

Disclosures

- Ortho-SUV Ltd. (employee)
- Springer-Verlag (honorarium)
- I will be discussing products/devices that are not FDA approved

St.Petersburg



St.Petersburg



- Founded by Peter the Great in 1703

- 1712-1918 – the capital of Russia

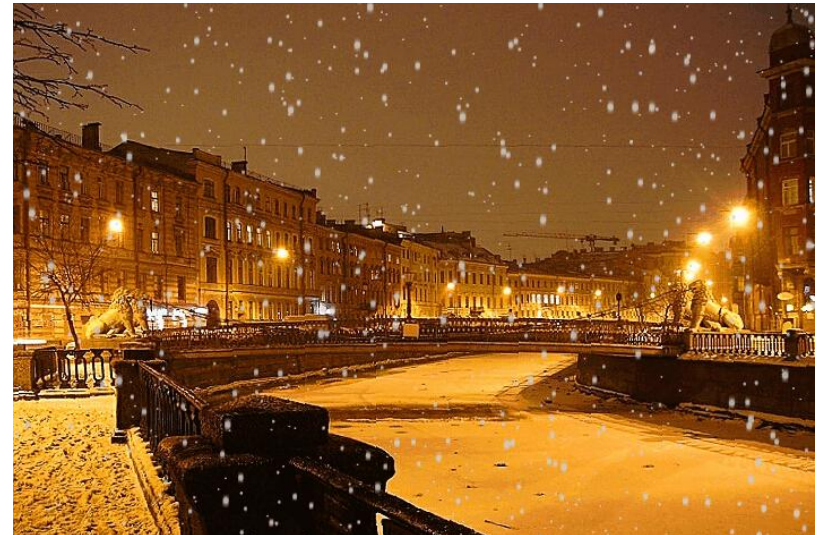
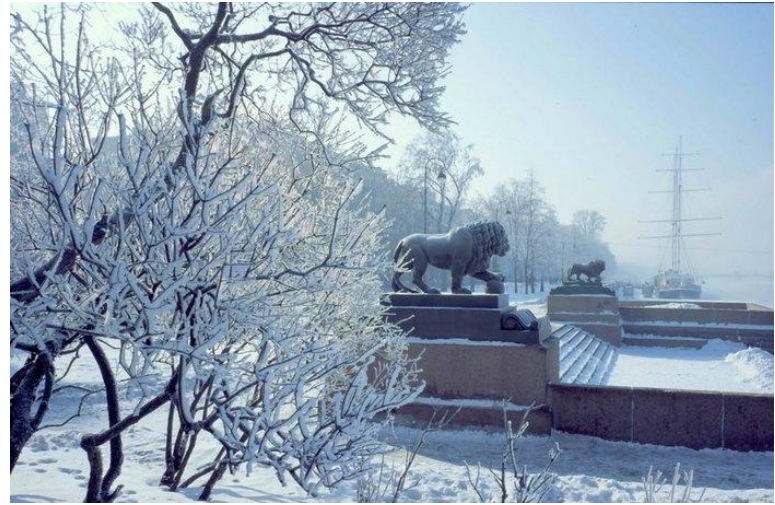
- Population - 5 300 000 (2017)

- SPb is important economical, scientific and cultural center of Russia

- Historical center of SPb was included into the list of UNESCO World Heritage Sites

- 700 big and 20.000 smaller are SPb industrial basis





St.Petersburg is beautiful in winter time as well...

R.R. Vreden Russian Research Institute of Traumatology and Orthopedics



About 1200 employees
210 orthopedic surgeons
112 scientific employees

13 professors
101 MD, PhD

AO Principles Based Long Bone Defect Classification (LBDC) Main options for long-bone defects treatment

