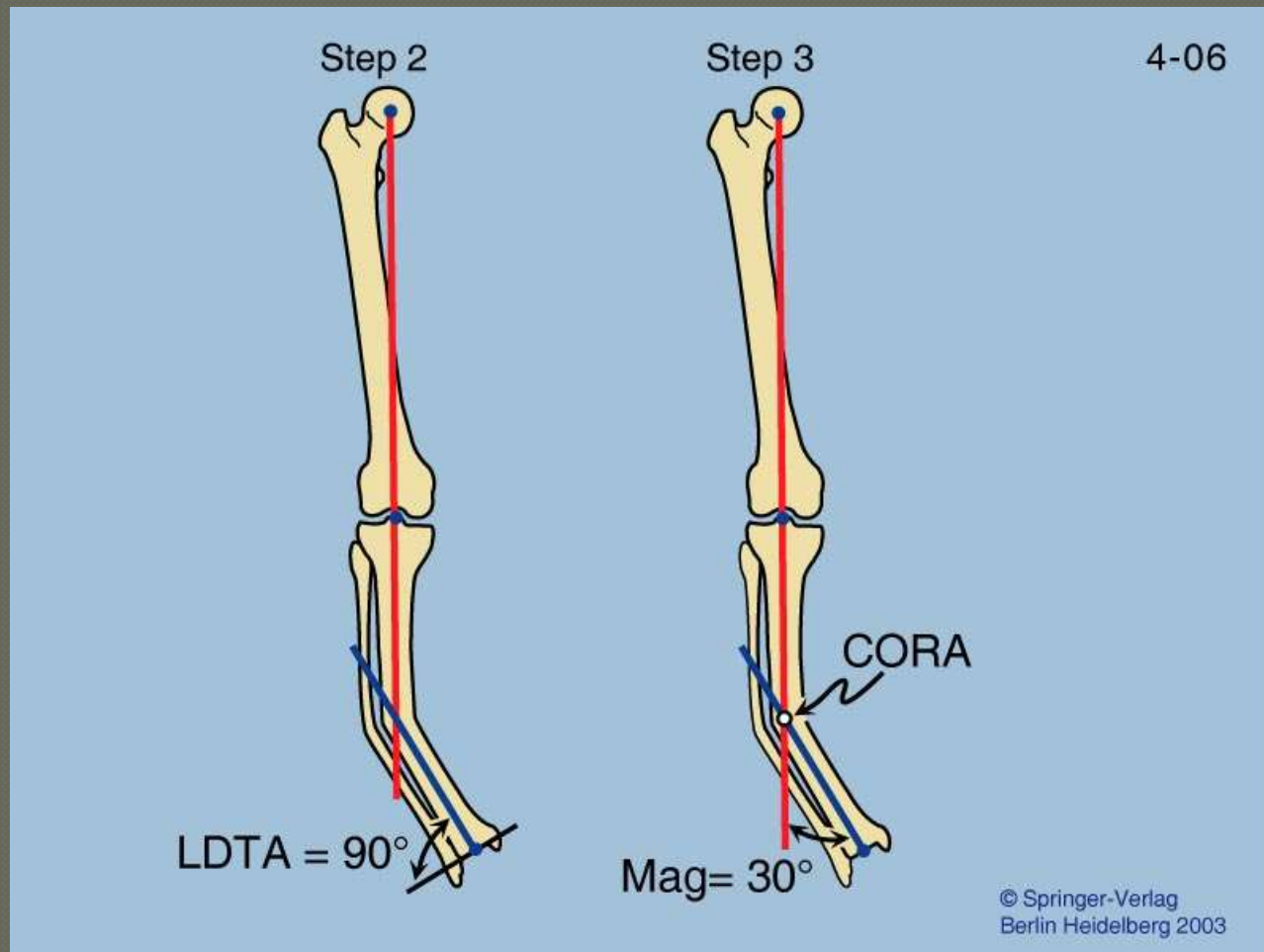
Radiographs

- 51" Erect Leg (10ft)
- 5% magnification
- MAD 7.8 cm medial
- LLD 3.2 cm
- Hypertrophic Nonunion, Stiff



CORA and magnitude of deformity

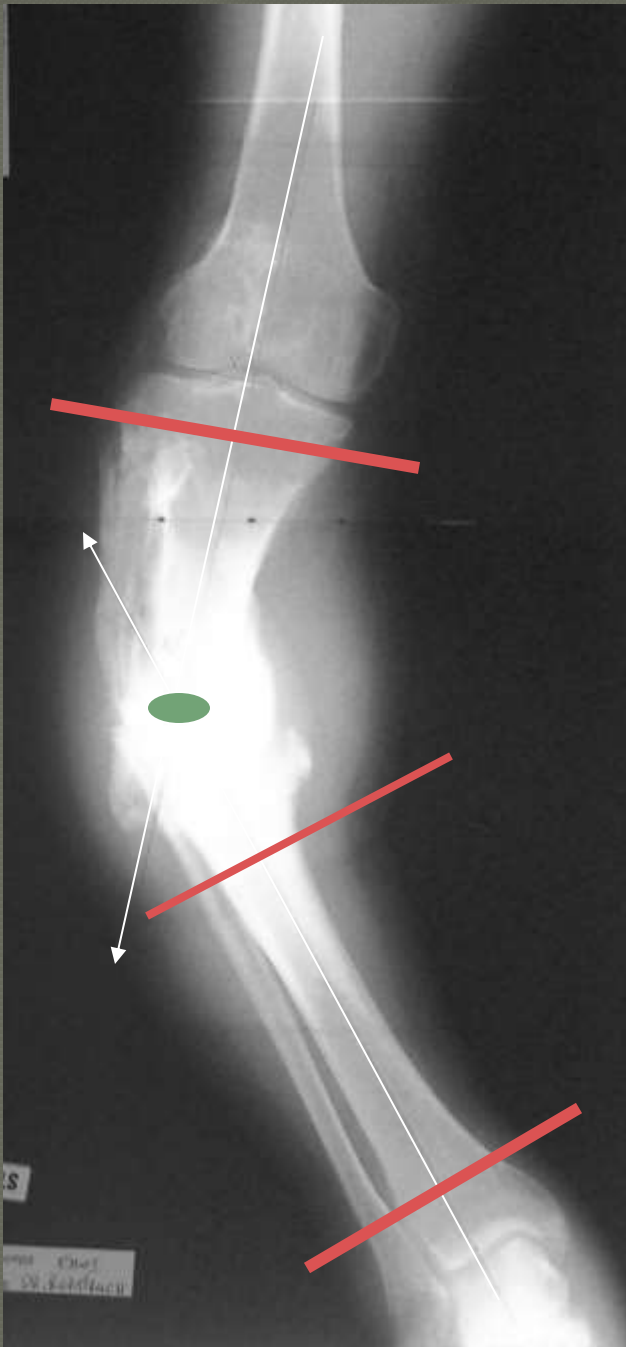
Normal Femur and Varus Tibia



Use extension of femur mech axis for proximal tibia mech. axis

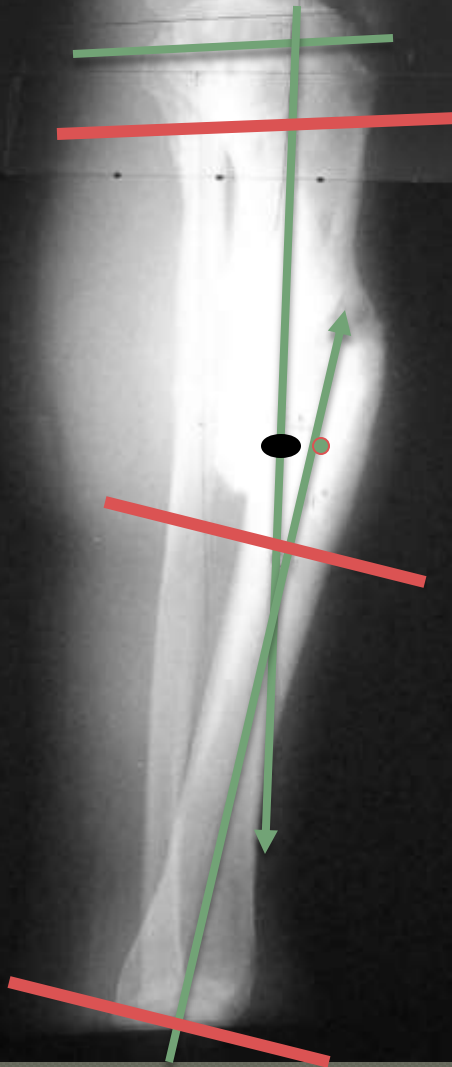
Radiographs

- 39 degrees varus deformity

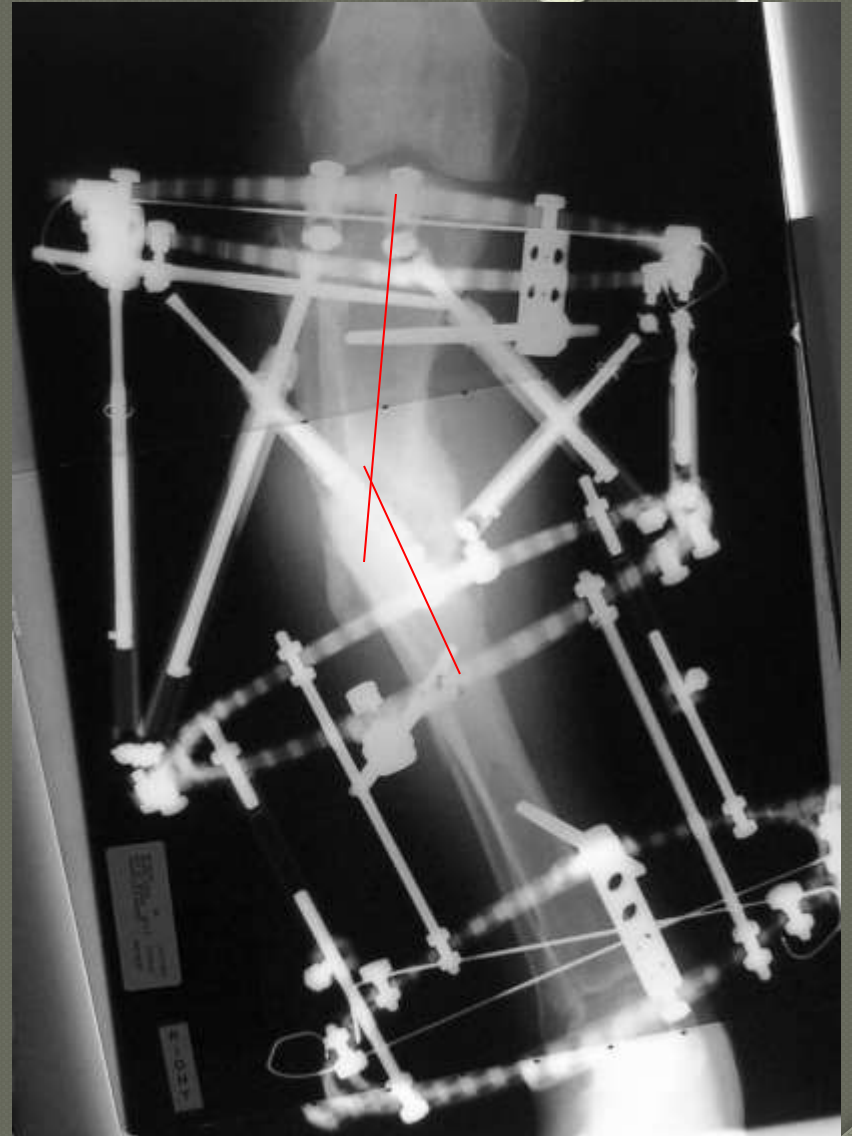


Radiographs

- 11 degrees procurvatum
- Anterior translation
 - 9 mm
- Hypertrophic Nonunion

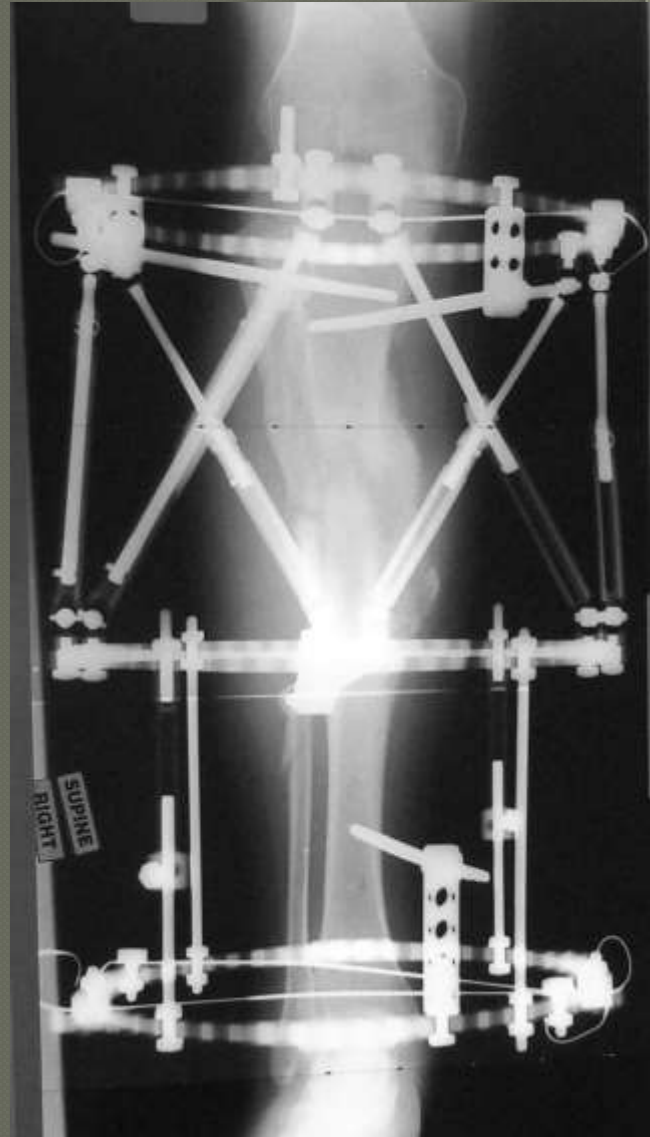
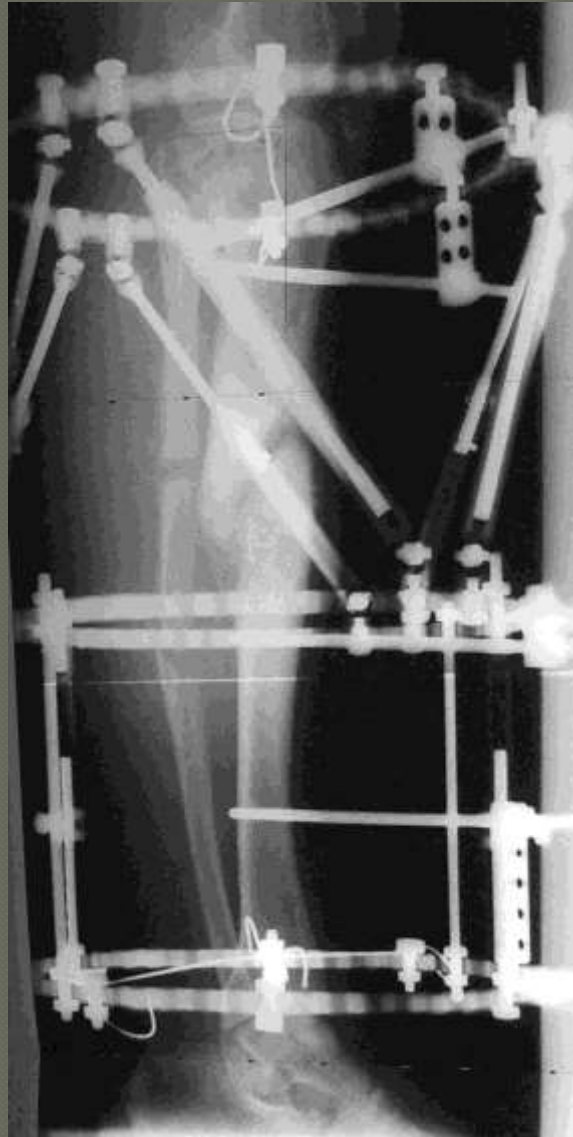