Leonid Solomin
Vreden RRITO
SPb State University



<http://rniito.org>

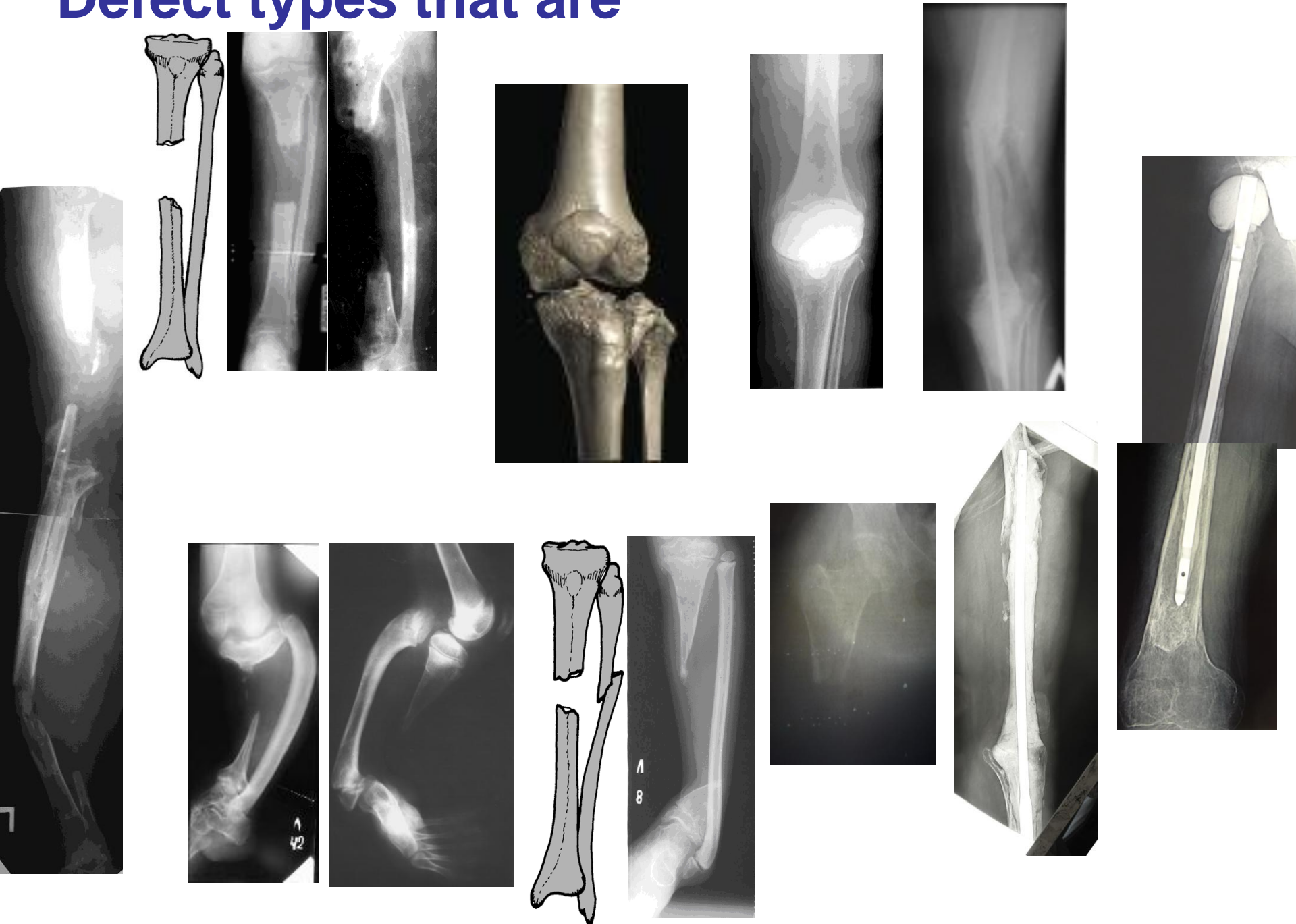


<http://spbu.ru>

Defects we meet often



Defect types that are

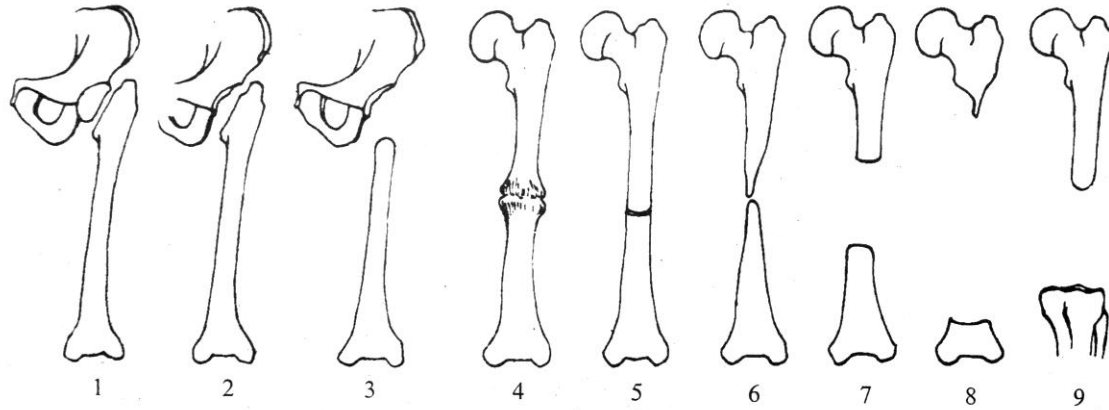


“A classification is useful only if it considers the severity of the bone lesion and serves as a basis for treatment and for evaluation of the results.”

Maurice E Müller,
1988

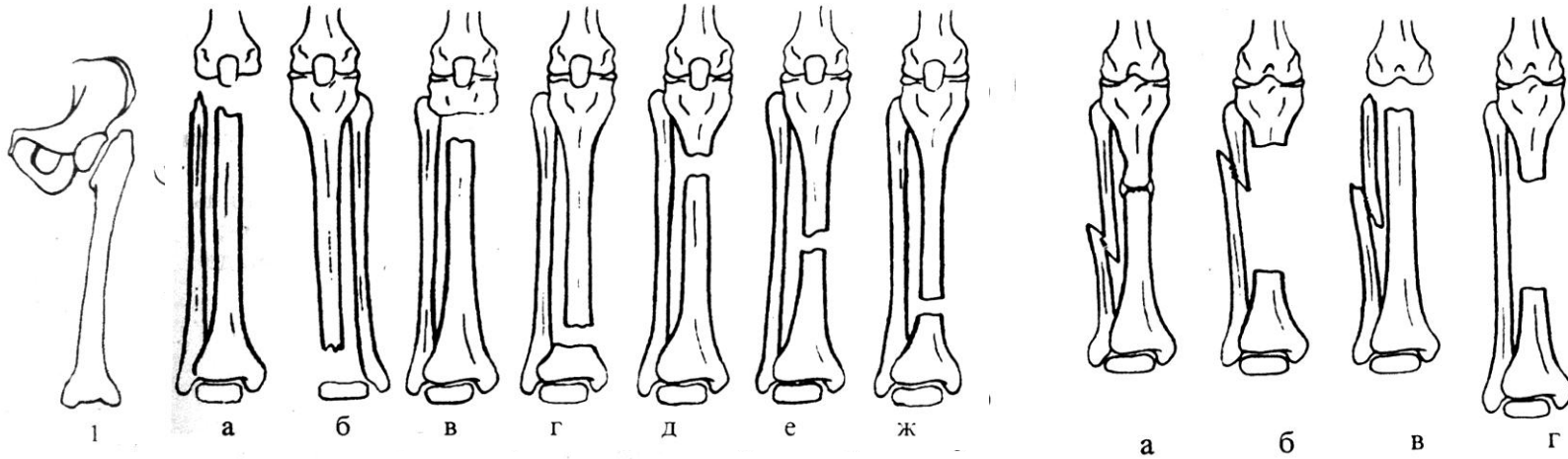


Method-based LBDC



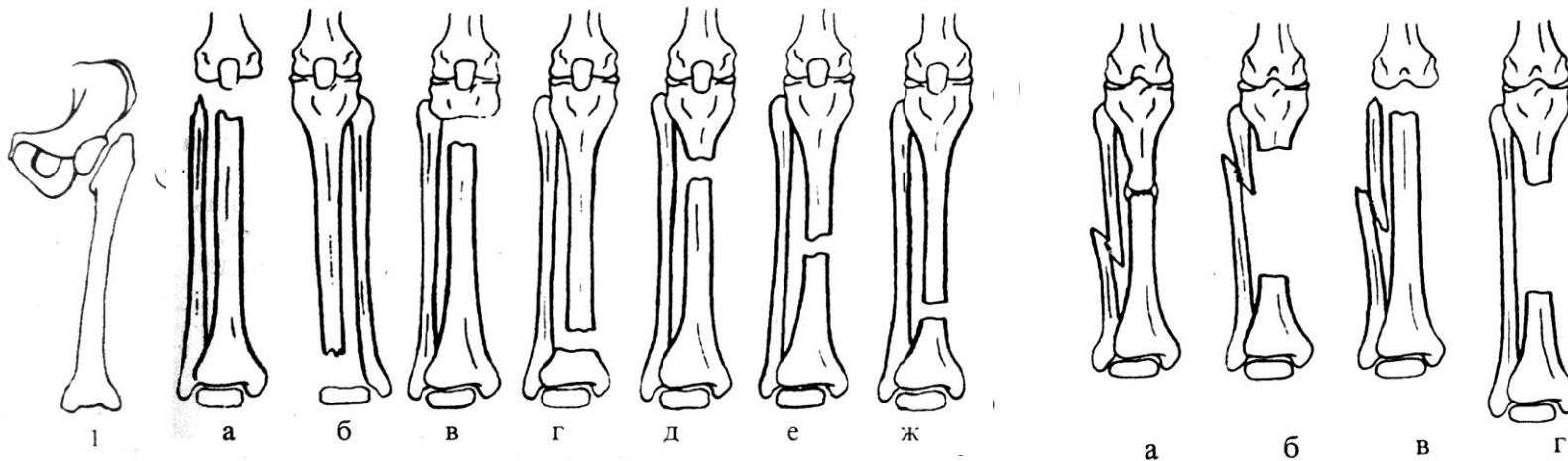
Shevtsov V.I. et al., 1996

Method-based LBDC

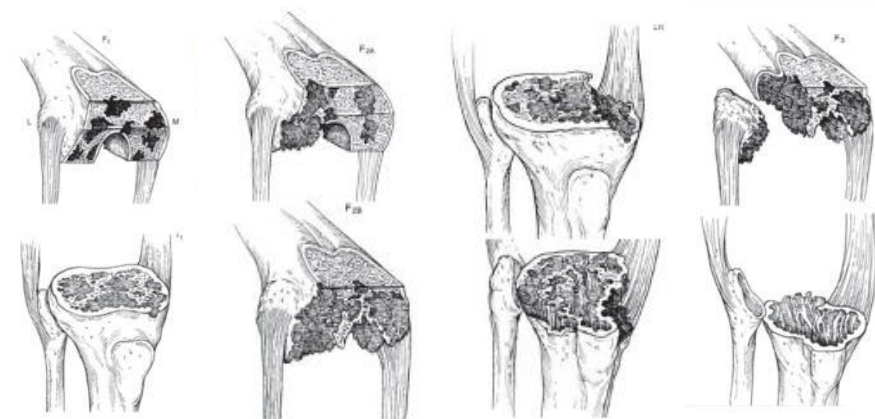


Shevtsov V.I. et al., 1996

Method-based LBDC



Shevtsov V.I. et al., 1996

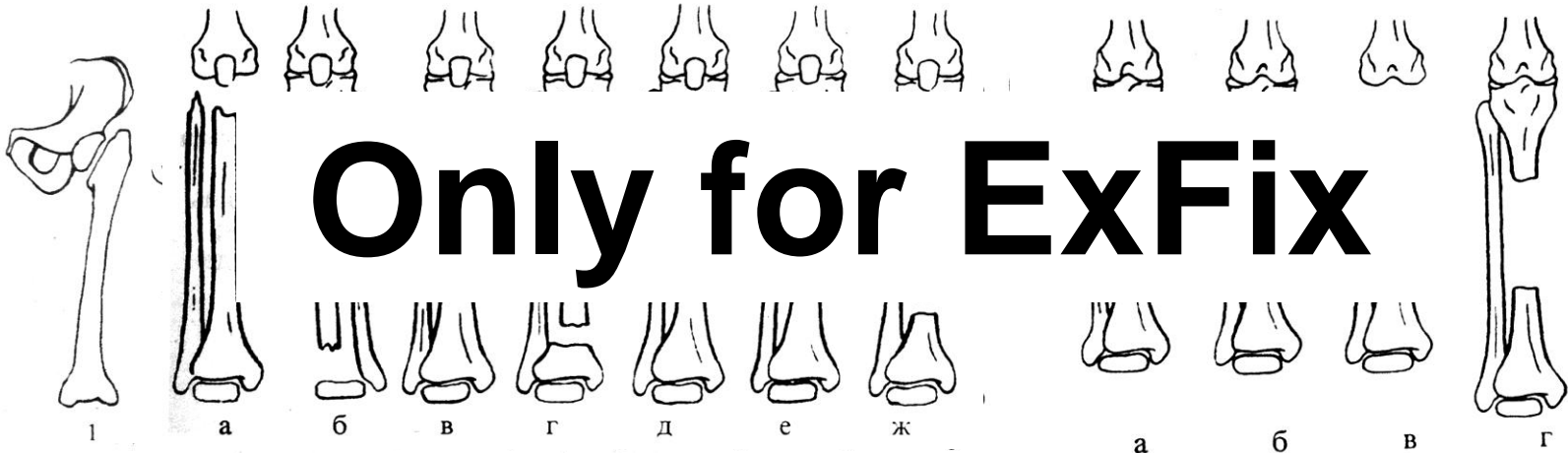


AORI (Engh et al., 1997)



Clatworthy M. et al., 2003

Method-based LBDC



Only for ExFix

Shevtsov V.I. et al., 1996



Only for arthroplasty



AORI (Engh et al., 1997)

Clatworthy M. et al., 2003

Size-based LBDC

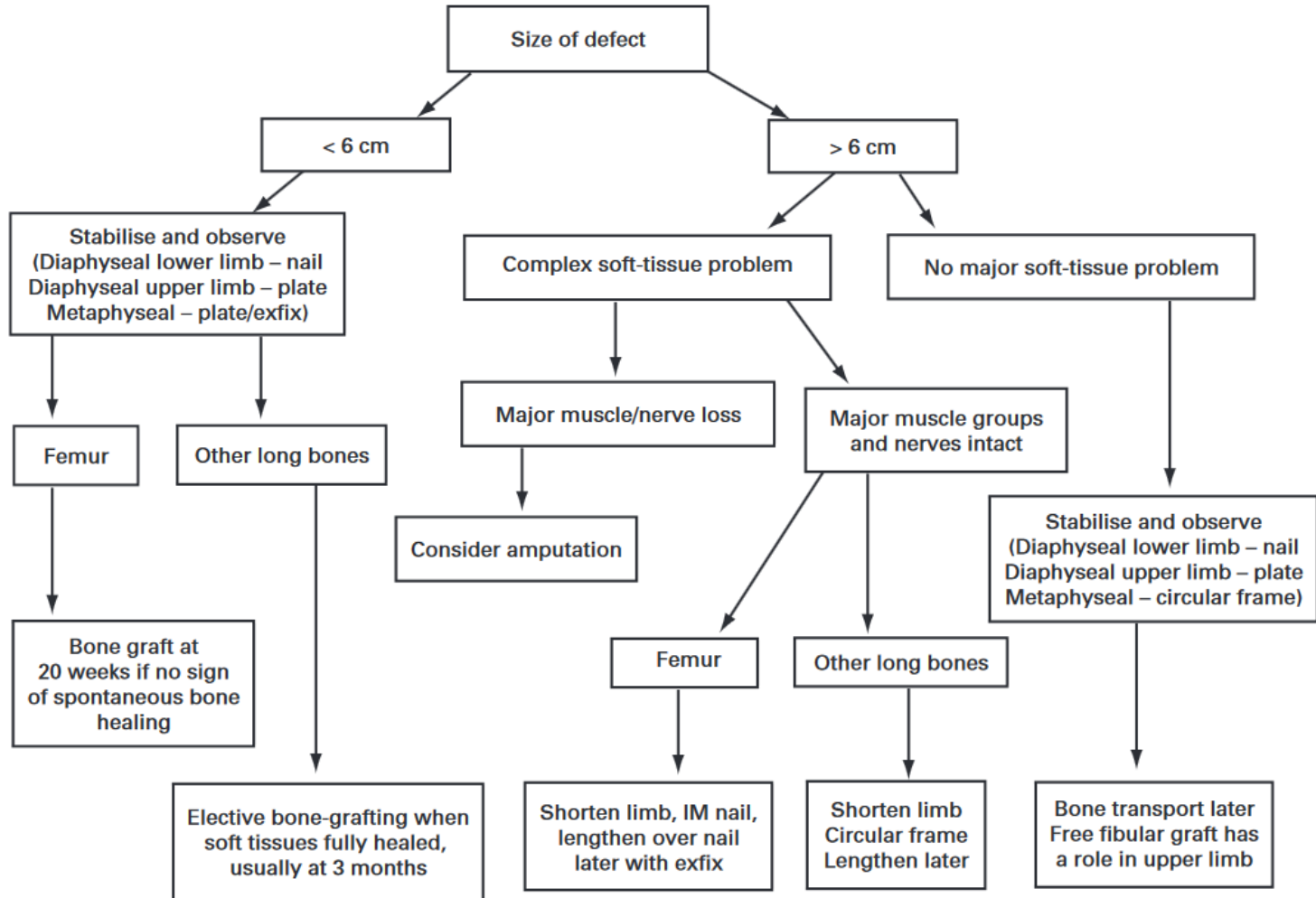
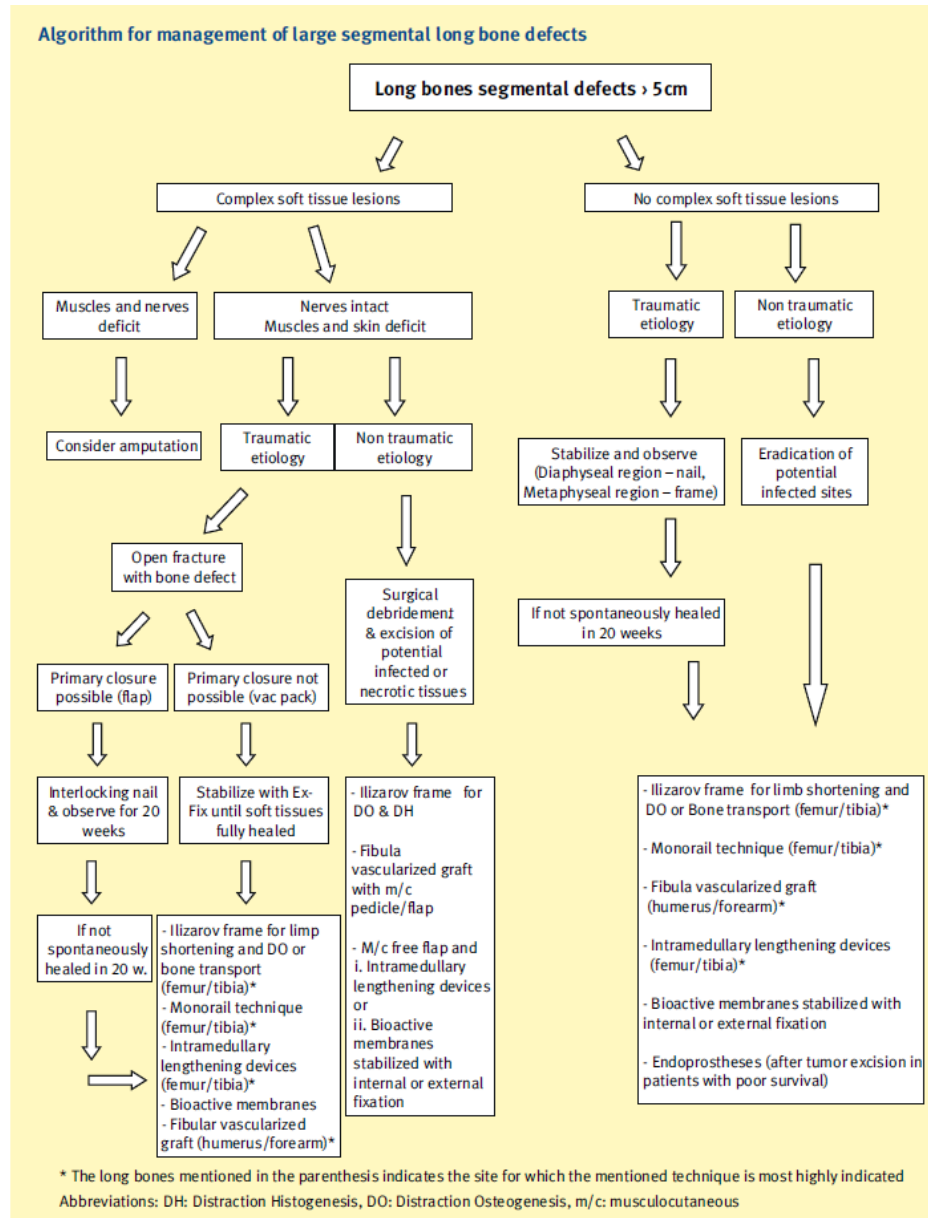