Surgery





End Distraction, day #38







5 months





Better ways to use the computer



Terminology

Reference Fragment

Origin /
Corresponding Point

Parameters Deformity
Mounting
Frame

Structure at Risk

Safe Velocity

Computer Program



Frame



Deformity Correction with External Fixation

- 3 Frame Parameters
- 4 Mounting Parameters
- 6 Deformity Parameters



DEFORMITY

Crooked frame / crooked bone



Total Residual Deformity Correction



CORRECTION



Deformity Parameters

Six Axis Deformity Correction

○ Frontal plane

- Angulation (e.g., varus)
- Translation

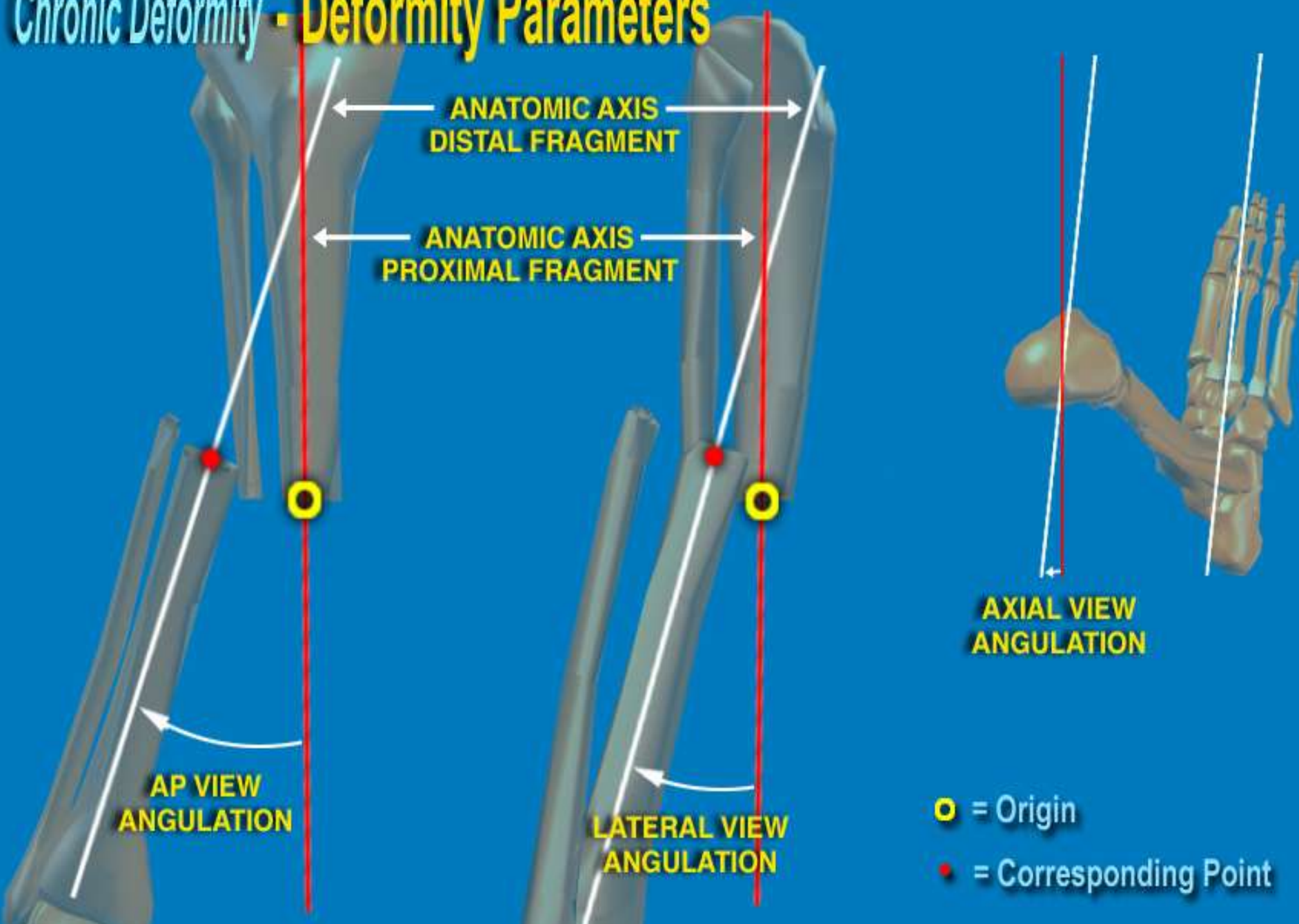
○ Sagittal Plane

- Angulation (e.g., procurvatum)
- Translation

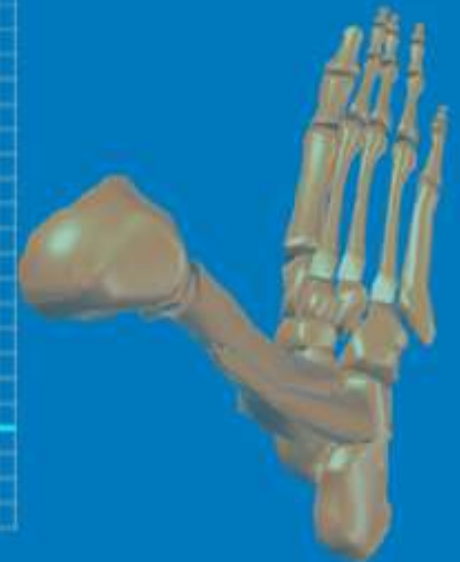
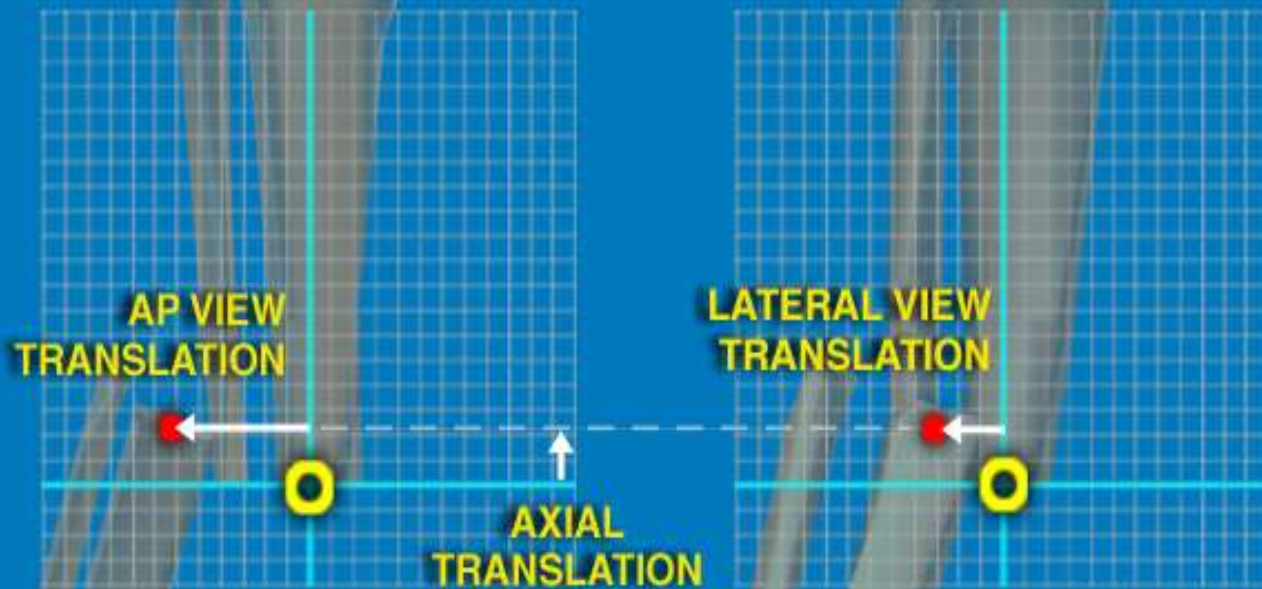
○ Axial Plane

- Angulation (rotational deformity)
- Translation (length, e.g, short)

Chronic Deformity - Deformity Parameters



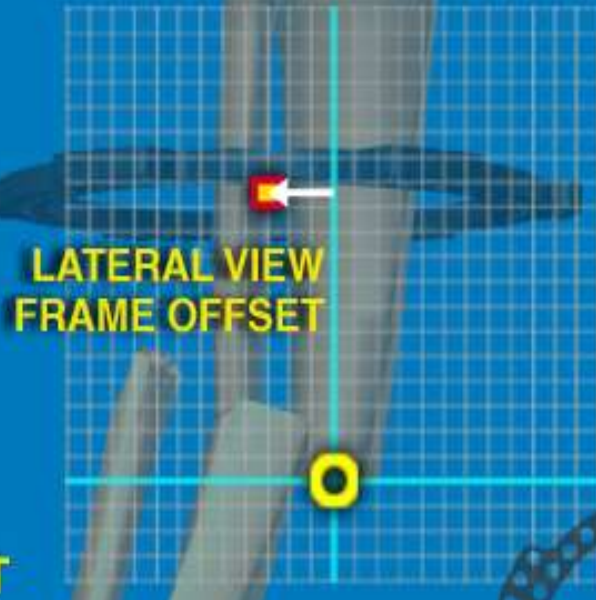
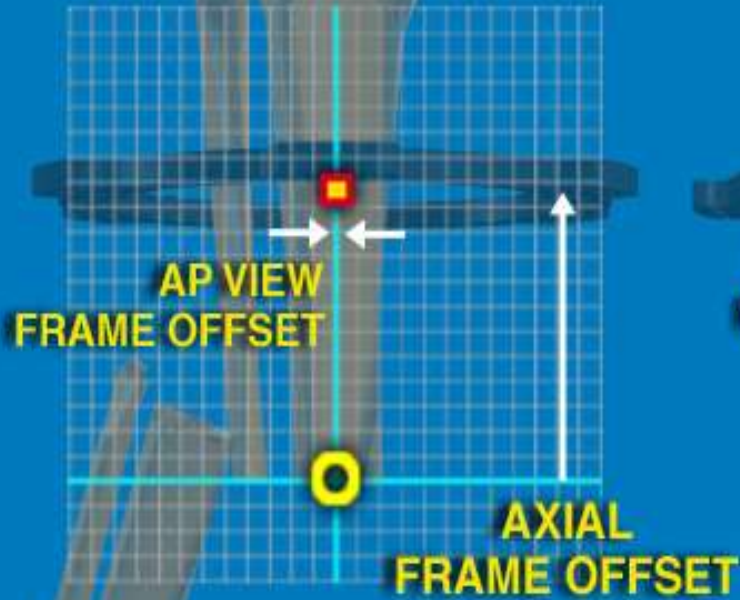
Chronic Deformity - Deformity Parameters



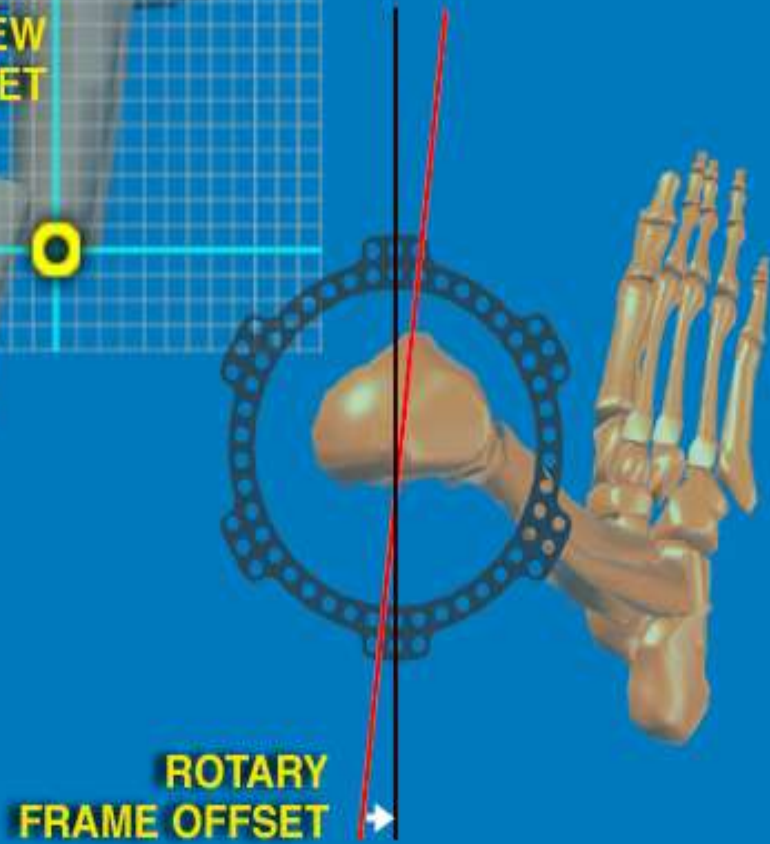
○ = Origin

● = Corresponding Point

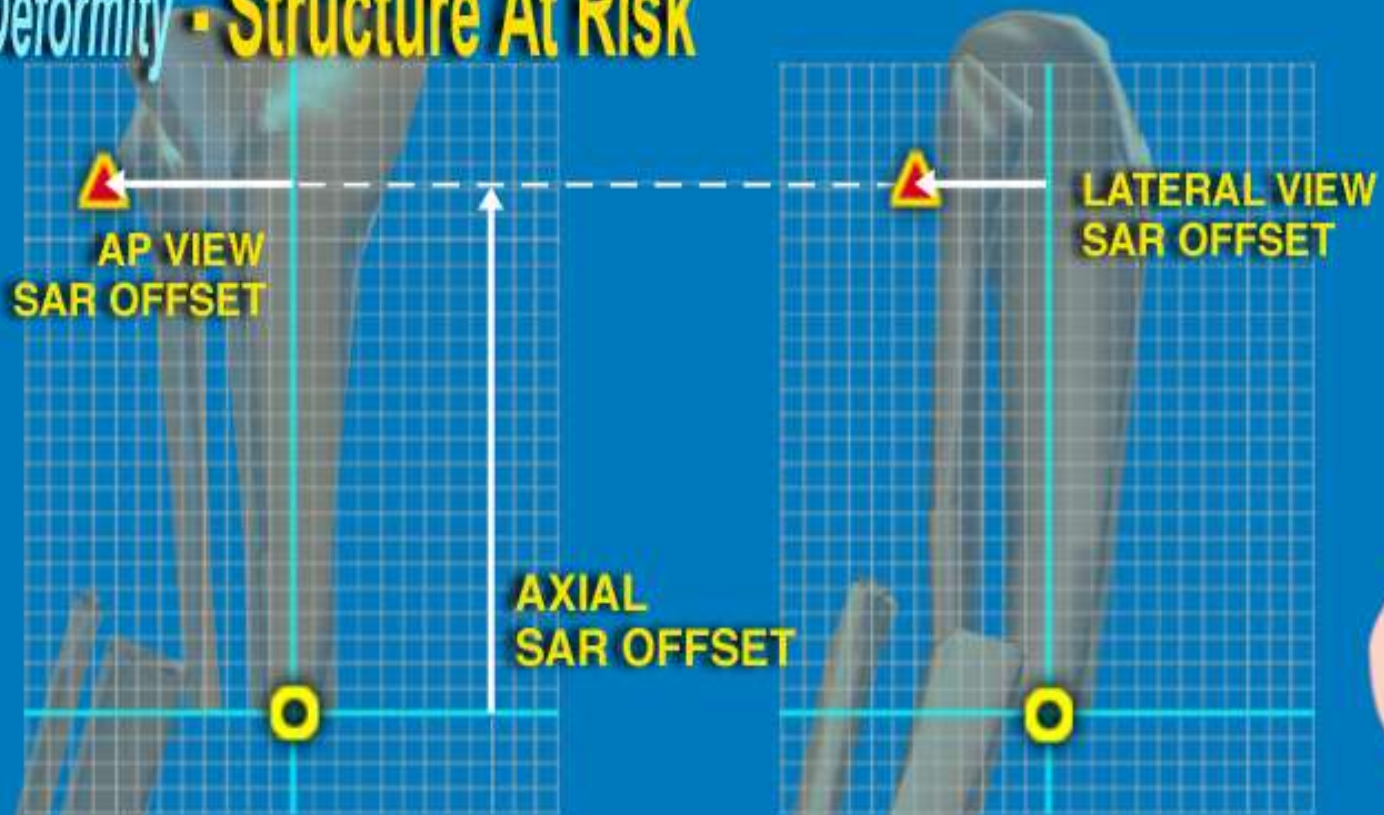
Chronic Deformity - Mounting Parameters



- = Center of Ring
- = Origin



Chronic Deformity - Structure At Risk

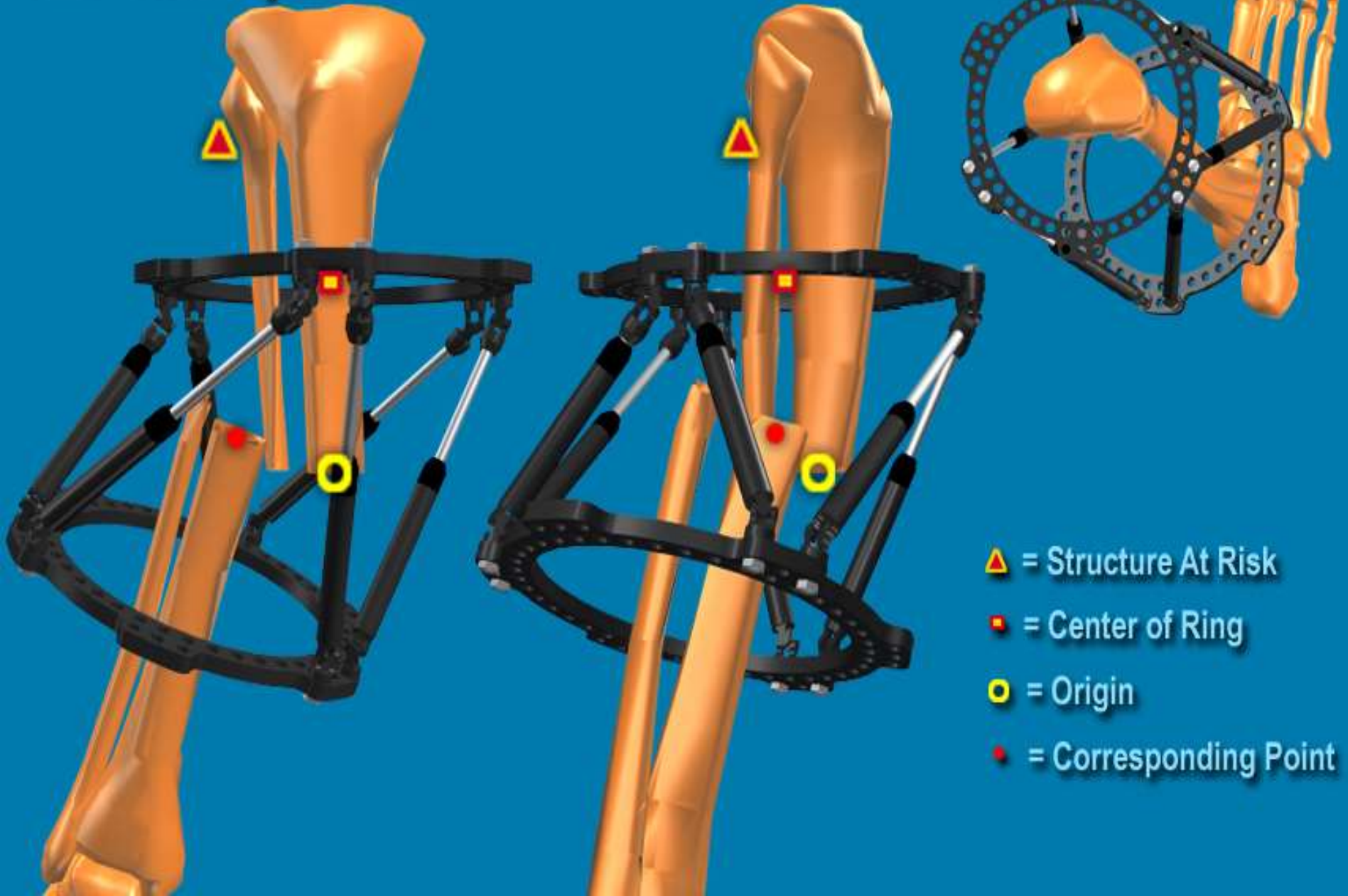


- ▲ = Structure At Risk
- = Origin

Chronic Deformity



Chronic Deformity



OR Taylor Spatial Frame worksheet
Limb Lengthening & Deformity Service, HSS

label

SIDE: _____

REFERENCE RING: _____

DEFORMITY:

AP angulation _____ Lateral angulation _____ Axial angulation _____

AP translation _____ Lateral translation _____ Axial translation _____

PROXIMAL RING SIZE: _____ opening_bt. _____

DISTAL RING SIZE: _____ opening_bt. _____

STRUTS: 1. _____ L M S XS XXS

2. _____ L M S XS XXS

3. _____ L M S XS XXS

4. _____ L M S XS XXS

5. _____ L M S XS XXS

6. _____ L M S XS XXS

MOUNTING PARAMETERS (frame offset relative to origin):

AP _____ Med / Lat

LATERAL _____ Ant / Post

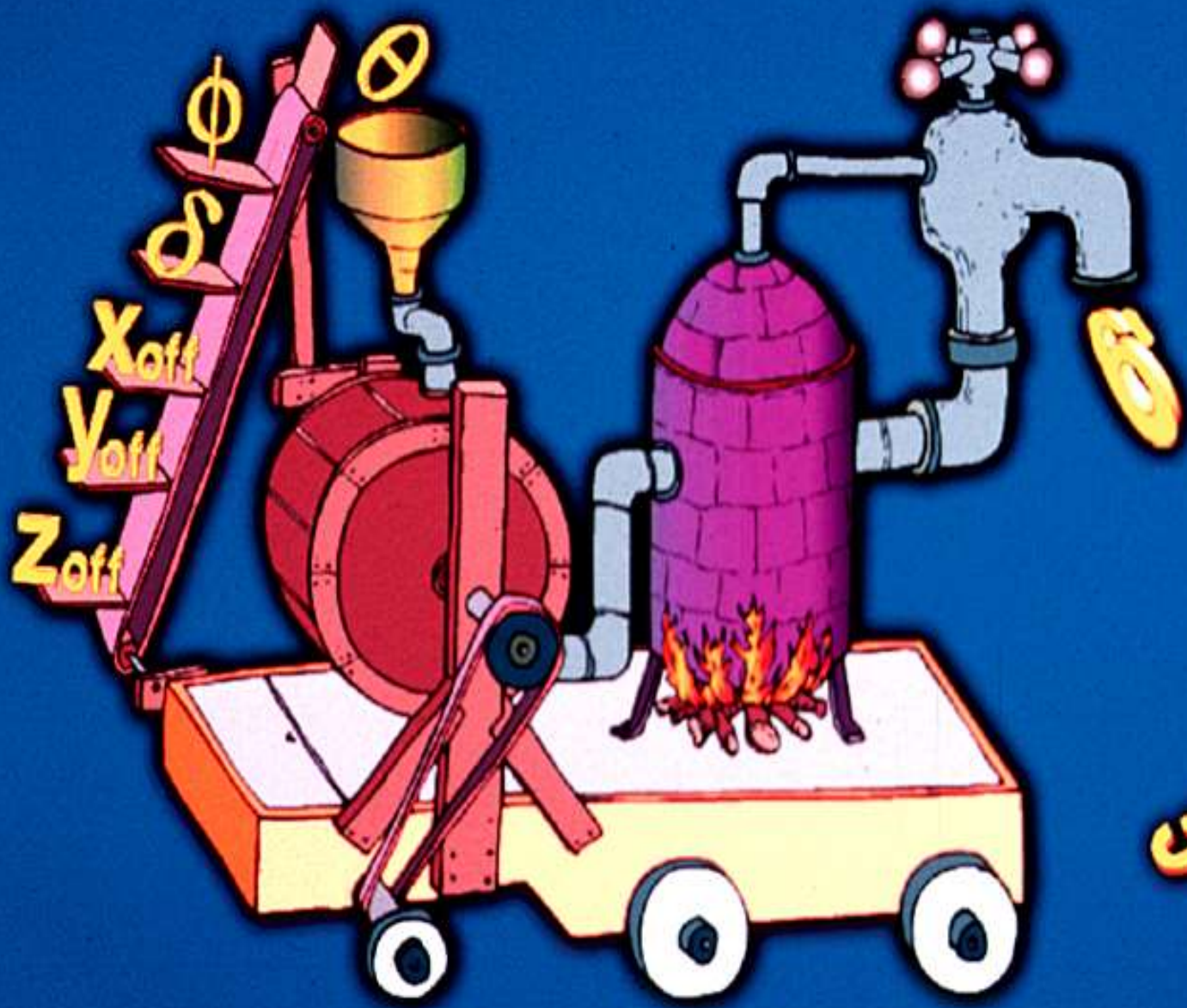
AXIAL _____ Prox / Dist

ROTARY_frame offset _____

SAR: _____

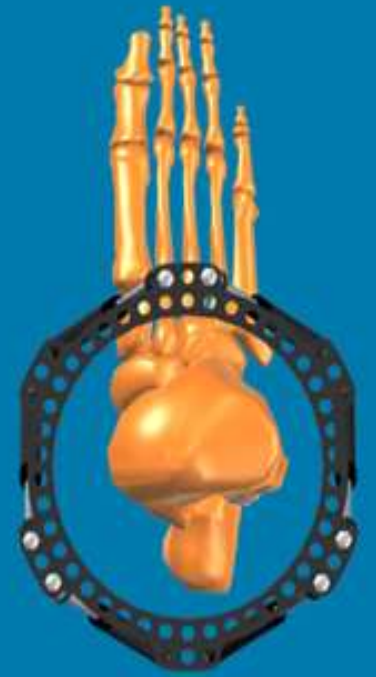
RATE: _____

START POD # _____



5427

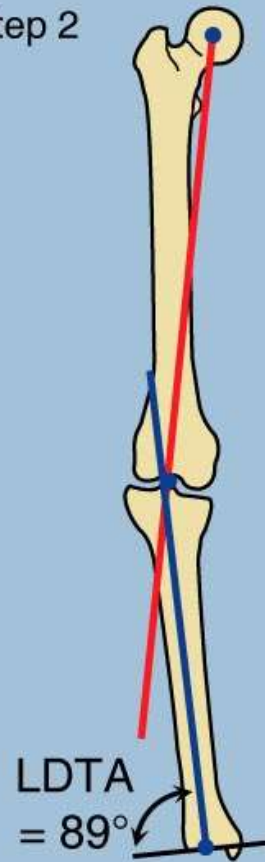
Chronic Deformity - Corrected



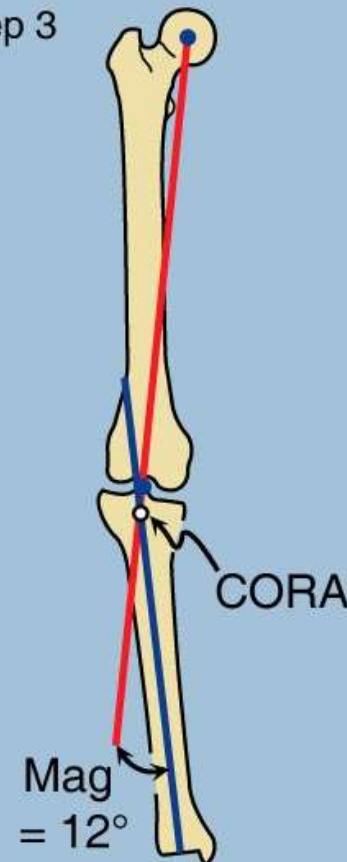


Normal Femur and Varus Tibia Metaphyseal deformity

Step 2

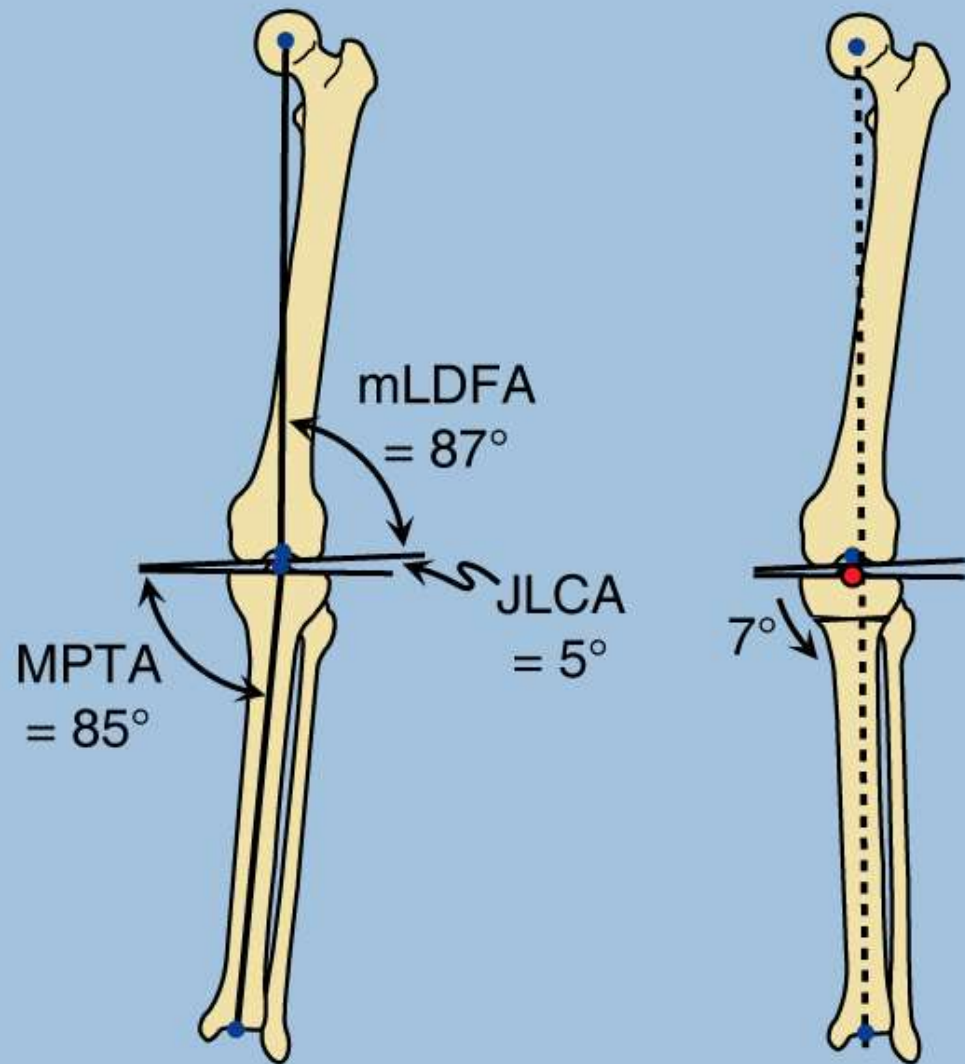


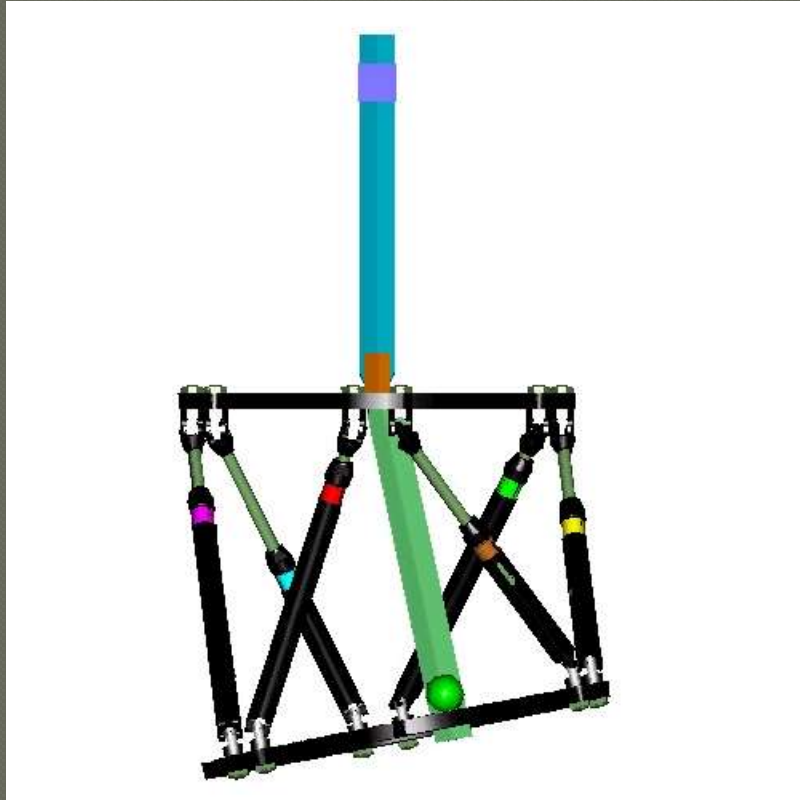
Step 3



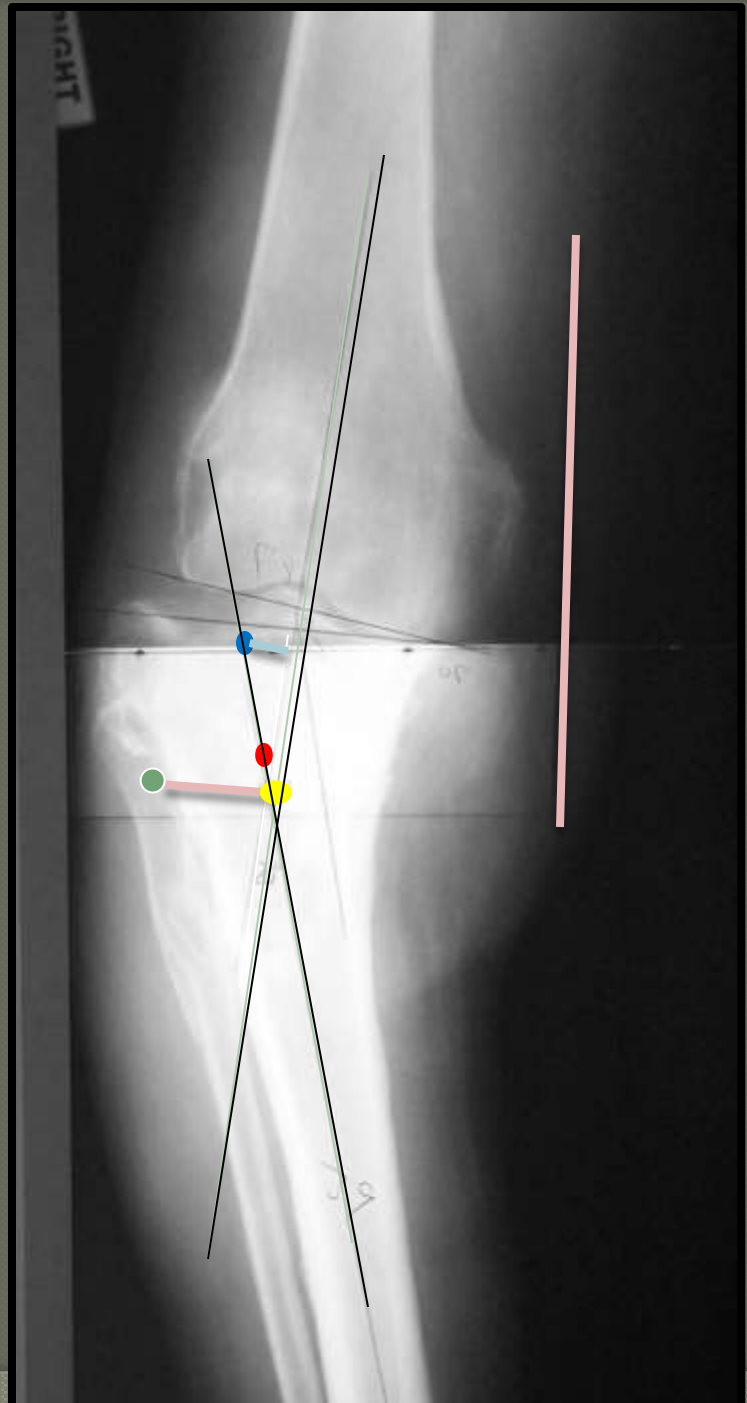
4-08

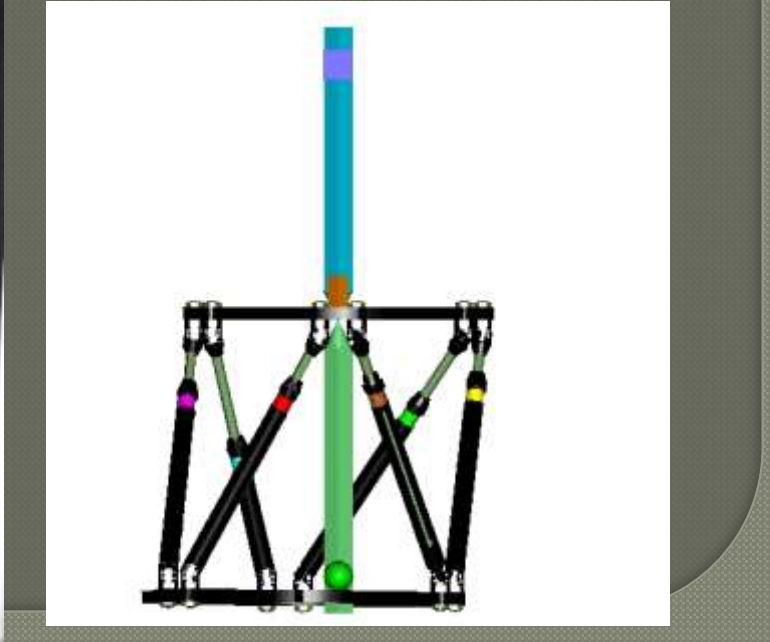
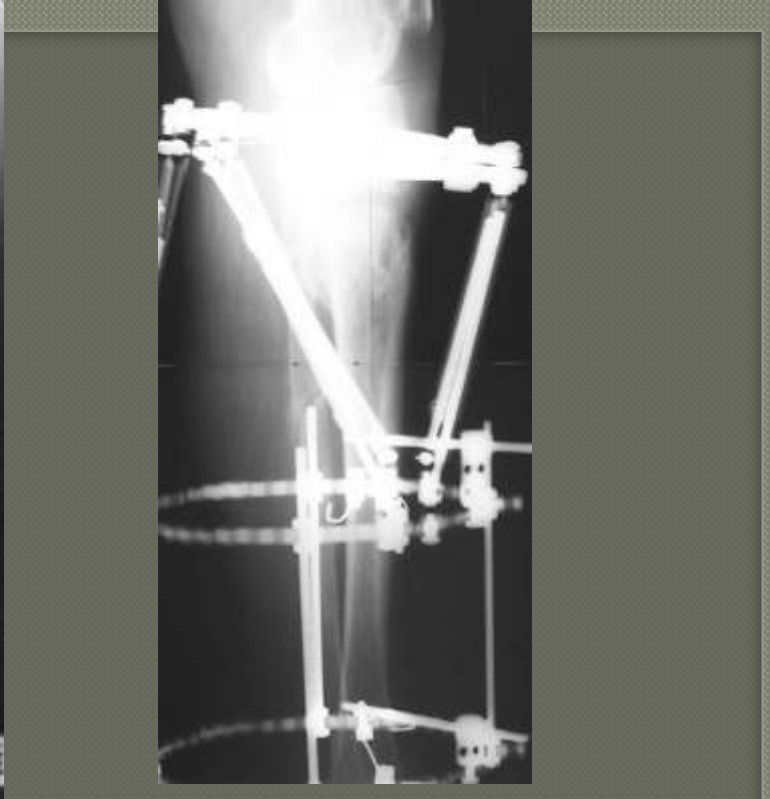
16-13d