Fig. 5

Algorithm for management of bone loss.

Size-based LBDC



Nikolaos G Lasanianos
et al., 2009

Size-based LBDC

Table 1

The Authors' Preferred Management of Segmental Bone Defects Based on Size

Management Method	Size of Defect	Advantages	Disadvantages
Autologous bone graft	<5 cm	One-stage reconstruction; no disease transmission; no immunologic rejection; low cost; standard of care with osteoinductive, osteoconductive, and osteogenic properties	Donor site morbidity, limited volume available, no structural capability
Allograft bone	Unknown	No donor site morbidity, "limitless" volume, structural properties with cortical allograft, volume expander	Limited graft incorporation/remodeling, potential disease transmission, no osteoinductive or osteogenic properties, cost/expense
Demineralized bone matrix	Unproven for segmental defects	Osteoinductive properties, no donor site morbidity, volume expander	No structural property, no evidence for segmental bone defect reconstruction, cost/expense
Bone morphogenetic proteins	Unproven for segmental defects	Osteoinductive, bone graft enhancer	Interferes with Masquelet technique, no structural capability, cost/expense
Induced membrane technique (Masquelet technique)	>10 cm (5–24 cm)	RIA graft harvest can provide adequate volume, internal or external fixation can be used, reconstruction time is independent of length of defect, low cost	Donor site morbidity, two-stage technique, long reconstructive period (average, 9 mo), described using external fixation, ratio of allograft to autograft cannot exceed 3:1 with theoretic defect limits
Distraction osteogenesis (Ilizarov technique)	5–10 cm (average) ^a	No donor site morbidity, no restrictions on defect length, reliable technique, can be used with a compromised soft-tissue envelope (STSG or free tissue flap), can decrease reconstructive time with multiple osteotomies and transport segments	Long reconstructive period, reconstructive period is length-dependent, high rate of complications with prolonged external fixation, cost of ring or spatial external fixation frame
Acute shortening	1–3 cm	Simplest and fastest method, allows early primary closure of soft-tissue wounds, well tolerated in upper extremity, well tolerated in single bone extremity segment, no donor site morbidity, low cost	Limb dysfunction especially in lower extremities, defect length is limited, may require secondary lengthening procedures to correct limb-length discrepancy
Vascularized fibular graft transfer	10–20 cm	Substantially shorter reconstruction time for large defect compared with Masquelet and Ilizarov techniques, fibular hypertrophy to support weight-bearing, low cost	Donor site morbidity, requires specialized microsurgical capability, high rate of regenerated bone fracture, typically limited to tibial defects
Amputation	NA	Shorter treatment time than limb salvage/segmental defect reconstruction; good functional outcomes in young, adult trauma patient with modern prosthesis	Permanent limb loss, high rate of secondary procedures for complications, lifetime prosthetic cost

NA = not applicable, RIA = reamer-irrigator-aspirator, STSG = split thickness skin graft

^a Theoretically, there is no limit in terms of size.

Size-based LBDC

- for which types of defects these classifications are?



Size-based LBDC

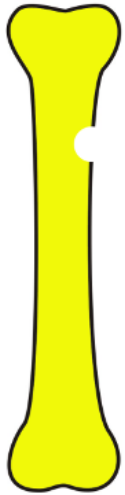
- for which types of defects these classifications are?



- for segmental!

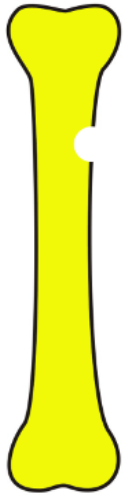
... but “6 cm defect” can be:

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limited

... but “6 cm defect” can be:

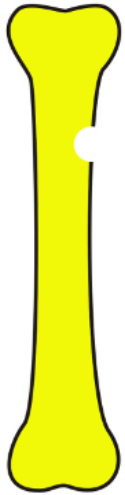


limited



shortening

... but “6 cm defect” can be:



limited

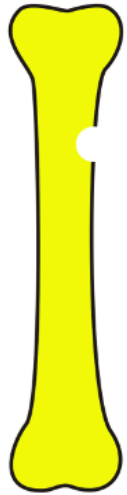


shortening



contact with
shortening

... but “6 cm defect” can be:



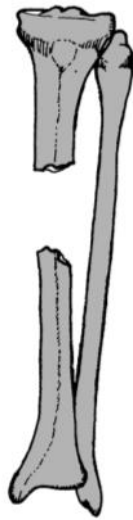
limited



shortening

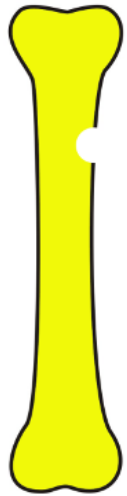


contact with shortening



segmental

... but “6 cm defect” can be:



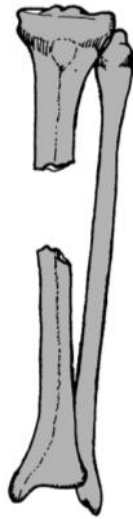
limited



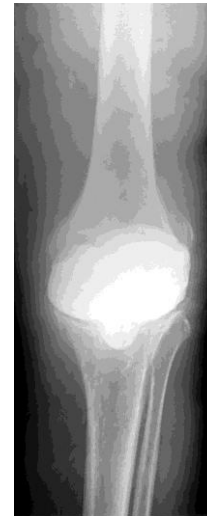
shortening



contact with shortening



segmental



complete articular

Goals

- to know the basic terminology
- to know the principle of long bone defects classification in accordance with the AO principles
- to be able to classify the defects of long bones
- to be able to practically use the classification

Definition

Bone defect

characterized by a loss of bone tissue as a result of injury or disease modifying the anatomical structure, physiology and function of bone

A.Barabash, 1995

Definition

Bone defect

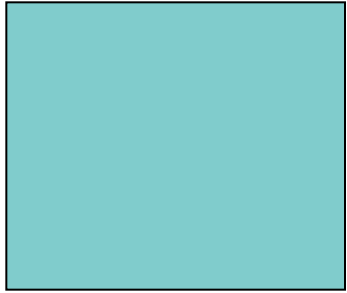
characterized by a loss of bone tissue as a result of injury or disease modifying the anatomical structure, physiology and function of bone