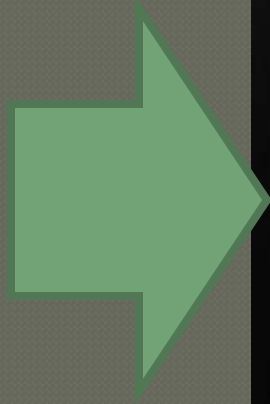


Min length = $w \sin 20$
= 4 mm

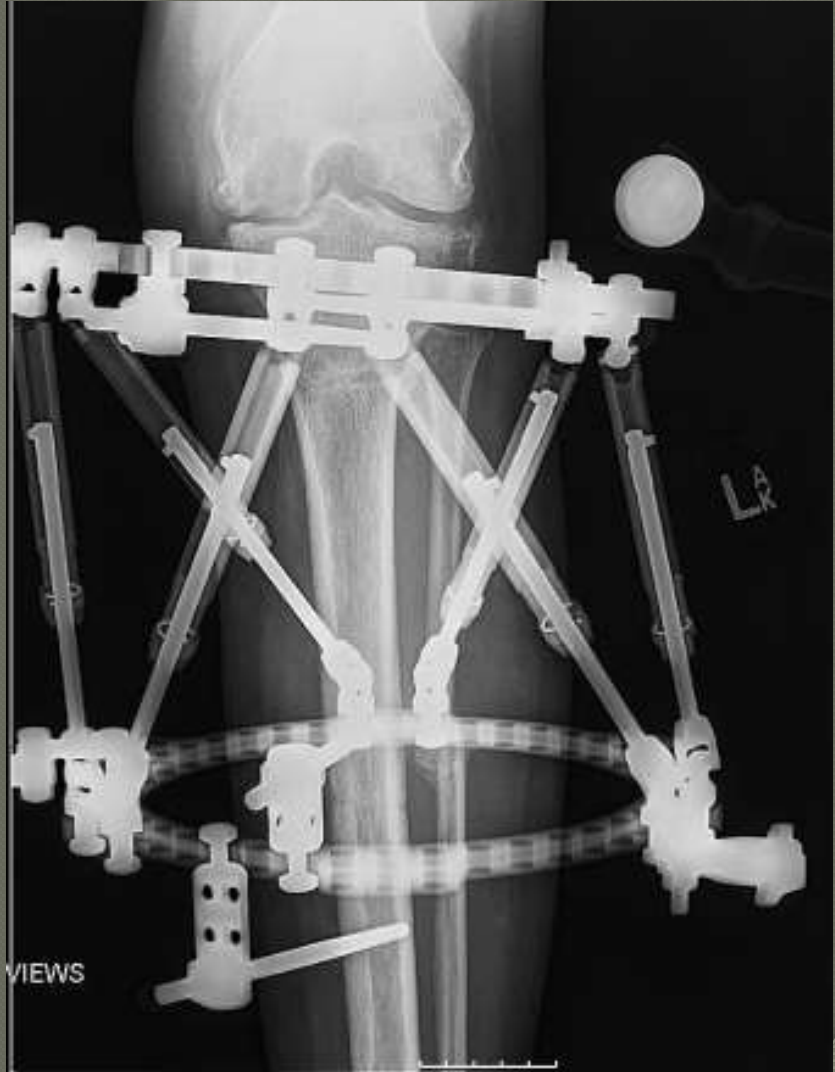




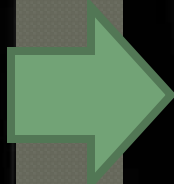








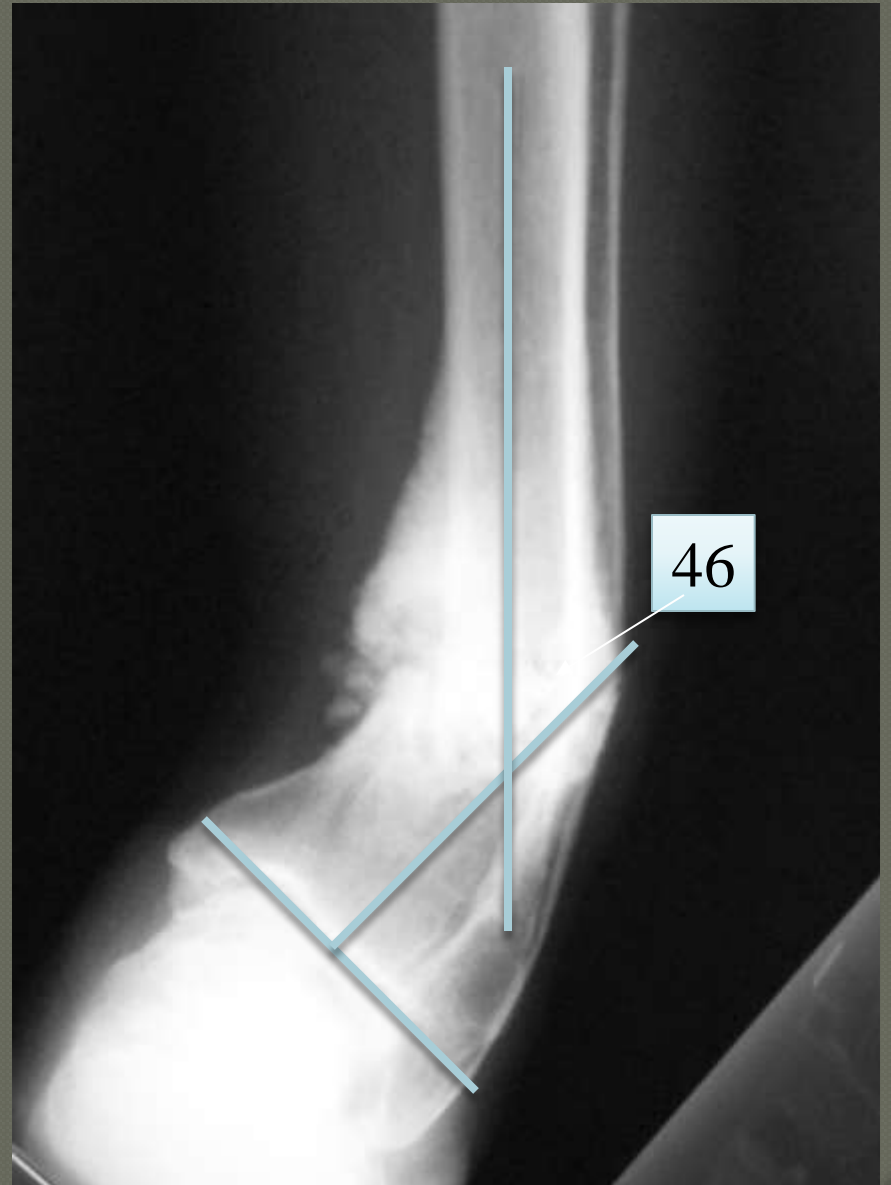




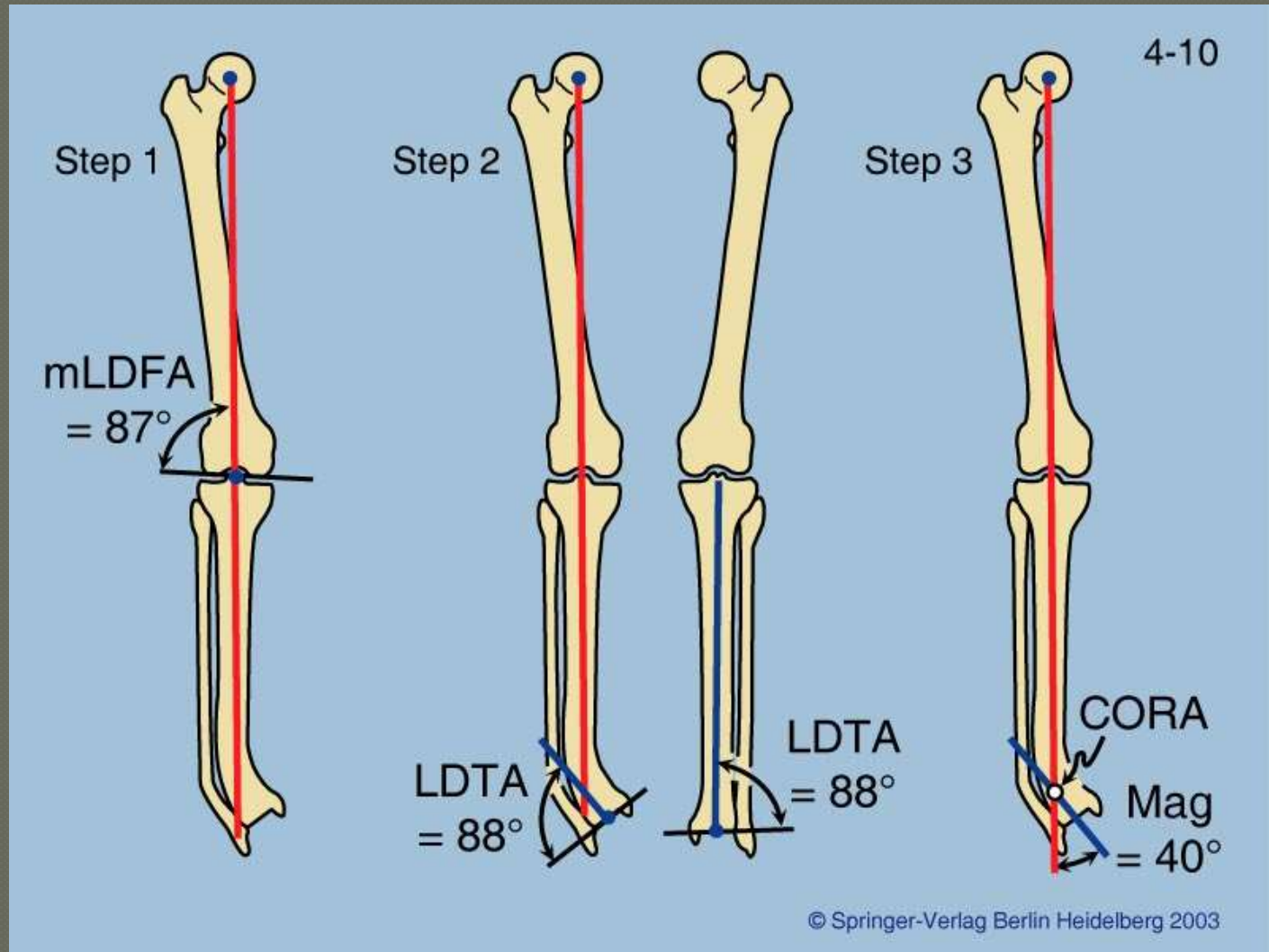
25 year old: This may change her future



PREOP



Normal femur, distal tibia varus



Use extension of femur mech axis for proximal tibia mech. axis



3 months



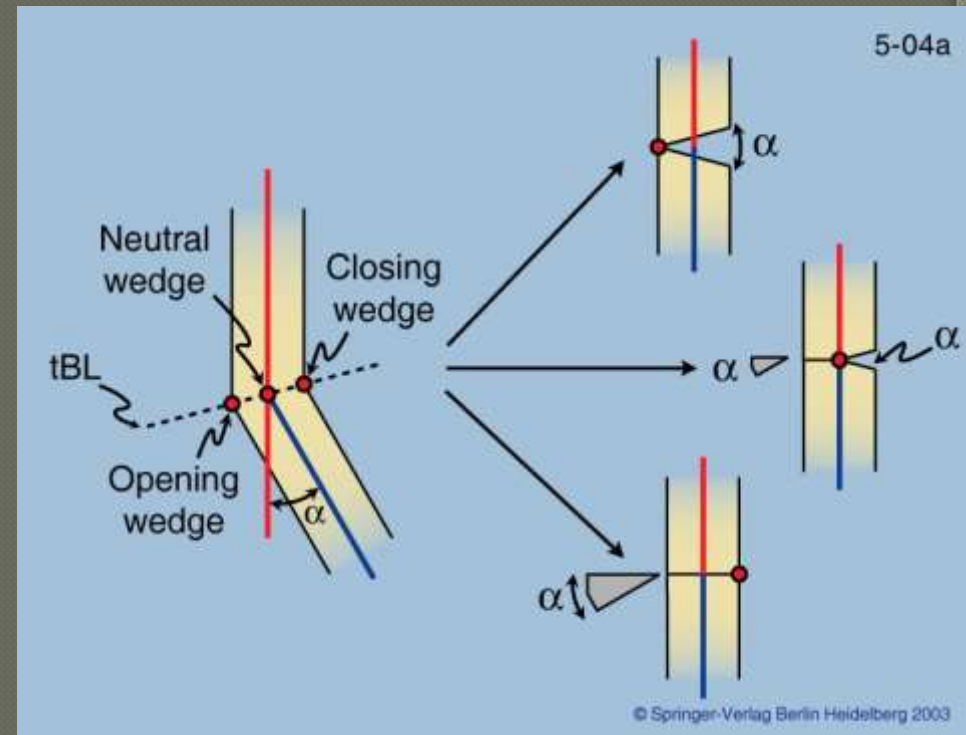
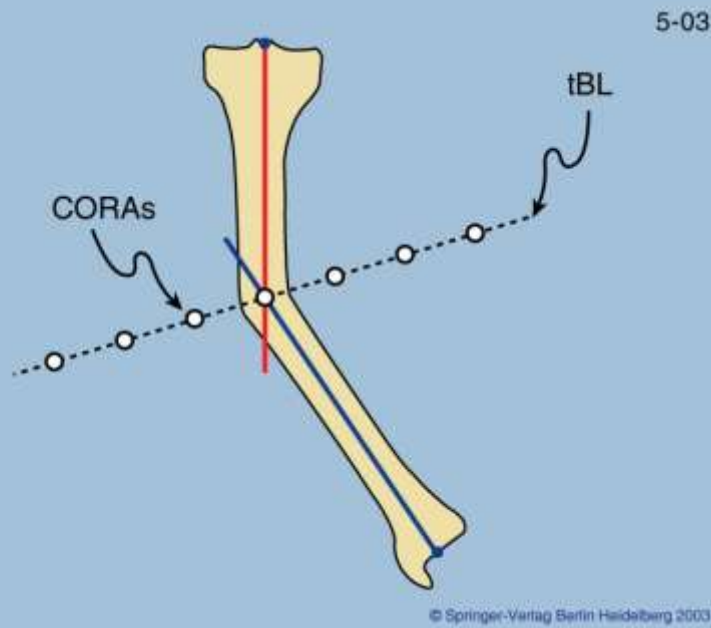


5 months



Osteotomy principle

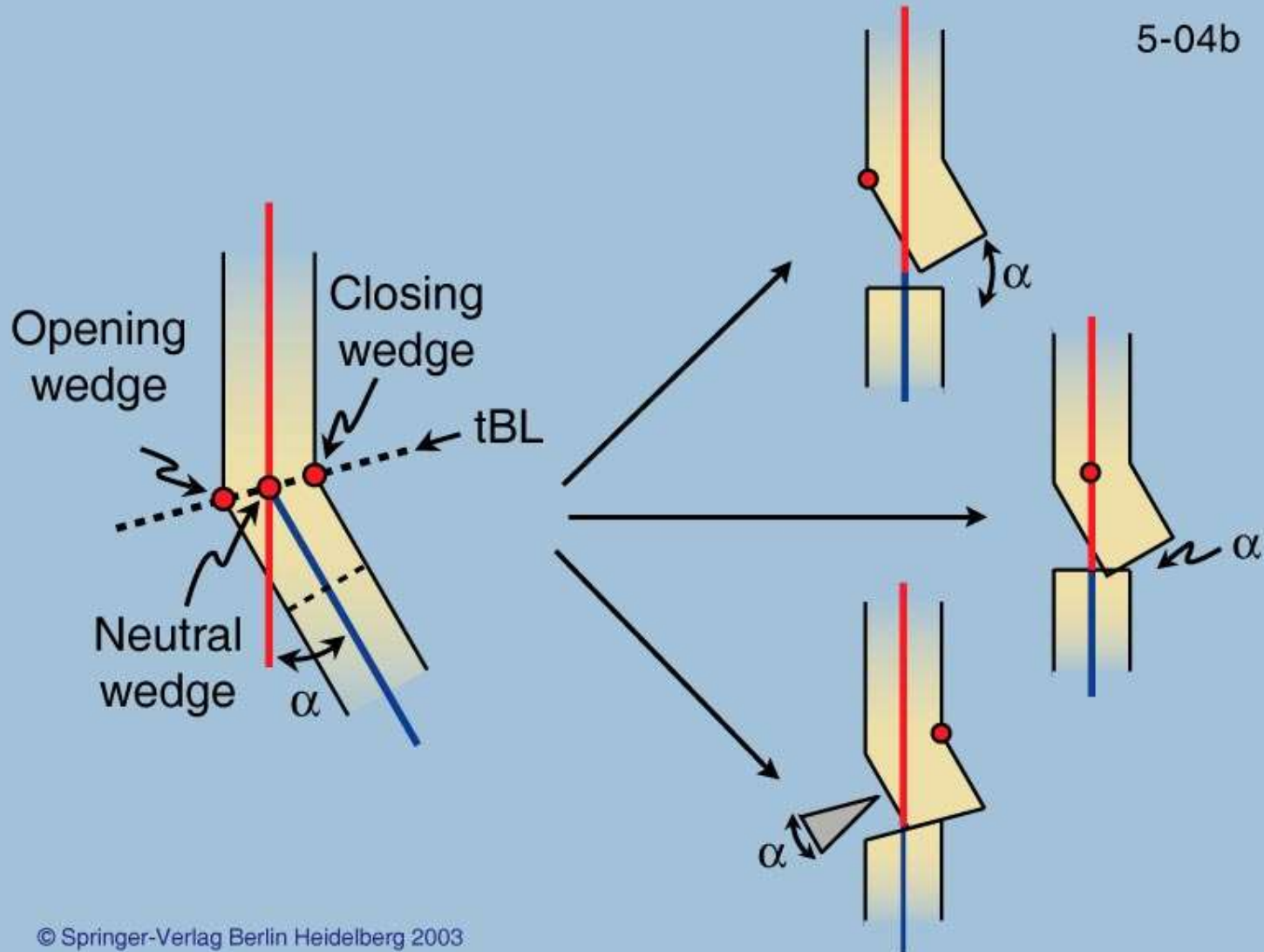
Gain length



Loose length

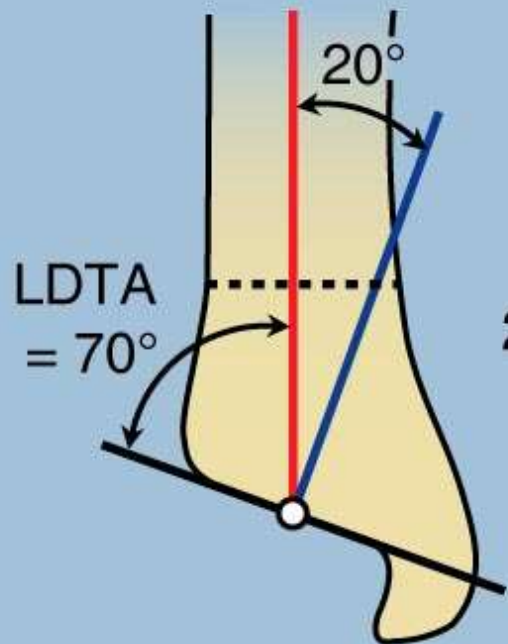
Osteotomy rule 2

If you make your osteotomy away from the CORA, you need to translate

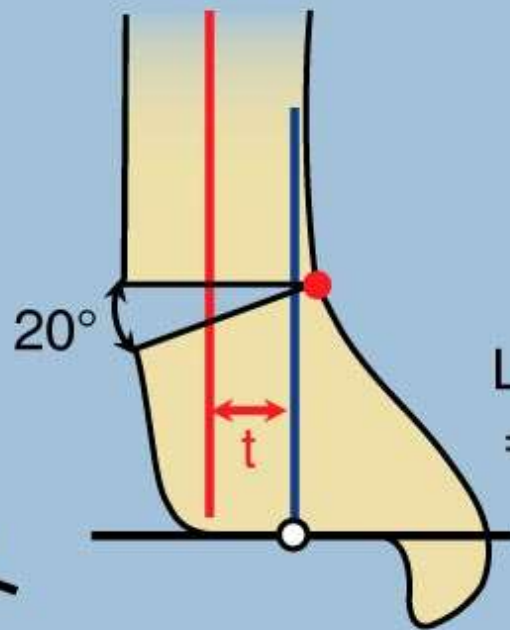


18-10a
Opening Wedge

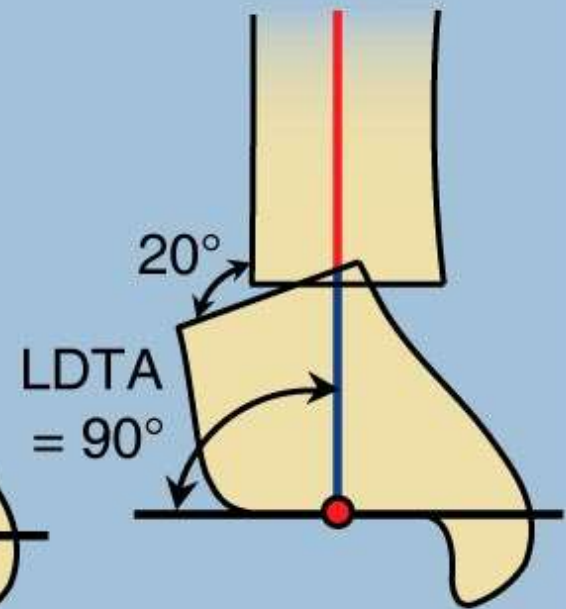
i

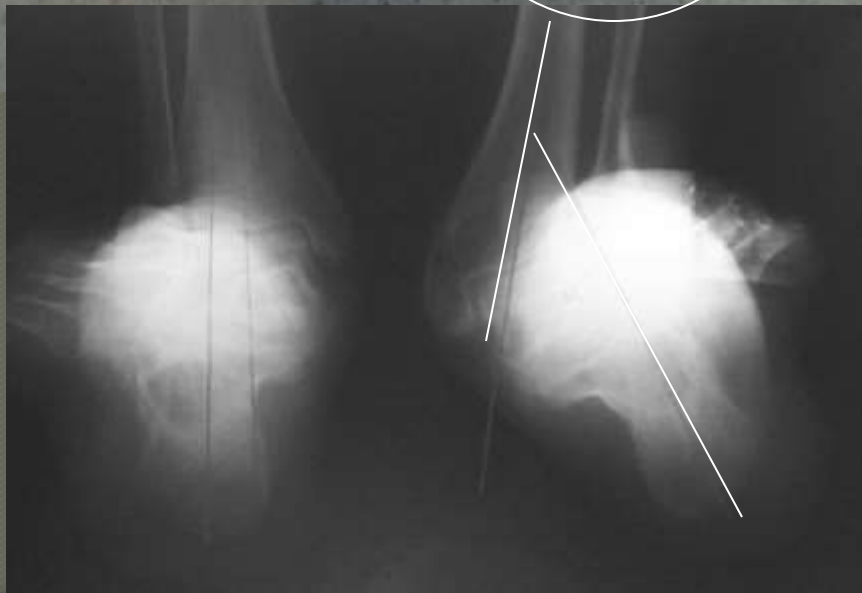


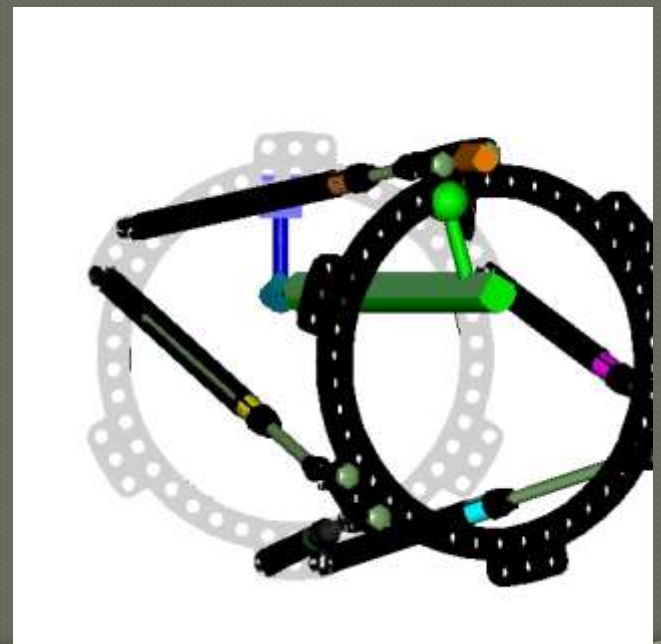
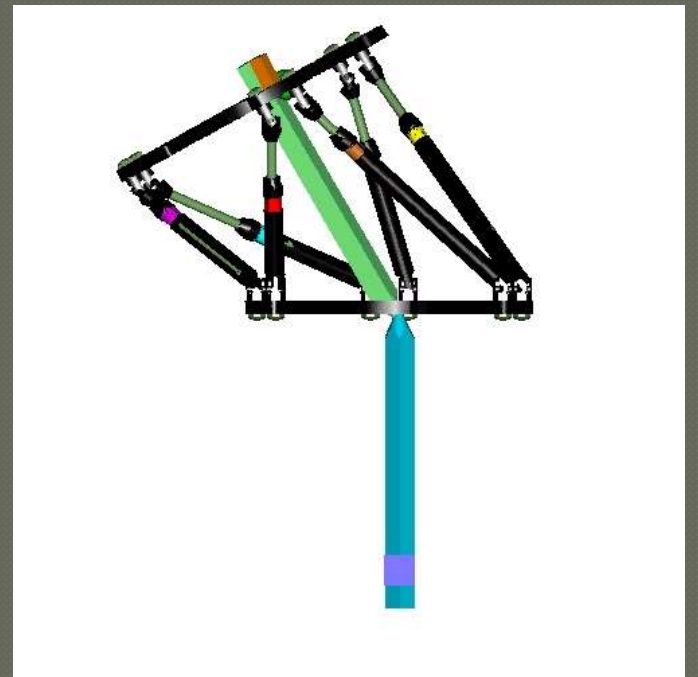
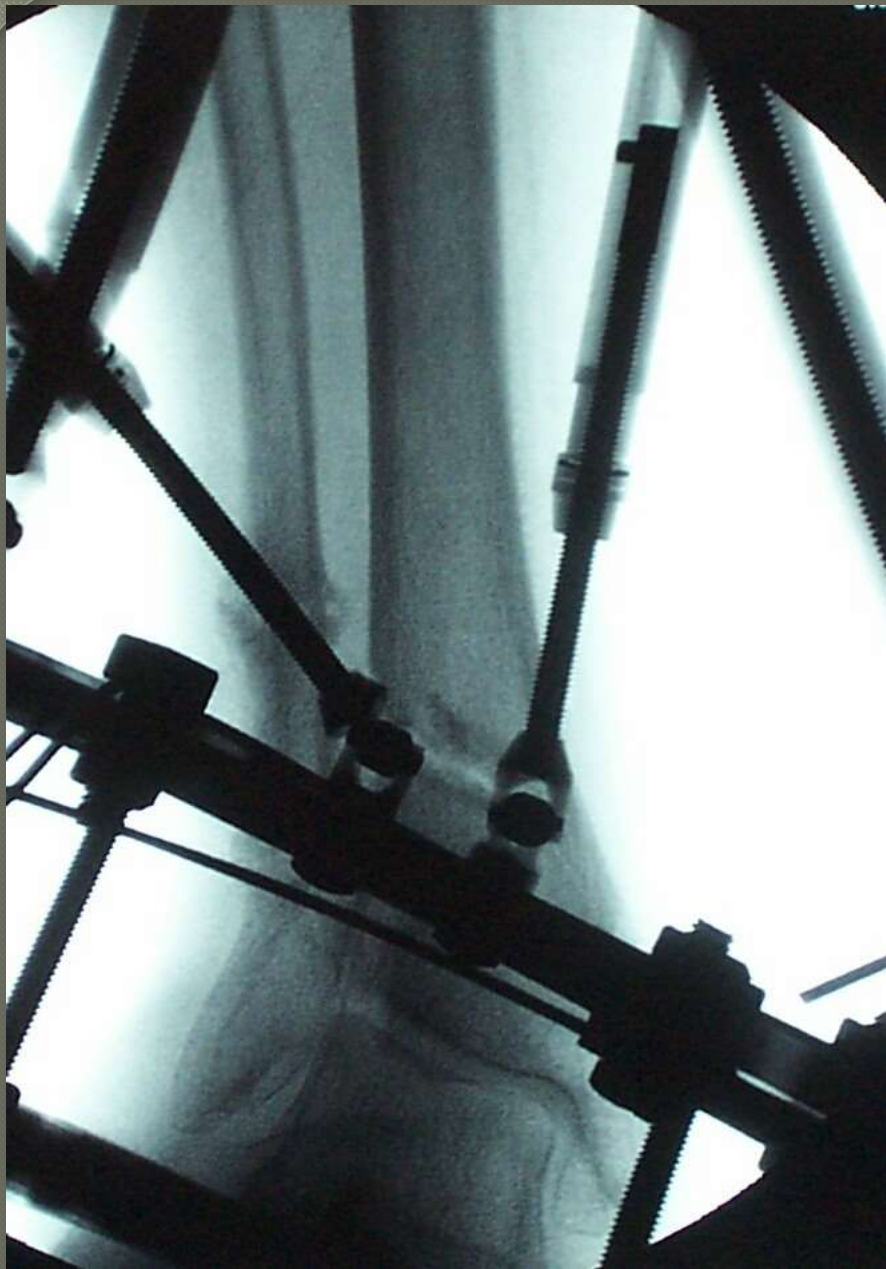
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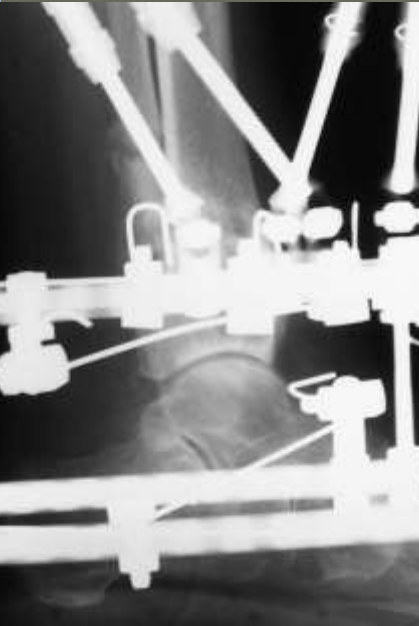
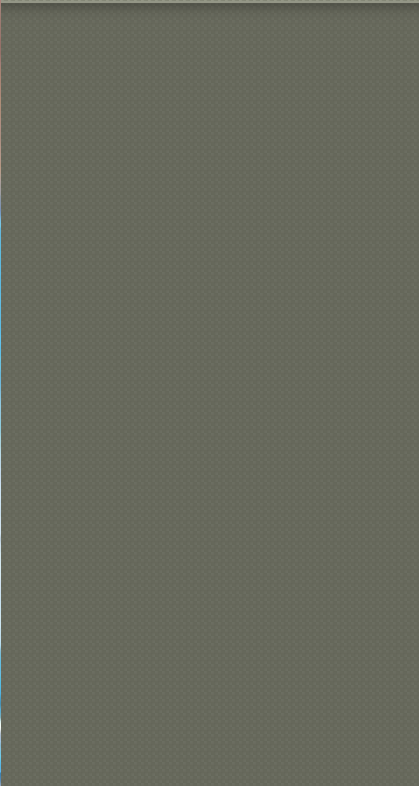