A.Barabash, 1995

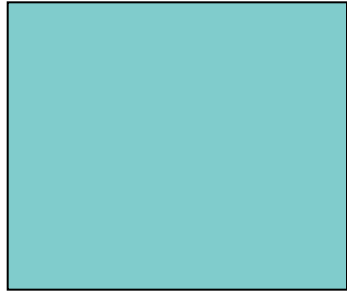
Definitions

- ephyseal
 - metaphyseal
 - diaphyseal
 - combined
-
- limited defect
 - bone fragments have contact
 - segmental defects (“defect-diastase”)
 - large
 - subtotal
 -

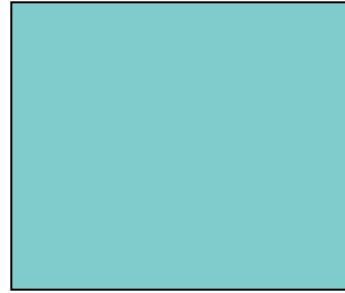
AO principles of classification



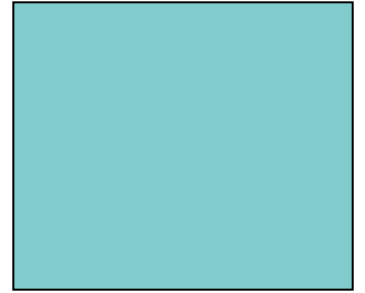
Bone



Segment

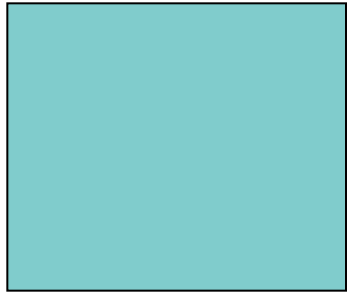


Type

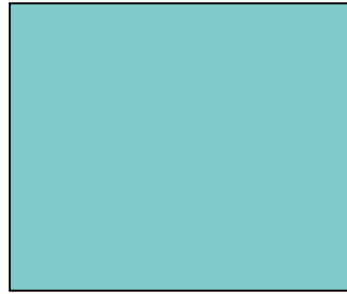


Group

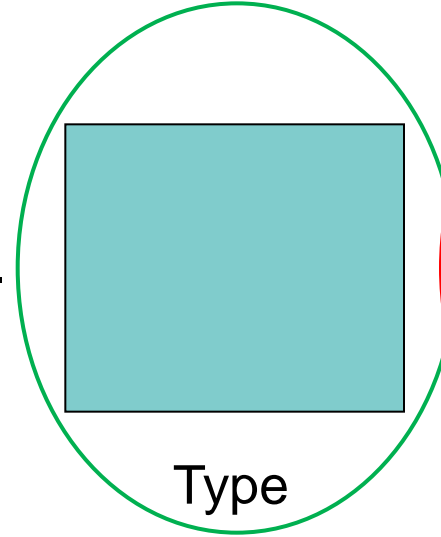
AO principles of classification



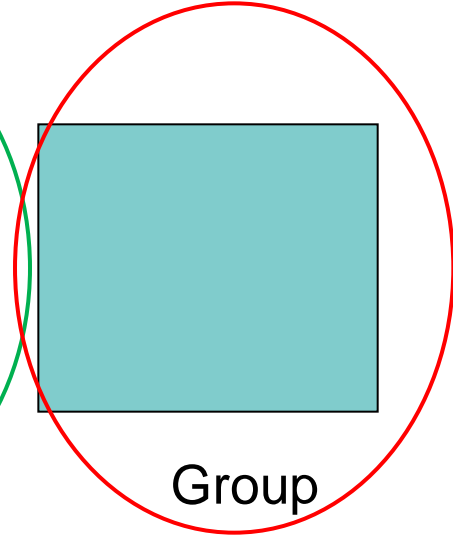
Bone



Segment



Type

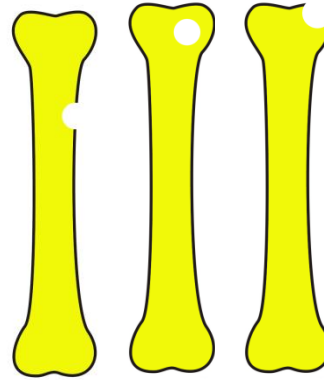


Group

Types of long bones defects

Types of long bones defects

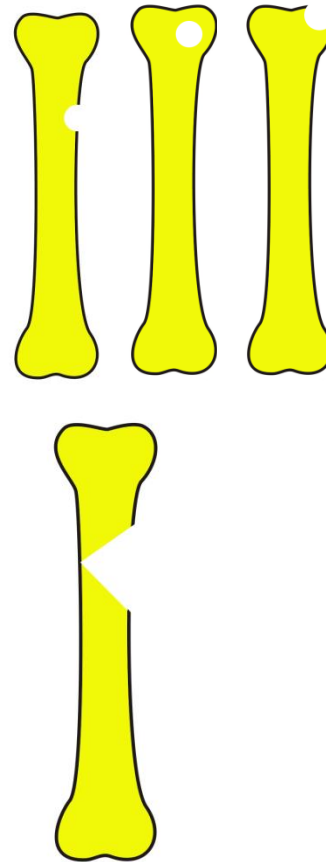
A – limited defects



Types of long bones defects

A – limited defects

B – bone fragments have contact

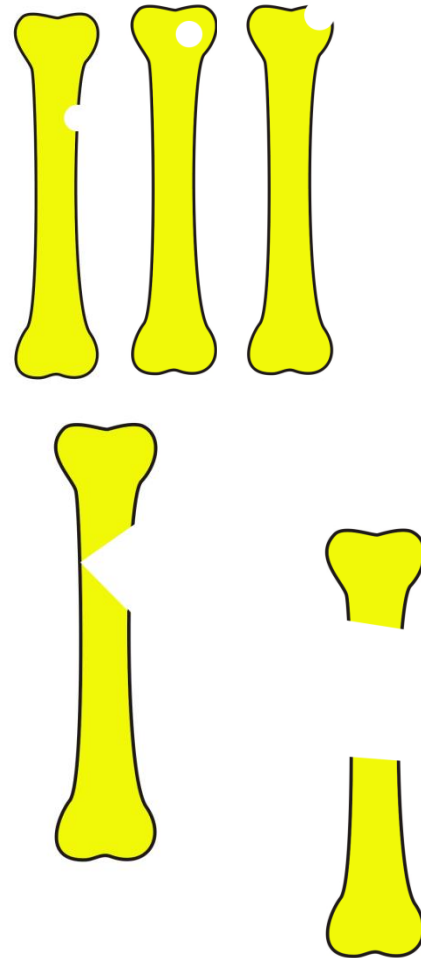


Types of long bones defects

A – limited defects

B – bone fragments have contact

C – bone fragments have no contact (segmental defects, “defect-diastase”)