iii



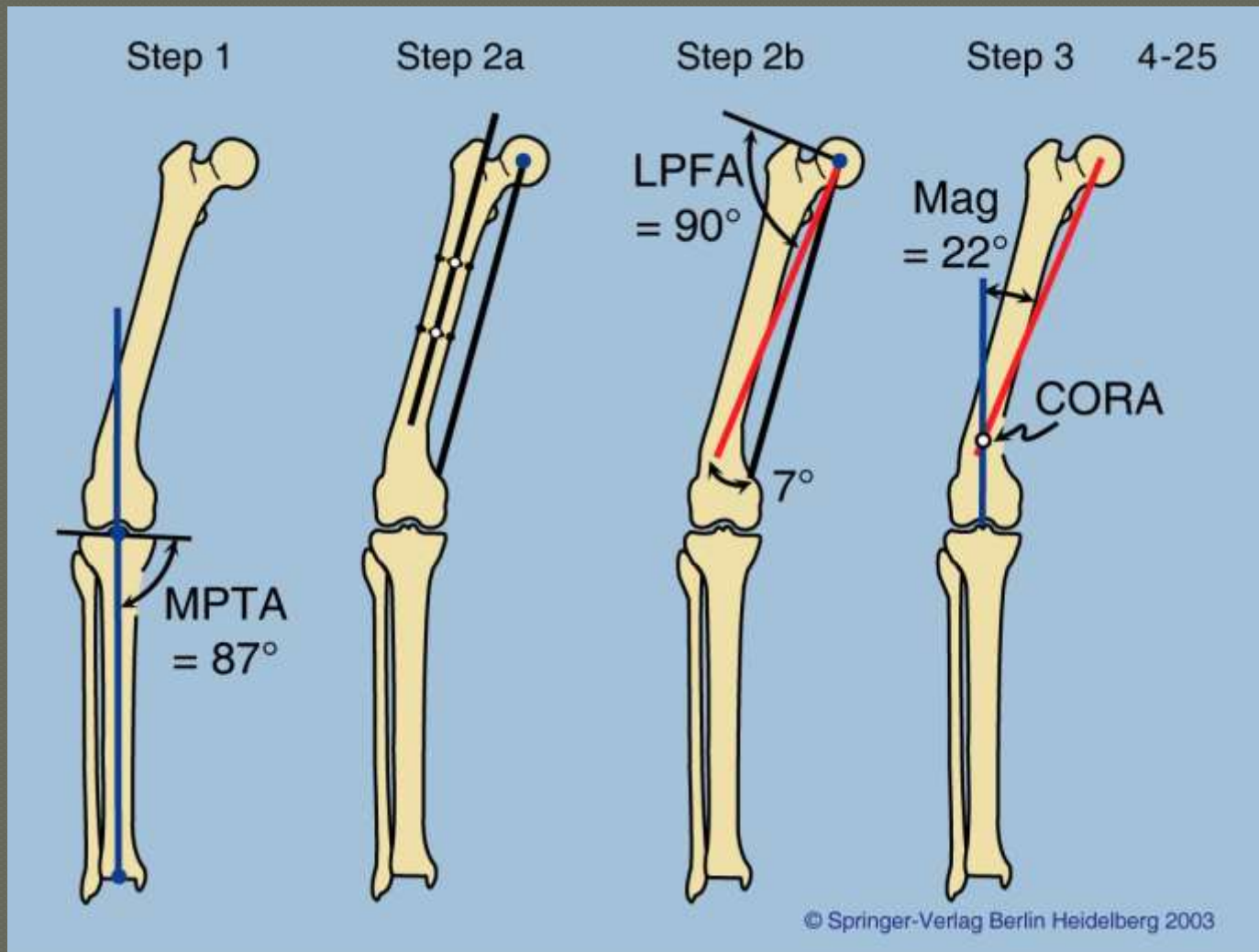


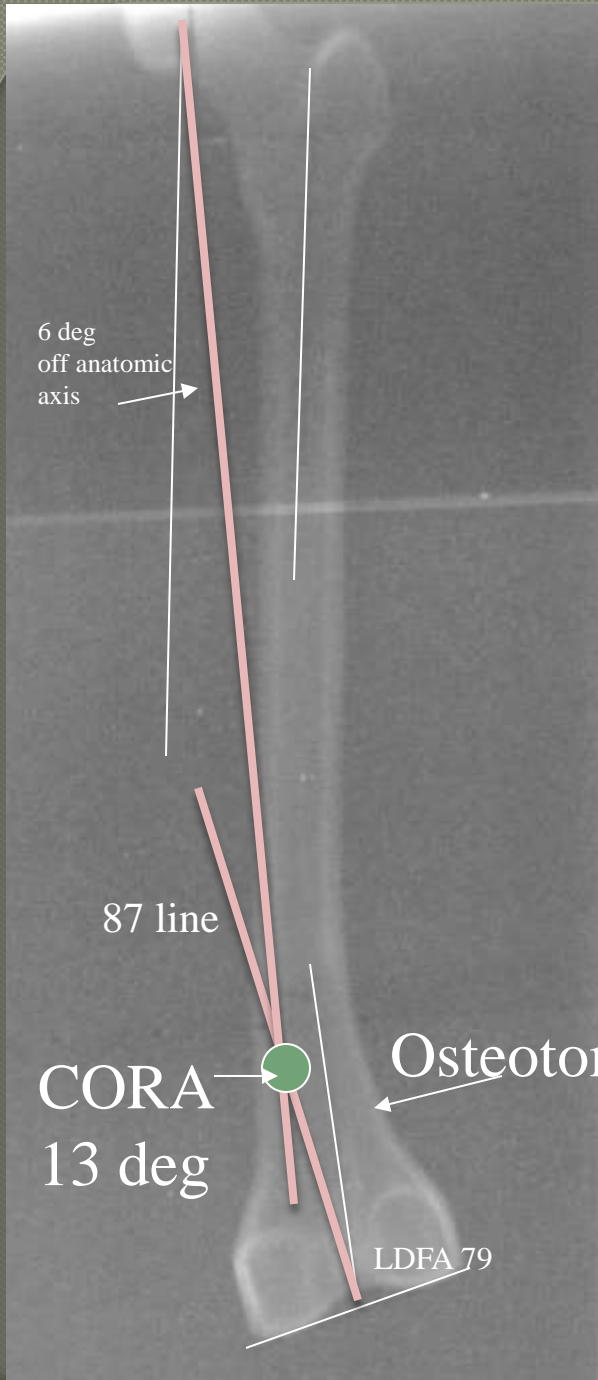


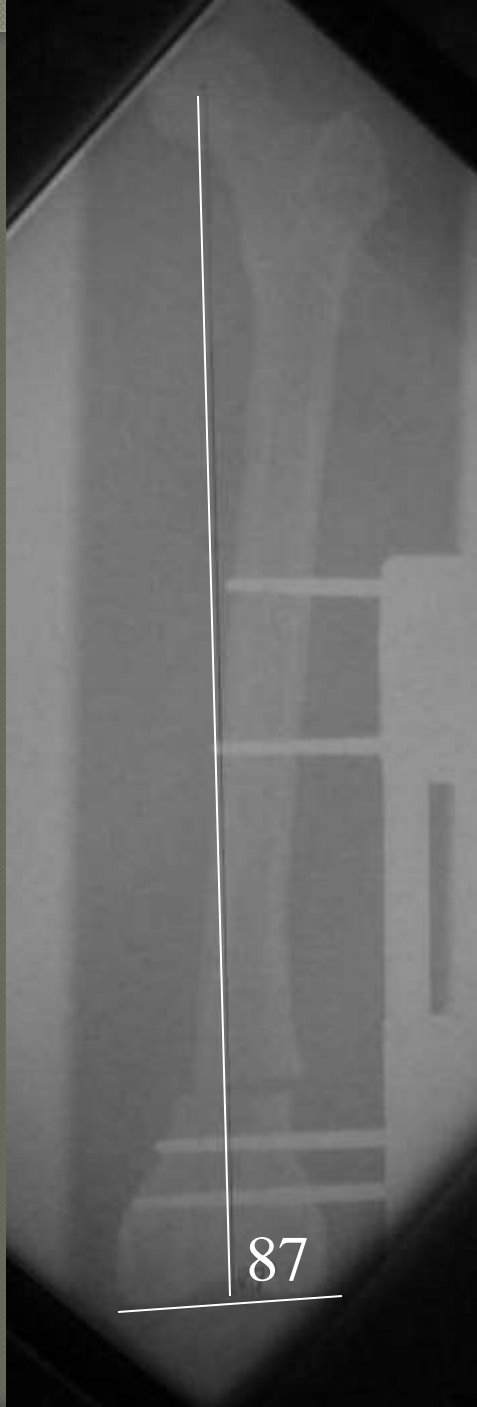




Normal tibia and Varus femur







Normal tibia, valgus femur









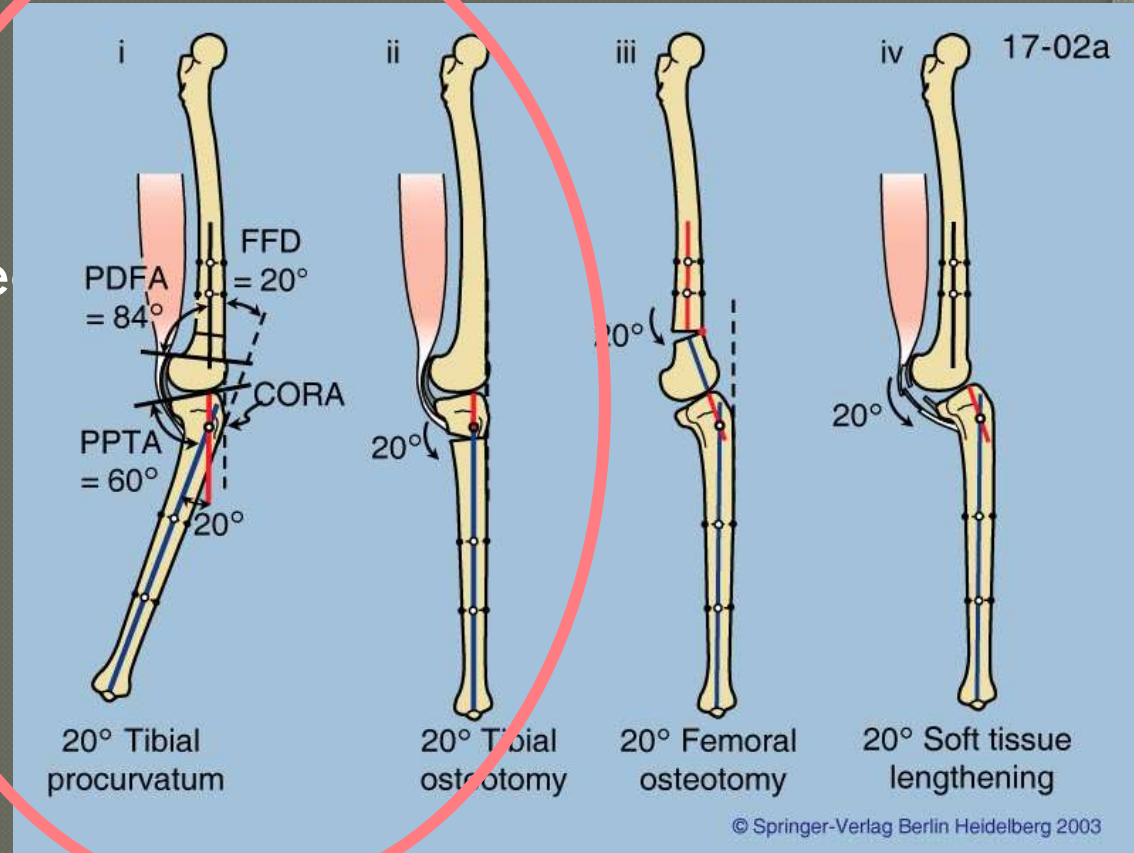


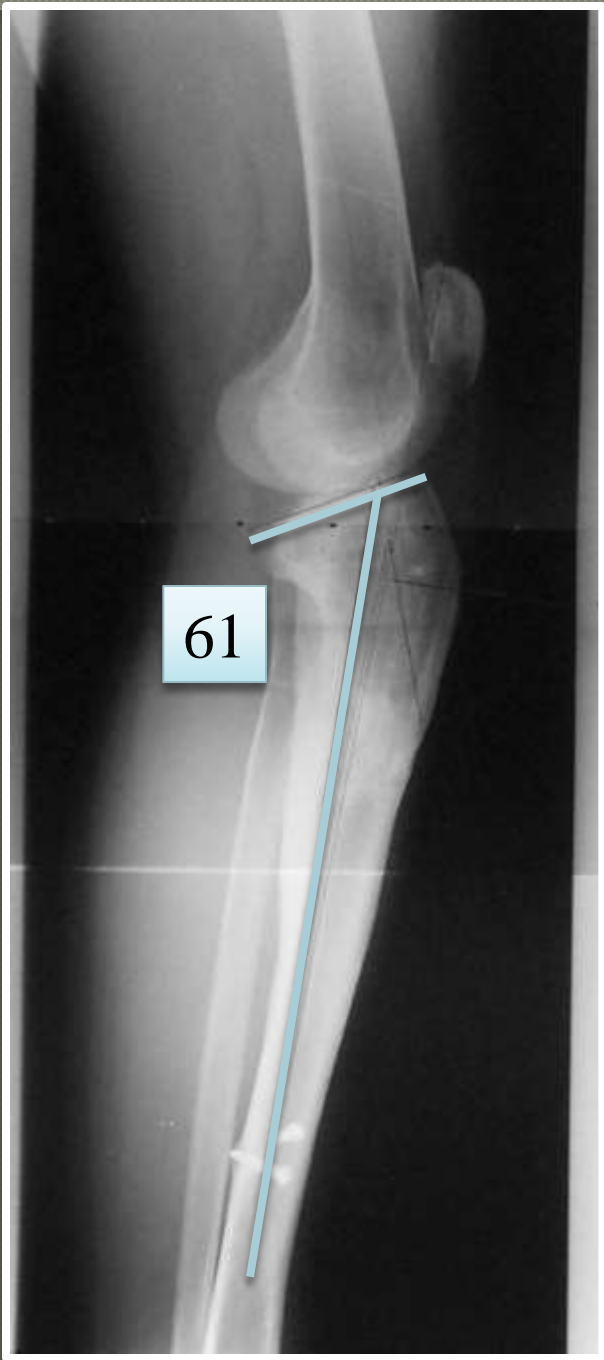


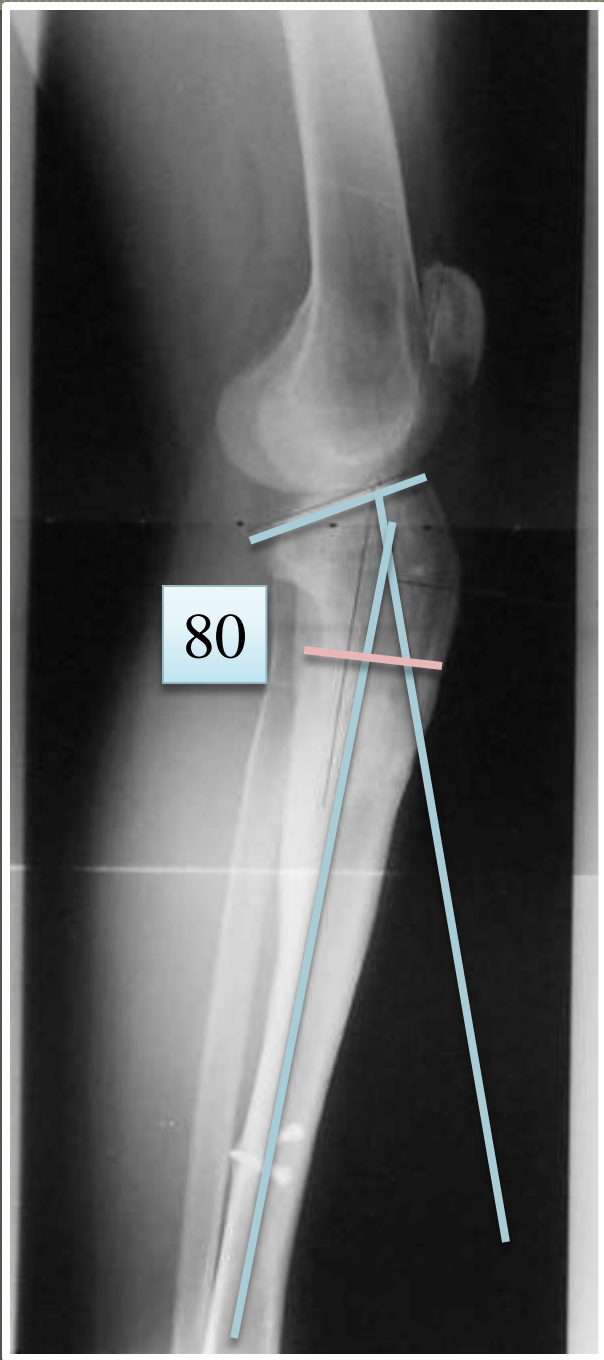
Sagittal plane deformity

Flexion deformity of knee

- femur
- tibia
- contracture of knee



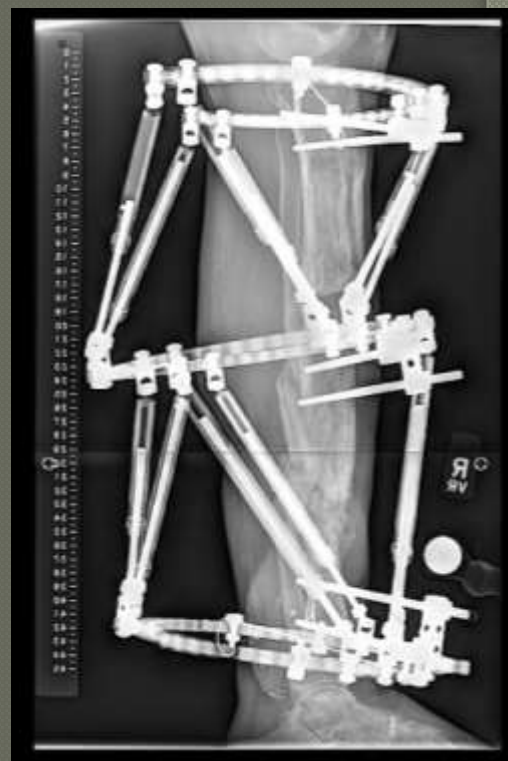
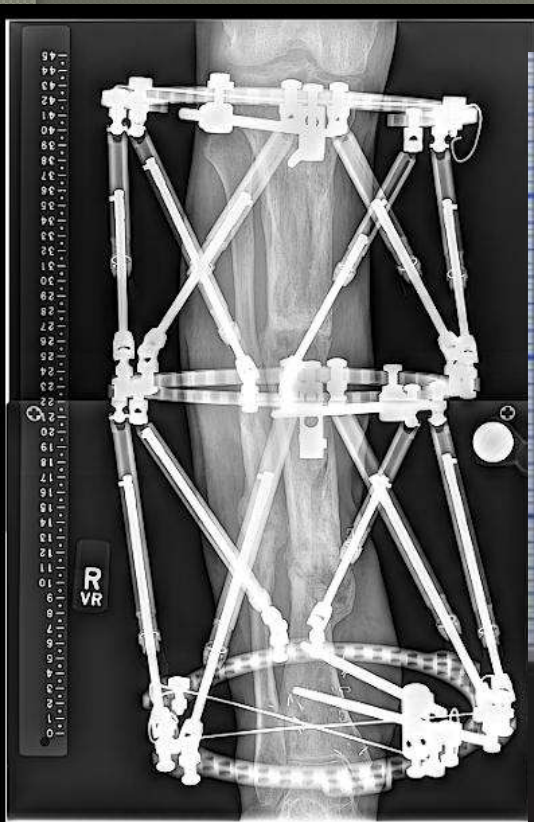












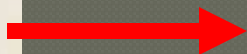




Blount's Disease













CORRECTION OF TIBIAL DEFORMITY WITH USE OF THE ILIZAROV-TAYLOR SPATIAL FRAME

BY S. ROBERT ROZBRUCH, MD, AUSTIN T. FRAGOMEN, MD, AND SVETLANA ILIZAROV, MD

Introduction

The Ilizarov-Taylor Spatial Frame (TSF; Memphis, Tennessee) is a powerful tibial deformity¹. A specialized featur virtual hinge, which allows for the simultaneous of multiplanar deformities and limb-length one osteotomy site. The power of the spatial precise control over the final limb length and its ability to correct a residual deformity. The multiplanar circular fixator permits early weight provides an ideal environment for both new and soft-tissue healing. The classic principle method are followed to ensure proper frame TSF web-based software is user-friendly and plified the planning of the correction of a deformity by utilizing standard anterior-post radiographic measurements. Computer-generated and easy-to-read struts have greatly simplified ment, which is crucial to the success of this technique.

Surgical Technique

Preoperative Planning

Patients are evaluated clinically by a history examination including observation of gait. S directed toward the assessment of leg length deviation, and rotational alignment (Fig. 1). 51-in (130-cm) radiograph in the frontal plane is a leg-length discrepancy, then blocks are placed foot to level the pelvis, and the block h Accurate limb lengths are measured in this mity about the knee is evaluated with a 36-i radiograph made with the knee in full exten tenoposterior and lateral radiographs of the well. Ankle deformity should be evaluated with centered on the ankle. Mechanical axis deviation with use of the malalignment test² (Fig. 2). femoral angle, medial proximal tibial angle, an imal tibial angle are measured to analyze d proximal part of the tibia. The lateral distal tibior distal tibial angle are measured for dist ties. The center of rotation of angulation³ locating the intersection of the proximal and chanical axes (Fig. 3). Often this point is chose

Download

Clin Orthop Relat Res (2010) 468:1352–1361
DOI 10.1007/s11999-009-1161-7

CLINICAL RESEARCH

Does the Taylor Spatial Frame Accurately Correct Tibial Deformities?

S. Robert Rozbruch MD, Kira Segal BA,
Svetlana Ilizarov MD, Austin T. Fragomen MD,
Gabriel Ilizarov MD

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Abstract

Background Optimal leg alignment is the goal of tibial osteotomy. The Taylor Spatial Frame (TSF) and the Ilizarov method enable gradual realignment of angulation and translation in the coronal, sagittal, and axial planes, therefore, the term six-axis correction.

Questions/purposes We asked whether this approach would allow precise correction of tibial deformities.

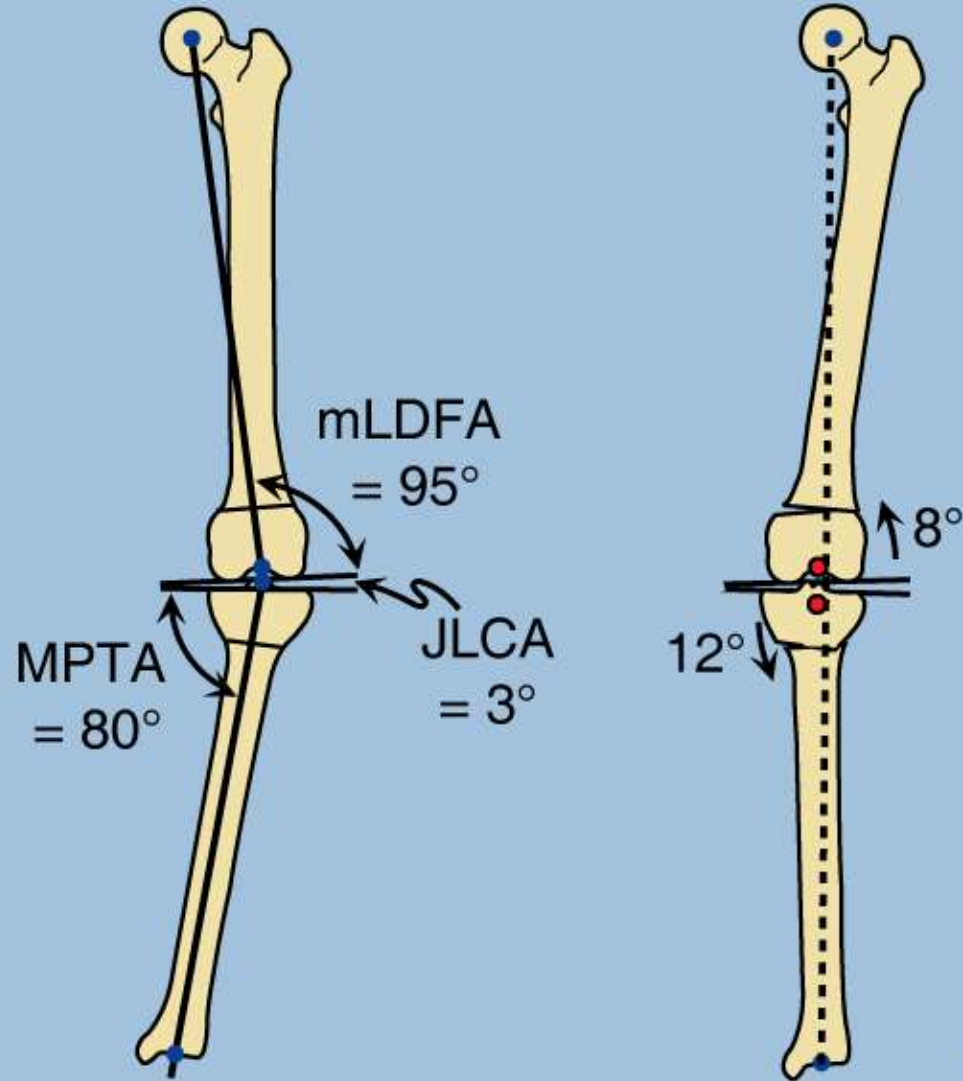
Methods We retrospectively reviewed 102 patients (122 tibiae) with tibial deformities treated with percutaneous osteotomy and gradual correction with the TSF. The proximal osteotomy group was subdivided into two sub-

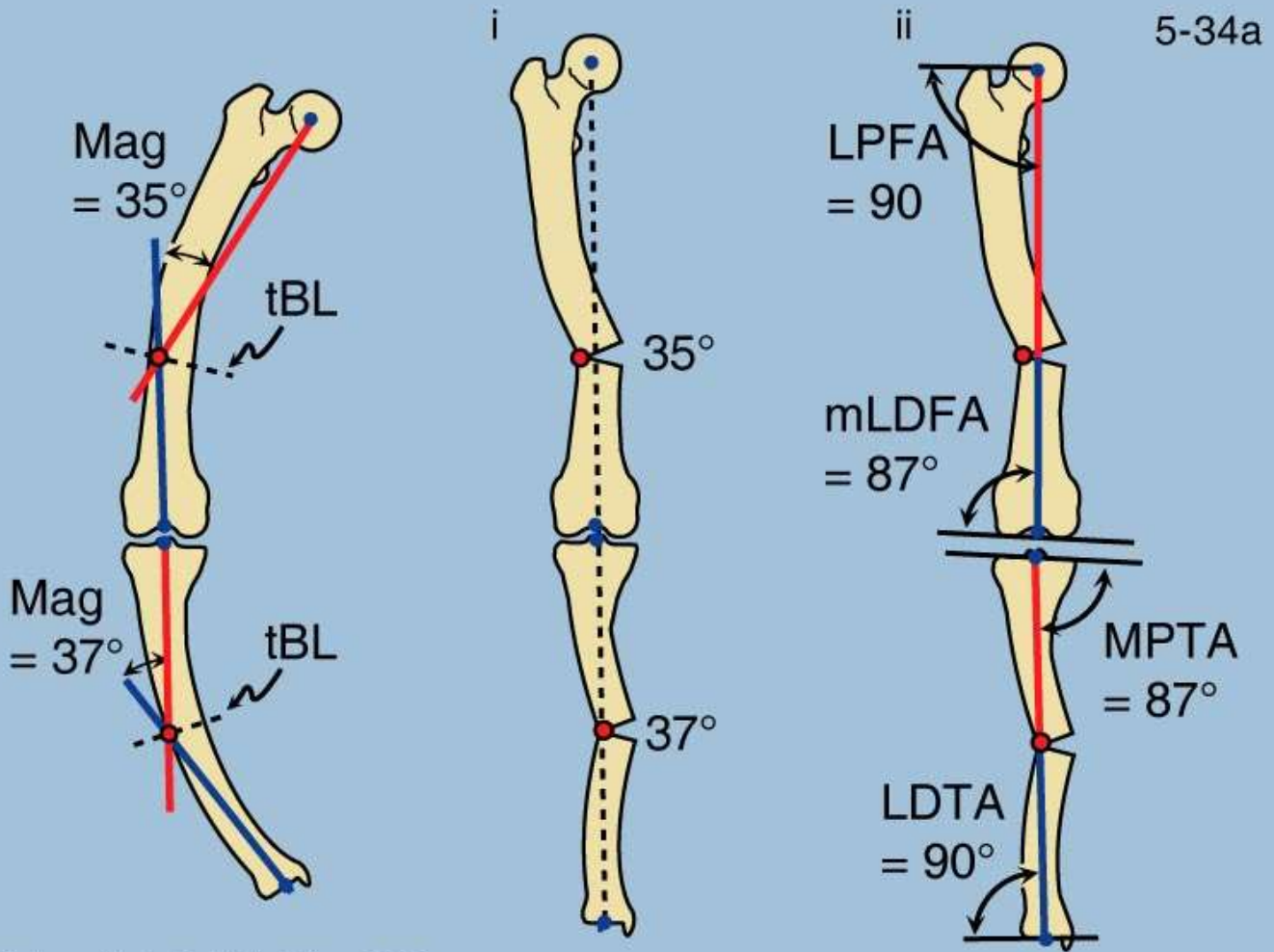
with a varus deformity and from 96° to 85° in patients with a valgus deformity. In the middle osteotomy group, all patients had less than 5° coronal plane deformity and 15 of 17 patients had less than 5° sagittal plane deformity. In the distal osteotomy group, the lateral distal tibial angle improved from 77° to 86° in patients with a valgus deformity and from 101° to 90° for patients with a varus deformity.

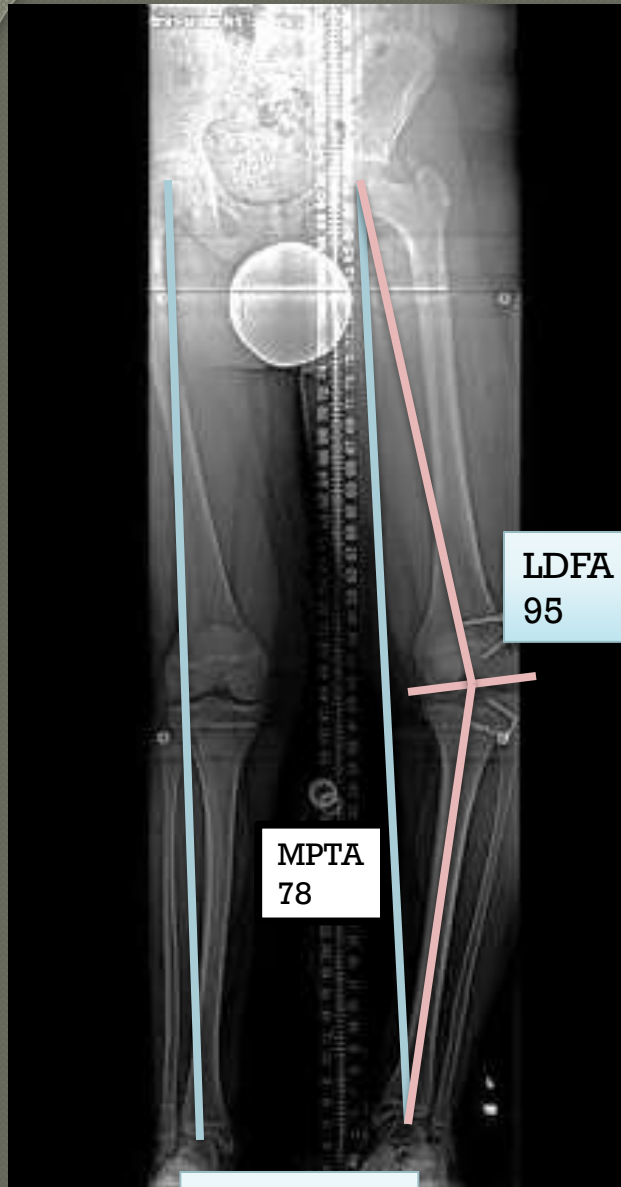
Conclusions Gradual correction of all tibial deformities with the TSF was accurate and with few complications.

Level of Evidence Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels

16-13j







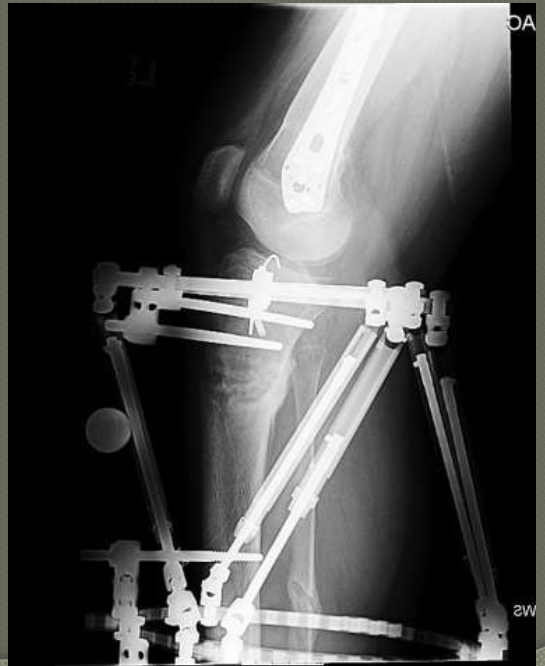
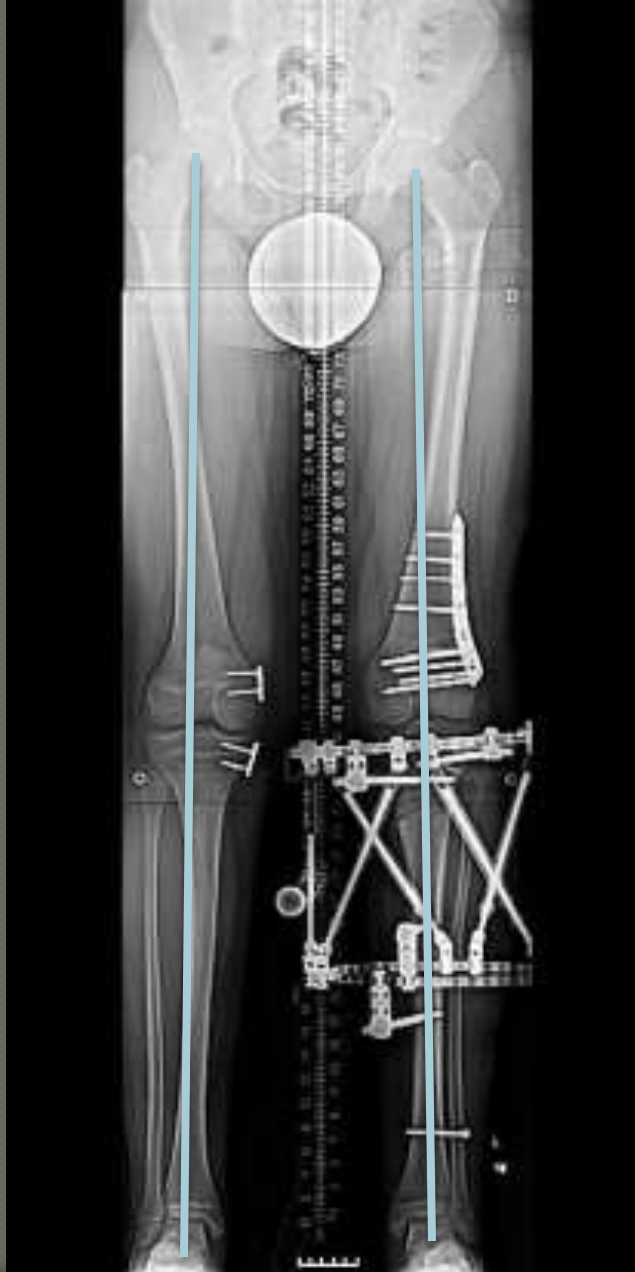
LDFA
95

MPTA
78

MAD
R 20 lat
L 70 medial

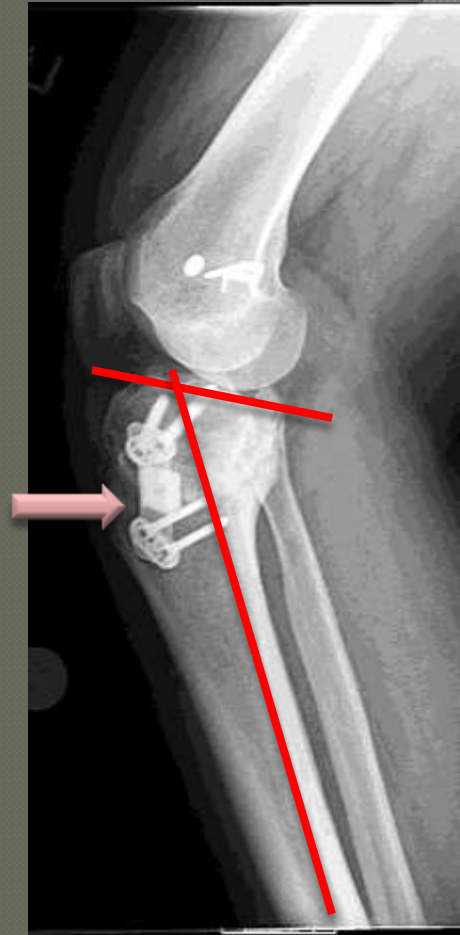


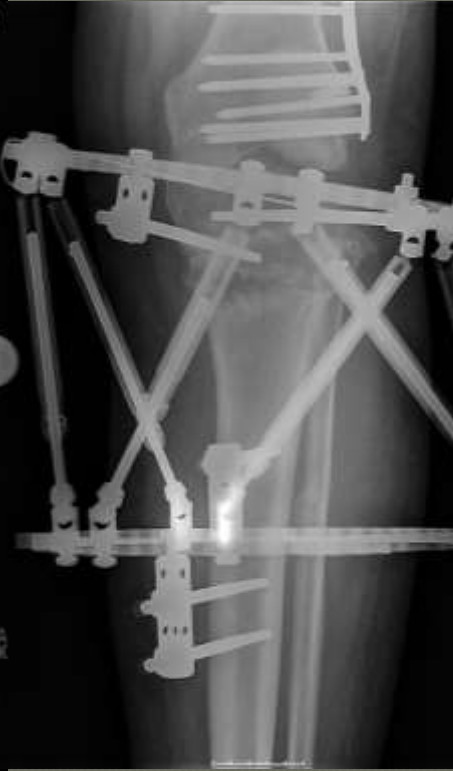
15 y/o M
LLD one inch
Tension band plate done 1 yr. earlier
not effective and screws broke

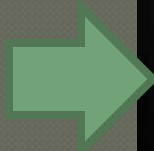
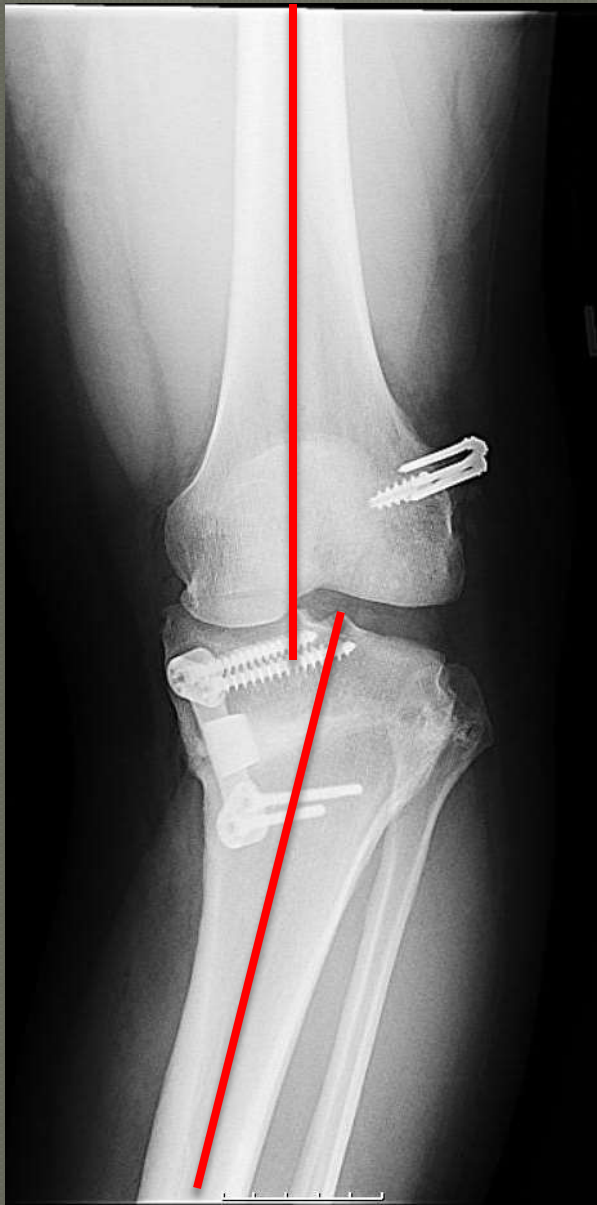




35 year old, femur + tibial deformity, LCL laxity, LLD, ACL laxity

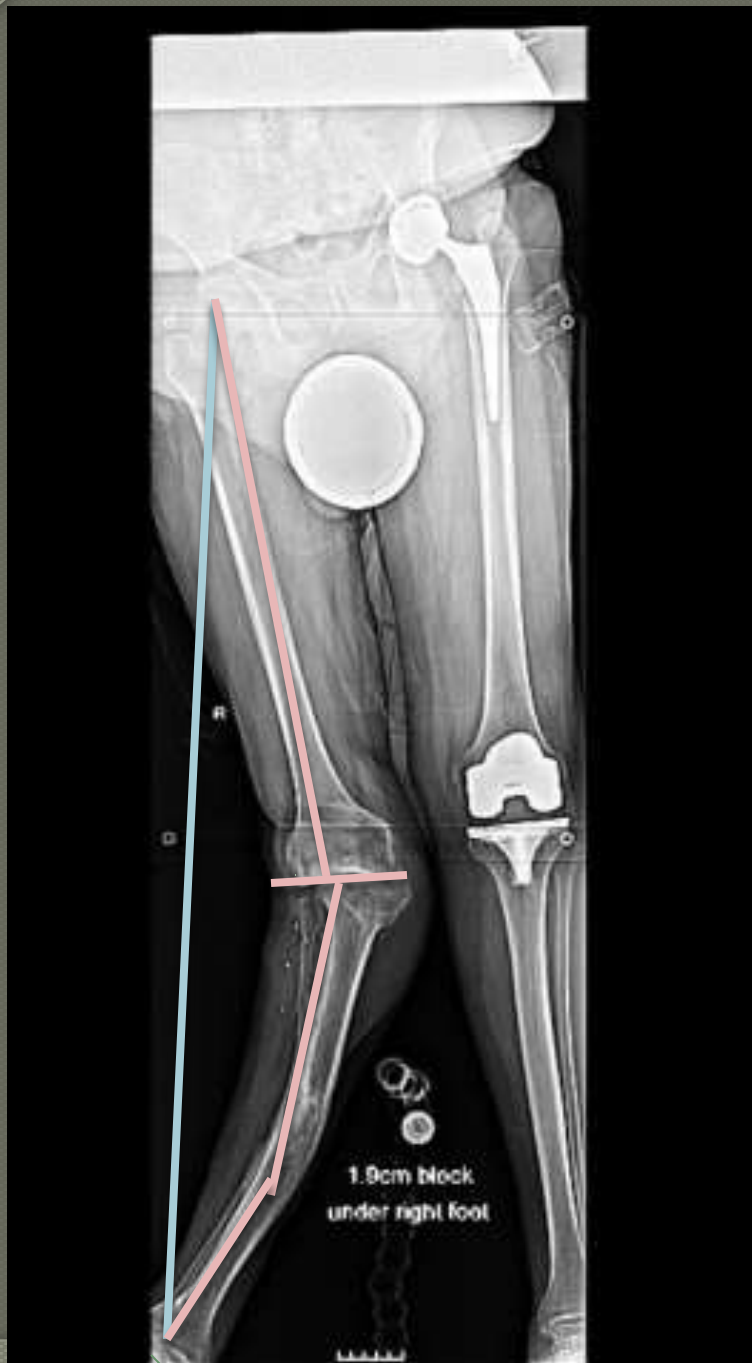






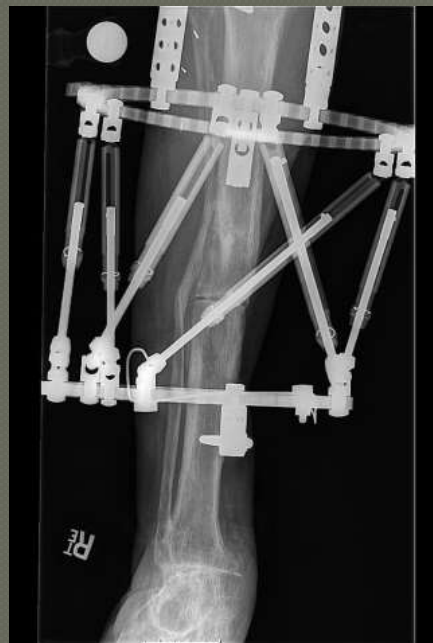
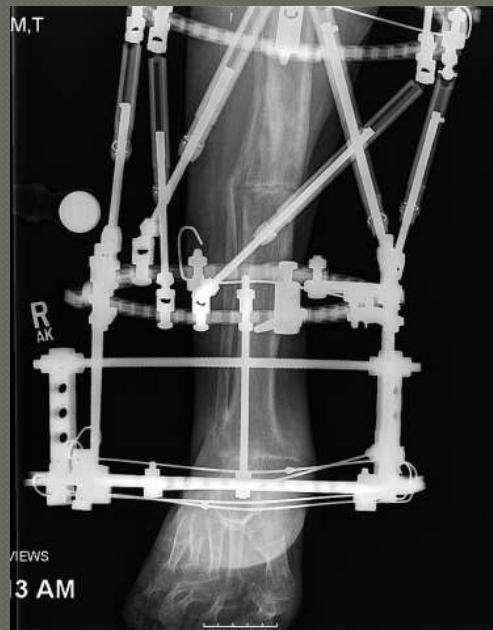






65 y/o M
 Old trauma 30 yrs ago
 Knee: unstable, valgus
 recurvatum
 Tibia: valgus def
 Ankle /foot: valgus &
 arthrosis
 LLD= 6 cm







TAYLOR SPATIAL FRAME



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SPATIALFRAME.COM VERSION 3.0™

Click [here](#) to see **What's New?**

Welcome to SPATIALFRAME.COM 3.0. For eight years Spatial Frame has been correcting post traumatic and congenital orthopaedic deformities. The TAYLOR SPATIAL FRAME external fixator is uniquely designed for those orthopedic surgeons that require a 100% accurate, minimally invasive, easily ex-plantible device.

SPATIALFRAME.COM is a one-of-a-kind web application designed to provide the orthopedist with all the software tools necessary to preoperatively plan or postoperatively adjust the TAYLOR SPATIAL FRAME external fixator.



To begin using TAYLOR SPATIAL FRAME contact your local Smith & Nephew sales representative; then click "Request an Account" at the bottom of this screen. Learn the latest techniques by attending an upcoming course. Click the "Spatial Frame Courses 2004-2005" link below to get the latest details.



Our next course will be April 8-10 in Atlanta, GA.

Welcome, Robert Rozbruch!

Useful Links

[Software License](#)

TAYLOR SPATIAL FRAME*



Home **Cases** Utilities Literature User Profile Logout Help

File Case Info Define Deformity Select Frame Mount Frame Initial Frame Final Frame Structure at Risk Prescription Report

Patient

Case Number:

Case Name:

Patient Initials:

Patient Number:

Date: (mm/dd/yyyy)

Correction Type:

Anatomy:

- Long Bone
- Forefoot 6x6 Miter
- Forefoot 6x6 Butt
- Forefoot 6+6

(Per the Health Insurance Portability and Accountability Act of 1996, the user should not include the patient's full name. The user should include the patient's initials in the Notes field and any other input field for non-compliance.)

Case Notes

Next

TAYLOR SPATIAL FRAME*



Home **Cases** Utilities Literature User Profile Logout Help

File Case Info **Define Deformity** Select Frame Mount Frame Initial Frame Final Frame Structure at Risk Prescription Report

Long Bone

Reference Fragment:

Proximal

Case Name: Macellaro, Richard 3-10-0

| | | | | | |
|--|-----------------------------------|--|----------------------------------|---|-----------------------------------|
| AP View Angulation (deg) | <input type="text" value="16.0"/> | Lateral View Angulation (deg) | <input type="text" value="7.0"/> | Axial View Angulation (deg) | <input type="text" value="10.0"/> |
| <input checked="" type="radio"/> Valgus <input type="radio"/> Varus | | <input type="radio"/> Apex Posterior <input checked="" type="radio"/> Apex Anterior | | <input type="radio"/> External <input checked="" type="radio"/> Internal | |
| AP View Translation (mm) | <input type="text" value="5.0"/> | Lateral View Translation (mm) | <input type="text" value="7.0"/> | Axial Translation (mm) | <input type="text" value="5.0"/> |
| <input type="radio"/> Medial <input checked="" type="radio"/> Lateral | | <input checked="" type="radio"/> Anterior <input type="radio"/> Posterior | | <input checked="" type="radio"/> Short <input type="radio"/> Long | |

Right AP View



Lateral Medial

Right Lateral View



Posterior Anterior

Right Axial View



Medial Lateral

Clicking on graphic will enlarge Previous Regenerate Views Next

TAYLOR SPATIAL FRAME*



Home Cases Utilities Literature User Profile Logout Help

File Case Info Define Deformity **Select Frame** Mount Frame Initial Frame Final Frame Structure at Risk Prescription Report

Long Bone

Case Name: Macellaro, Richard
3-10-0

Ring Selection: ?