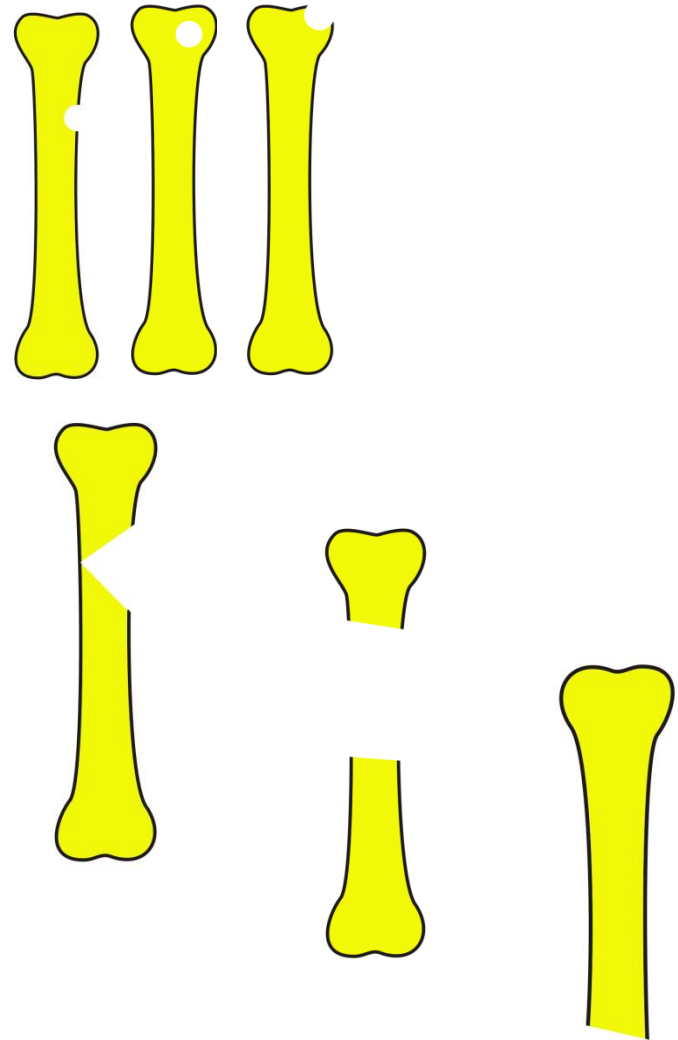
Types of long bones defects

A – limited defects

B – bone fragments have contact

C – bone fragments have no contact (segmental defects, “defect-diastase”)

D – complete articular defects



Types and groups of long bone defects

A – limited defects (<30%)

Types and groups of long bone defects

A – limited defects (<30%)

A1 – diaphyseal



Types and groups of long bone defects

A – limited defects (<30%)

A1 – diaphyseal

A2 – metaphyseal



Types and groups of long bone defects

A – limited defects (<30%)

A1 – diaphyseal

A2 – metaphyseal

A3 – epyphiseal



Types and groups of long bone defects

B – bone fragments have contact

Types and groups of long bone defects

B – bone fragments have contact

B1 – full contact with the anatomical shortening



Types and groups of long bone defects

B – bone fragments have contact

B1 – full contact with the anatomical shortening

B2 – limited contact without anatomical shortening



Types and groups of long bone defects

B – bone fragments have contact

B1 – full contact with the anatomical shortening

B2 – limited contact without anatomical shortening (“NU with bone loss”)

B3 – limited contact with anatomic shortening



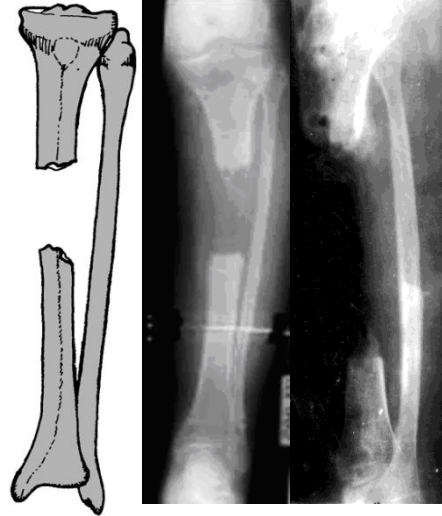
Types and groups of long bone defects

C – bone fragments have no contact (segmental defects, “defect-diastrase”)

Types and groups of long bone defects

C – bone fragments have no contact (segmental defects, “defect-diastase”)

C1 – segmental defects without shortening

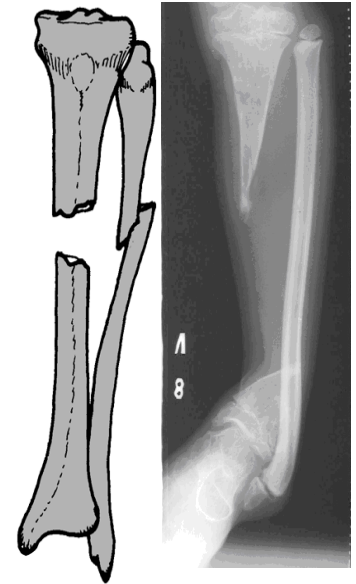
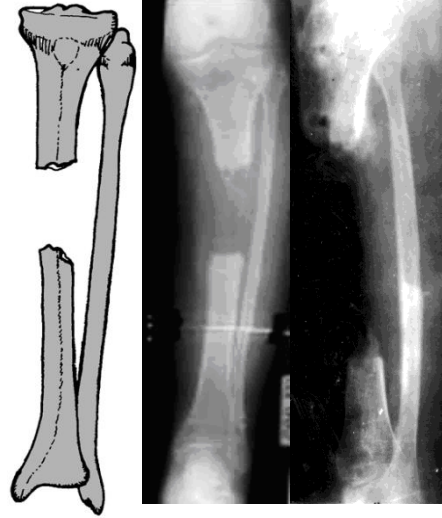


Types and groups of long bone defects

C – bone fragments have no contact (segmental defects, “defect-diastase”)

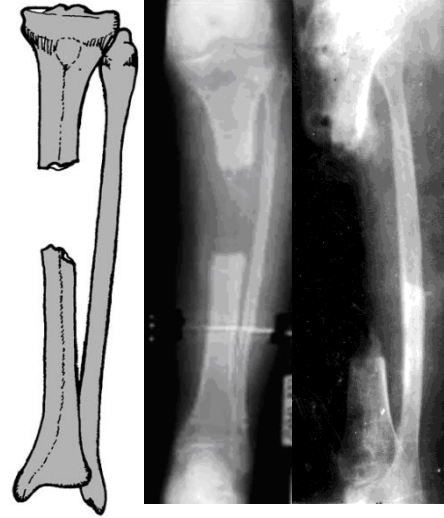
C1 – segmental defects without shortening

C2 – segmental defects with shortening



Types and groups of long bone defects

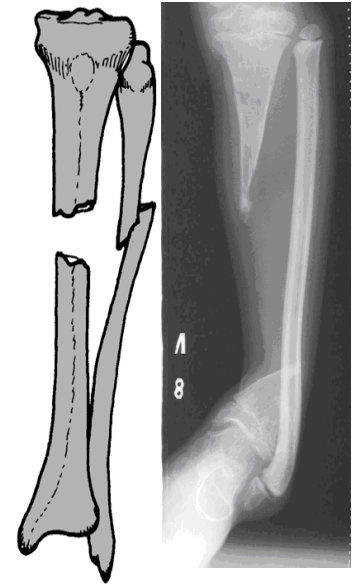
C – bone fragments have no contact (segmental defects, “defect-diastrase”)