Proximal Ring*:

Distal Ring:

Open Ring Orientation



Strut Family:

Standard Struts (Chronic) Fast Fx ® (Chronic) Use Selection Below (Total Residual)

Strut Selection:

| Size: | Standard Struts | | | | Fast Fx ® | | | |
|-----------|----------------------------|----------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | Extra Short | Short | Medium | Long | Extra Short | Short | Medium | Long |
| Range: | 75-96 mm | 90-125 mm | 116-178 mm | 169-283 mm | 91-121mm | 116-152 mm | 143-205 mm | 195-311 mm |
| Cat. No.: | 7107-0205 | 7107-0210 | 7107-0220 | 7107-0230 | 7107-0705 | 7107-0710 | 7107-0720 | 7107-0730 |
| | Select All | Select All | Select All | Select All | Select All | Select All | Select All | Select All |
| Strut 1 | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Strut 2 | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Strut 3 | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Strut 4 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Strut 5 | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Strut 6 | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Previous

Next



Mouting Parameters: center ring is 20 mm posterior to origin



Long Bone




Case Name: Macellaro, Richard 3-10-0

Operative Mode ?

Total Residual Chronic Residual

Mounting Parameters

| | | | | | |
|--|----------------------------------|--|-----------------------------------|---|------------------------------------|
| AP View Frame Offset (mm) | <input type="text" value="5.0"/> | Lateral View Frame Offset (mm) | <input type="text" value="24.0"/> | Axial Frame Offset (mm) | <input type="text" value="120.0"/> |
| <input type="radio"/> Medial to Origin | | <input type="radio"/> Anterior to Origin | | <input checked="" type="radio"/> Proximal to Origin | |
| <input checked="" type="radio"/> Lateral to Origin | | <input checked="" type="radio"/> Posterior to Origin | | <input type="radio"/> Distal to Origin | |
| | | | | Rotary Frame Angle (deg) | <input type="text" value="10.0"/> |
| | | | | <input checked="" type="radio"/> Frame Externally Rotated | |
| | | | | <input type="radio"/> Frame Internally Rotated | |

| | | |
|--|---|---|
| <p>Right AP View</p>  | <p>Right Lateral View</p>  | <p>Right Axial View</p>  |
|--|---|---|

Clicking on graphic will enlarge ?

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Home | **Cases** | Utilities | Literature | User Profile | Logout | Help

File | Case Info | Define Deformity | Select Frame | Mount Frame | **Initial Frame** | Final Frame | Structure at Risk | Prescription | Report

Long Bone Case Name: Macellaro, Richard 3-10-0

Initial Settings for Total Residual Operative Mode

| | | | | | |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Strut 1 ● (mm) (Red) | Strut 2 ● (mm) (Orange) | Strut 3 ● (mm) (Yellow) | Strut 4 ● (mm) (Green) | Strut 5 ● (mm) (Blue) | Strut 6 ● (mm) (Violet) |
| <input type="text" value="162"/> | <input type="text" value="176"/> | <input type="text" value="170"/> | <input type="text" value="187"/> | <input type="text" value="145"/> | <input type="text" value="146"/> |

| | | |
|--|---|---|
| <p>Right AP View</p> <p>Lateral Medial</p> | <p>Right Lateral View</p> <p>Posterior Anterior</p> | <p>Right Axial View</p> <p>Medial Lateral</p> |
|--|---|---|

Deformity Parameters

| | | |
|-------------------------------------|---|---------------------------------------|
| AP View Angulation: 16.0° Valgus | Lateral View Angulation: 7.0° Apex Anterior | Axial View Angulation: 10.0° Internal |
| AP View Translation: 5.0 mm Lateral | Lateral View Translation: 7.0 mm Anterior | Axial Translation: 5.0 mm Short |

Mounting Parameters

| | | |
|--|--|--|
| AP View Frame Offset: 5.0 mm Lateral to Origin | Lateral View Frame Offset: 24.0 mm Posterior to Origin | Rotary Frame Angle: 10.0° Frame Externally Rotated |
| | | Axial Frame Offset: 120.0 mm Proximal to Origin |

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[File](#) | [Case Info](#) | [Define Deformity](#) | [Select Frame](#) | [Mount Frame](#) | [Initial Frame](#) | **[Final Frame](#)** | [Structure at Risk](#) | [Prescription](#) | [Report](#)

Long Bone

Case Name: Macellaro, Richard 3-10-0

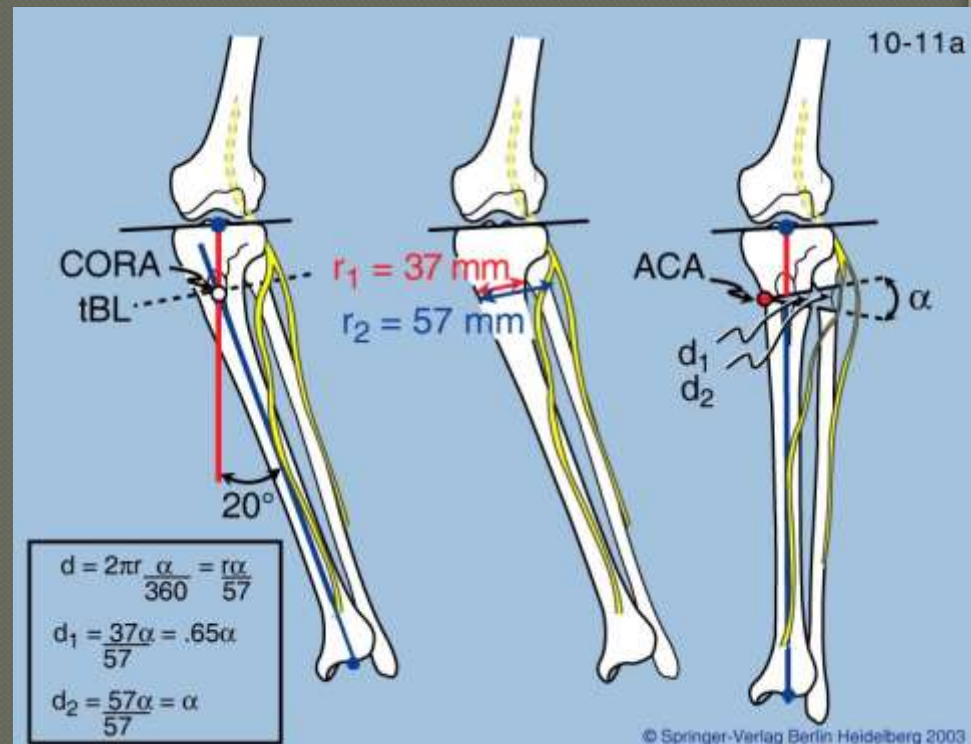
Final Settings for Total Residual Operative Mode

| Strut 1 (mm) (Red) 193 | Strut 2 (mm) (Orange) 164 | Strut 3 (mm) (Yellow) 158 | Strut 4 (mm) (Green) 184 | Strut 5 (mm) (Blue) 191 | Strut 6 (mm) (Violet) 168 | | | | | | |
|--|--|---|--------------------------------|---|---------------------------------|--|--|--|-----------------------------|----------------------------------|---|
| <p>Right AP View</p> <p>Lateral Medial</p> | | <p>Right Lateral View</p> <p>Posterior Anterior</p> | | <p>Right Axial View</p> <p>Medial Lateral</p> | | | | | | | |
| <p>Final Deformity Parameters</p> <table border="1"> <tr> <td>AP View Angulation: 0.0°</td> <td>Lateral View Angulation: 0.0°</td> <td>Axial View Angulation: 0.0°</td> </tr> <tr> <td>AP View Translation: 0.0 mm</td> <td>Lateral View Translation: 0.0 mm</td> <td>Axial Translation: 0.0 mm</td> </tr> </table> | | | | | | AP View Angulation: 0.0° | Lateral View Angulation: 0.0° | Axial View Angulation: 0.0° | AP View Translation: 0.0 mm | Lateral View Translation: 0.0 mm | Axial Translation: 0.0 mm |
| AP View Angulation: 0.0° | Lateral View Angulation: 0.0° | Axial View Angulation: 0.0° | | | | | | | | | |
| AP View Translation: 0.0 mm | Lateral View Translation: 0.0 mm | Axial Translation: 0.0 mm | | | | | | | | | |
| <p>Mounting Parameters</p> <table border="1"> <tr> <td>AP View Frame Offset: 5.0 mm Lateral to Origin</td> <td>Lateral View Frame Offset: 24.0 mm Posterior to Origin</td> <td>Rotary Frame Angle: 10.0° Frame Externally Rotated</td> </tr> <tr> <td></td> <td></td> <td>Axial Frame Offset: 120.0 mm Proximal to Origin</td> </tr> </table> | | | | | | AP View Frame Offset: 5.0 mm Lateral to Origin | Lateral View Frame Offset: 24.0 mm Posterior to Origin | Rotary Frame Angle: 10.0° Frame Externally Rotated | | | Axial Frame Offset: 120.0 mm Proximal to Origin |
| AP View Frame Offset: 5.0 mm Lateral to Origin | Lateral View Frame Offset: 24.0 mm Posterior to Origin | Rotary Frame Angle: 10.0° Frame Externally Rotated | | | | | | | | | |
| | | Axial Frame Offset: 120.0 mm Proximal to Origin | | | | | | | | | |

Clicking on graphic will enlarge ?

Rate of deformity correction

- Define structure at risk
 - Concavity of the deformity
 - Bone
 - Soft-tissue
- Not more than 1mm per day
 - Tailored to specific patient
 - Based on postop assessments



TAYLOR SPATIAL FRAME*



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File Case Info Define Deformity Select Frame Mount Frame Initial Frame Final Frame **Structure at Risk** Prescription Report

Long Bone

Case Name: Macellaro, Richard 3-10-0

| | | | |
|---|-----------------------------------|--|----------------------------------|
| AP View SAR Offset (mm) | <input type="text" value="30.0"/> | Lateral View SAR Offset (mm) | <input type="text" value="0.0"/> |
| <input type="radio"/> Medial to Origin | | <input type="radio"/> Anterior to Origin | |
| <input checked="" type="radio"/> Lateral to Origin | | <input type="radio"/> Posterior to Origin | |
| Axial SAR Offset (mm) | <input type="text" value="70.0"/> | Max Safe Distraction Rate (mm/day) | <input type="text" value="1.0"/> |
| <input checked="" type="radio"/> Proximal to Origin | | | |
| <input type="radio"/> Distal to Origin | | | |
| Minimum Correction Time (days): | <input type="text"/> | <input type="button" value="Calculate Minimum Correction Time"/> | |

Enter Correction Time (days):

Long Bone

[Open a printable version of this page in a new window](#)

Robert Rozbruch
 Office Phone: 212-606-1415
 Case Number:
 Case Name: Macellaro, Richard 3-10-0

Prescription Start Date
 03/12/2005

Prescription

| Date | Day | Strut 1 (Red) | Strut 2 (Orange) | Strut 3 (Yellow) | Strut 4 (Green) | Strut 5 (Blue) | Strut 6 (Violet) | View |
|---------|-----|------------------|---------------------|---------------------|--------------------|-------------------|---------------------|----------------------|
| 3/12/05 | 0 | 162 | 176 | 170 | 187 | 145 | 146 | View |
| 3/13/05 | 1 | 163 | 176 | 170 | 187 | 147 | 147 | View |
| 3/14/05 | 2 | 164 | 175 | 169 | 187 | 148 | 148 | View |
| 3/15/05 | 3 | 165 | 175 | 169 | 187 | 150 | 148 | View |
| 3/16/05 | 4 | 166 | 174 | 168 | 187 | 151 | 149 | View |
| 3/17/05 | 5 | 167 | 174 | 168 | 186 | 153 | 150 | View |
| 3/18/05 | 6 | 168 | 174 | 168 | 186 | 155 | 151 | View |
| 3/19/05 | 7 | 169 ^a | 173 | 167 | 186 | 156 | 151 | View |
| 3/20/05 | 8 | 171 ^a | 173 | 167 | 186 | 158 | 152 | View |
| 3/21/05 | 9 | 172 ^a | 172 | 166 | 186 | 159 | 153 | View |
| 3/22/05 | 10 | 173 ^a | 172 | 166 | 186 | 161 | 154 | View |
| 3/23/05 | 11 | 174 ^a | 171 | 165 | 186 | 162 | 154 | View |
| 3/24/05 | 12 | 175 ^a | 171 | 165 | 186 | 164 | 155 | View |
| 3/25/05 | 13 | 176 ^a | 171 | 165 | 186 | 166 | 156 | View |
| 3/26/05 | 14 | 177 ^a | 170 | 164 | 186 | 167 | 157 | View |
| 3/27/05 | 15 | 178 ^a | 170 | 164 | 185 | 169 ^b | 157 | View |
| 3/28/05 | 16 | 179 | 169 | 163 | 185 | 170 ^b | 158 | View |
| 3/29/05 | 17 | 180 | 169 | 163 | 185 | 172 ^b | 159 | View |
| 3/30/05 | 18 | 181 | 169 | 163 | 185 | 174 ^b | 160 | View |
| 3/31/05 | 19 | 182 | 168 | 162 | 185 | 175 ^b | 160 | View |

| | | | | | | | | |
|---------|----|------------------|-----|-----|-----|------------------|-----|----------------------|
| 3/23/05 | 11 | 174 ^a | 171 | 165 | 186 | 162 | 154 | View |
| 3/24/05 | 12 | 175 ^a | 171 | 165 | 186 | 164 | 155 | View |
| 3/25/05 | 13 | 176 ^a | 171 | 165 | 186 | 166 | 156 | View |
| 3/26/05 | 14 | 177 ^a | 170 | 164 | 186 | 167 | 157 | View |
| 3/27/05 | 15 | 178 ^a | 170 | 164 | 185 | 169 ^b | 157 | View |
| 3/28/05 | 16 | 179 | 169 | 163 | 185 | 170 ^b | 158 | View |
| 3/29/05 | 17 | 180 | 169 | 163 | 185 | 172 ^b | 159 | View |
| 3/30/05 | 18 | 181 | 169 | 163 | 185 | 174 ^b | 160 | View |
| 3/31/05 | 19 | 182 | 168 | 162 | 185 | 175 ^b | 160 | View |
| 4/1/05 | 20 | 183 | 168 | 162 | 185 | 177 ^b | 161 | View |
| 4/2/05 | 21 | 184 | 167 | 161 | 185 | 178 ^b | 162 | View |
| 4/3/05 | 22 | 186 | 167 | 161 | 185 | 180 | 163 | View |
| 4/4/05 | 23 | 187 | 166 | 160 | 185 | 181 | 163 | View |
| 4/5/05 | 24 | 188 | 166 | 160 | 185 | 183 | 164 | View |
| 4/6/05 | 25 | 189 | 166 | 160 | 184 | 185 | 165 | View |
| 4/7/05 | 26 | 190 | 165 | 159 | 184 | 186 | 166 | View |
| 4/8/05 | 27 | 191 | 165 | 159 | 184 | 188 | 166 | View |
| 4/9/05 | 28 | 192 | 164 | 158 | 184 | 189 | 167 | View |
| 4/10/05 | 29 | 193 | 164 | 158 | 184 | 191 | 168 | View |

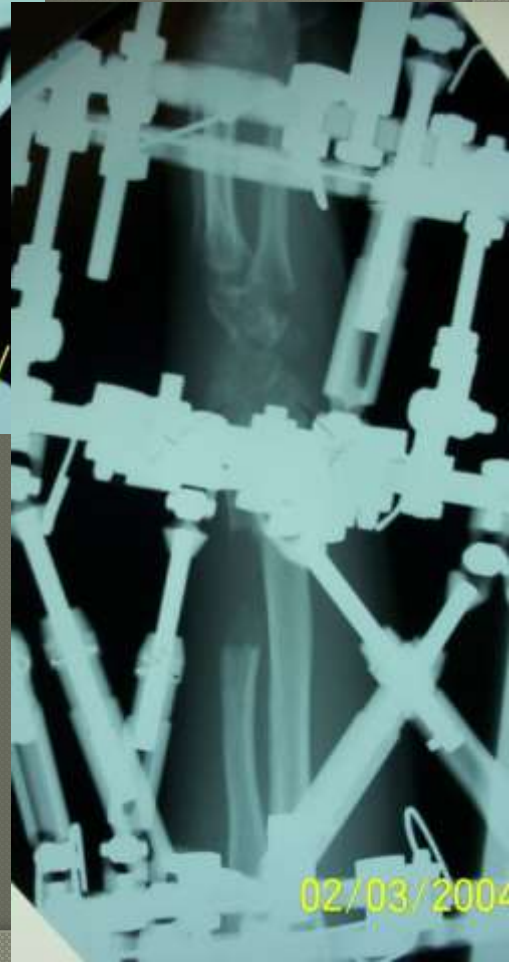
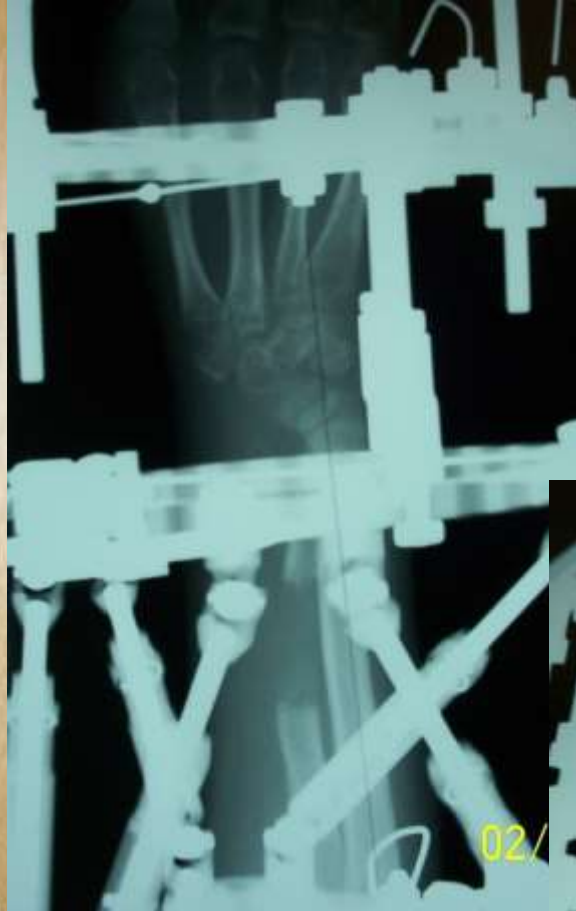
Strut Change-Outs

| Change-Out | Strut | Overlap Interval | | Strut Change | |
|------------|------------|------------------|-----------------|------------------------------|----------------------------|
| | | First Day | Last Day | From | To |
| a | 1 ● (Red) | 7 (3/19/05) | 15 (3/27/05) | 7107-0220 Medium Standard | 7107-0230 Long Standard |
| b | 5 ● (Blue) | 15 (3/27/05) | 21 (4/2/05) | 7107-0220 Medium Standard | 7107-0230 Long Standard |

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Thank You



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