C1 – segmental defects without shortening

C2 – segmental defects with shortening

C3 – subtotal defects



Types and groups of long bone defects

D – complete articular defects

Types and groups of long bone defects



D – complete articular defects

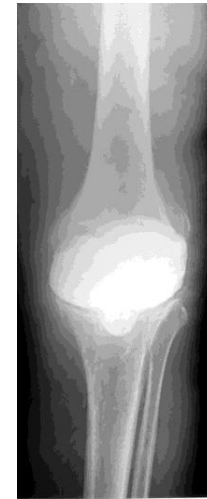
D1 – epiphyseal

Types and groups of long bone defects

D – complete articular defects

D1 – epiphyseal

D2 – epimethaphyseal



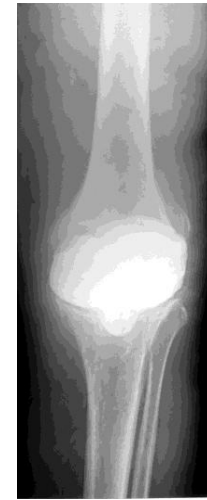
Types and groups of long bone defects

D – complete articular defects

D1 – epiphyseal

D2 – epimethaphyseal

D3 – epimethadiaphyseal



Types and groups of long bone defects

D – complete articular defects

D1 – epiphyseal

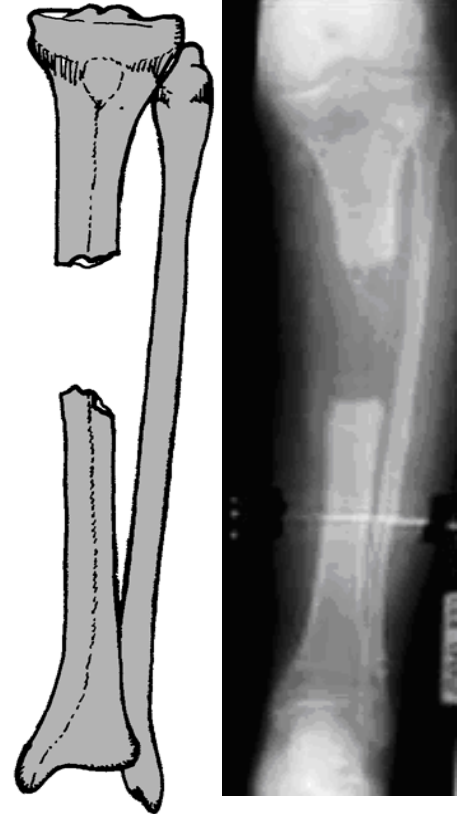
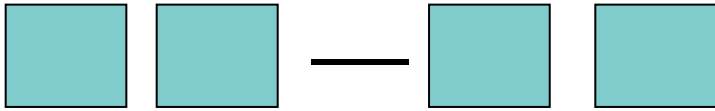
D2 – epimethaphyseal

D3 – epimethadiaphyseal

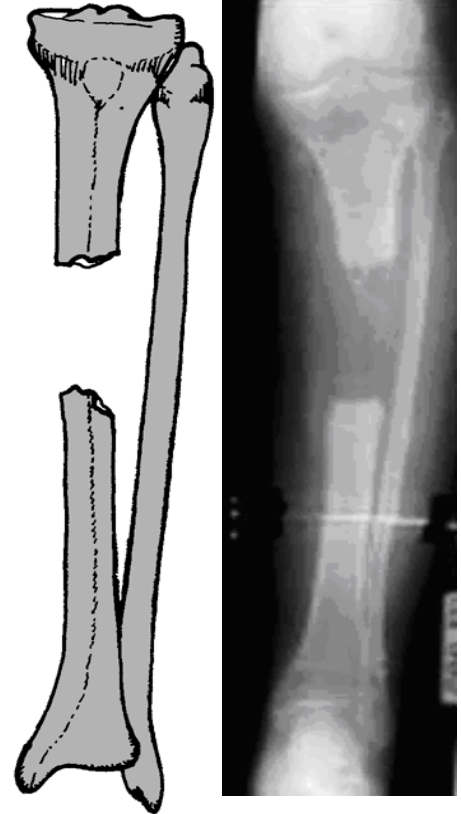
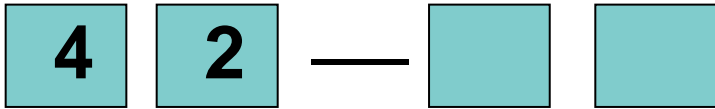
D4 – amputation



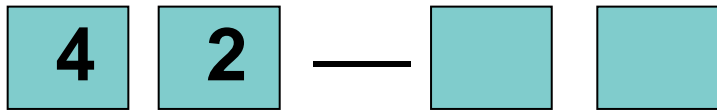
... let's try to classify:



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... let's try to classify:

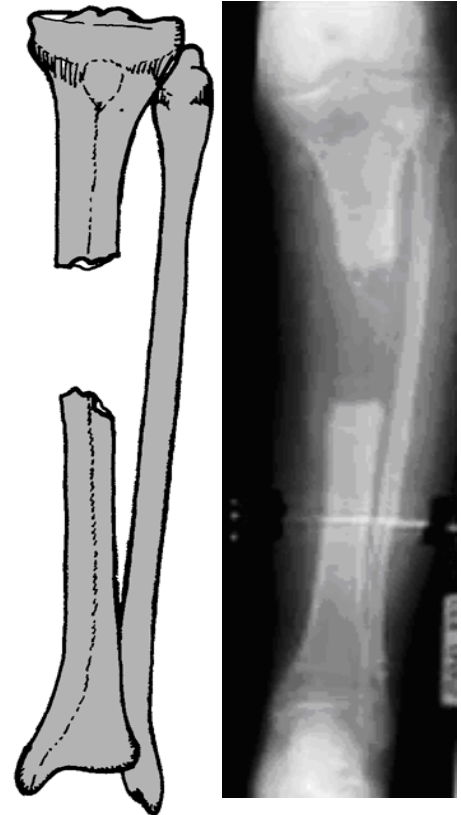


A – limited defects

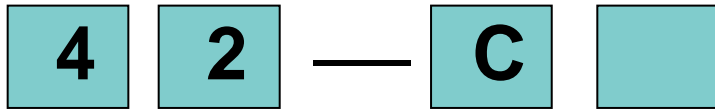
B – bone fragments have contact

C – bone fragments have no contact (segmental defects, “defect-diastrase”)

D – complete articular defects



... let's try to classify:

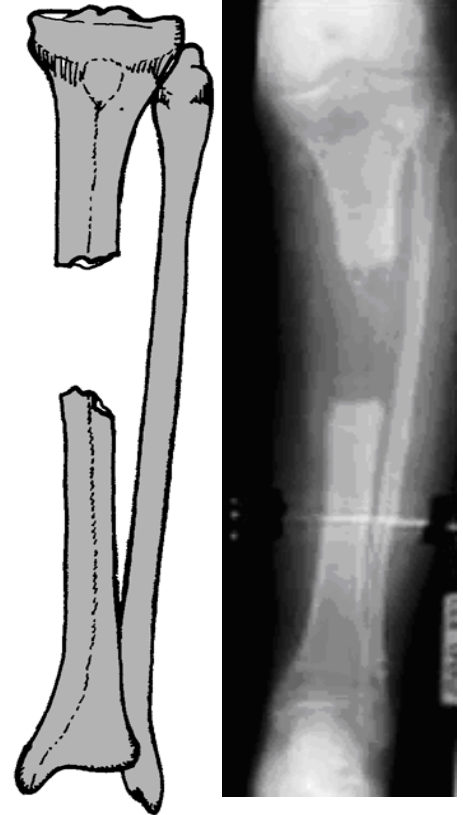


A – limited defects

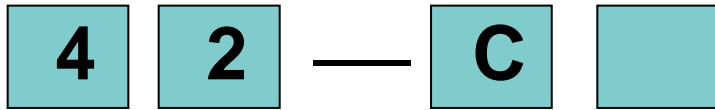
B – bone fragments have contact

C – bone fragments have no contact (segmental defects, “defect-diastase”)

D – complete articular defects



... let's try to classify:



A – limited defects

B – bone fragments have contact

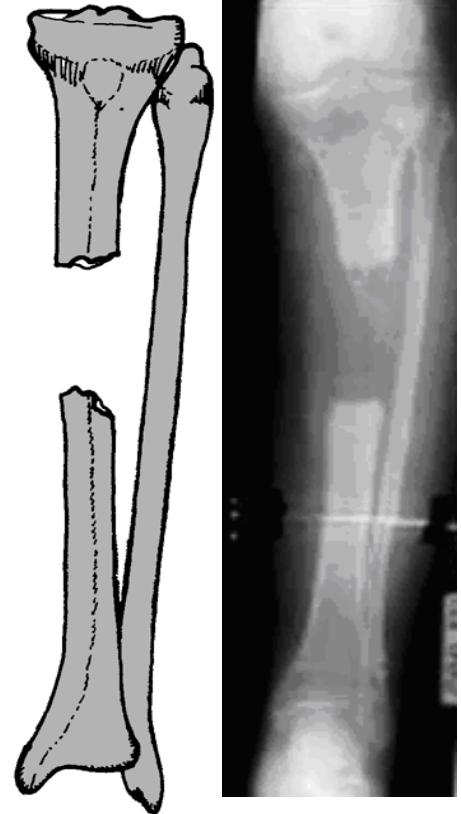
C – bone fragments have no contact (segmental defects, “defect-diastrase”)

D – complete articular defects

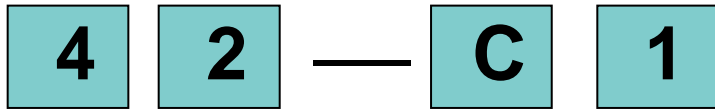
C1 – segmental defects without shortening

C2 – segmental defects with shortening

C3 – subtotal defects



... let's try to classify:



A – limited defects

B – bone fragments have contact

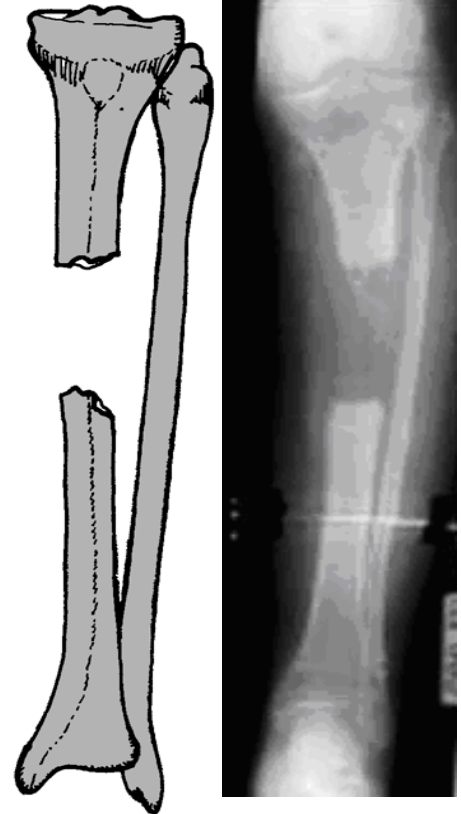
C – bone fragments have no contact (segmental defects, “defect-diastrase”)

D – complete articular defects

C1 – segmental defects without shortening

C2 – segmental defects with shortening

C3 – subtotal defects



... let's try to use!

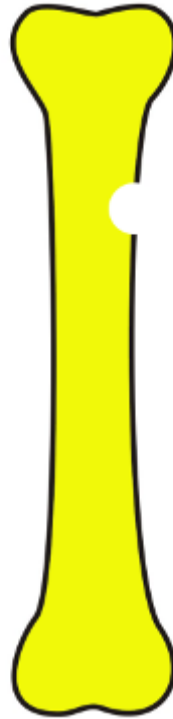
Type A

A – limited defects (<20%)

A1 – diaphyseal

A2 – metaphyseal

A3 – epiphyseal

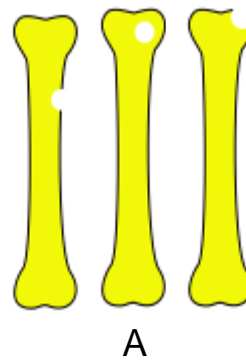


Type A: Grafting

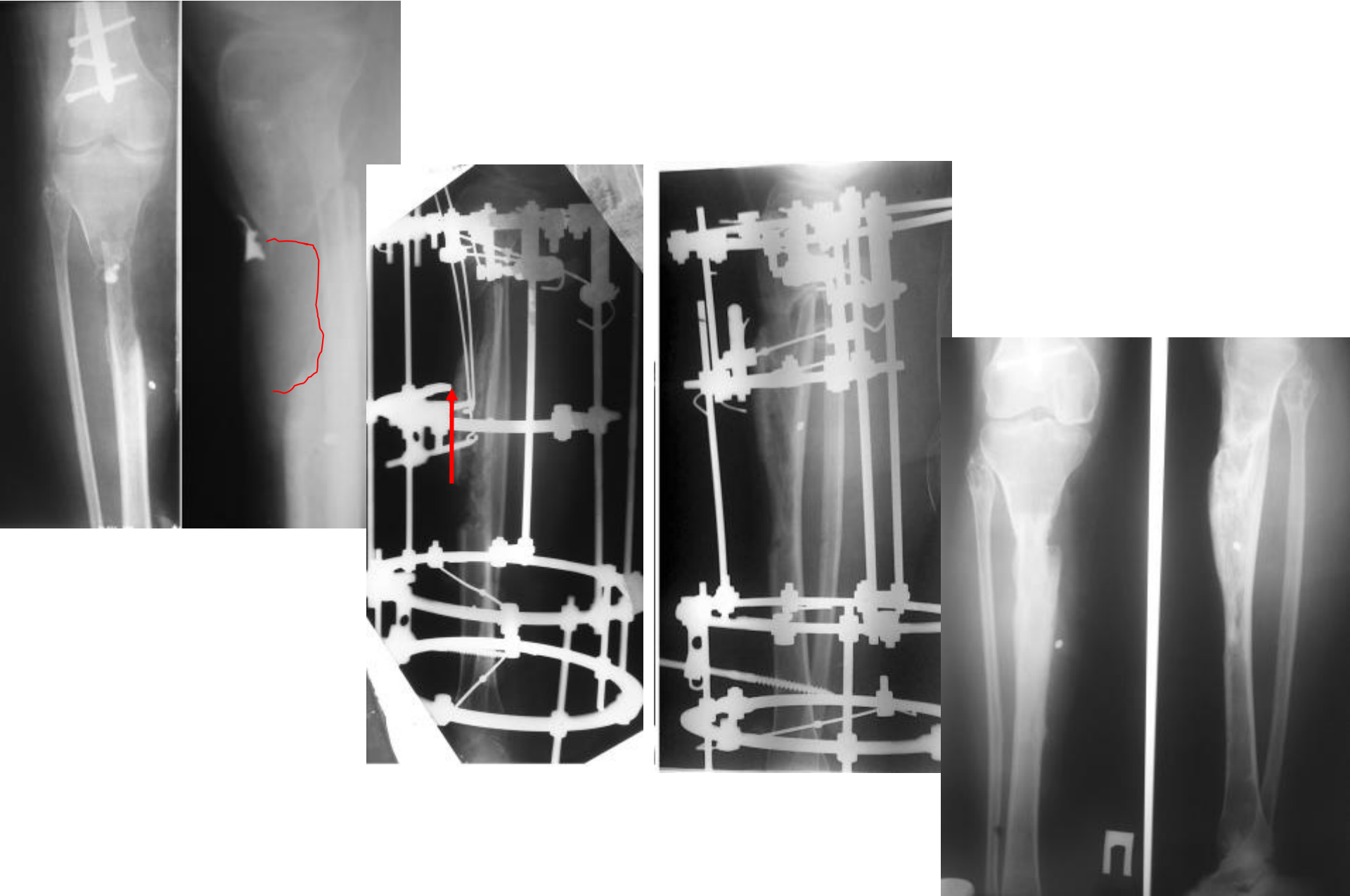
Grafting

by not blood-supplied grafts

- autografts
- allografts
- biomaterials (decalcified bone matrix)
- synthetic bone substitutes
- biocomposites



Type A1.3: Splint transport



Type B

B – bone fragments have contact

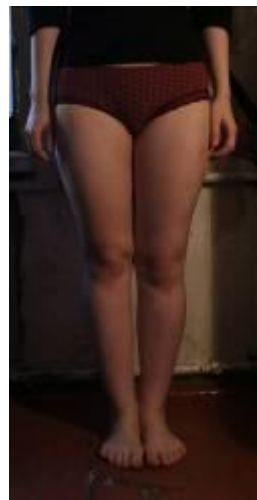
B1 – full contact with the anatomical shortening

B2 – limited contact without anatomical shortening

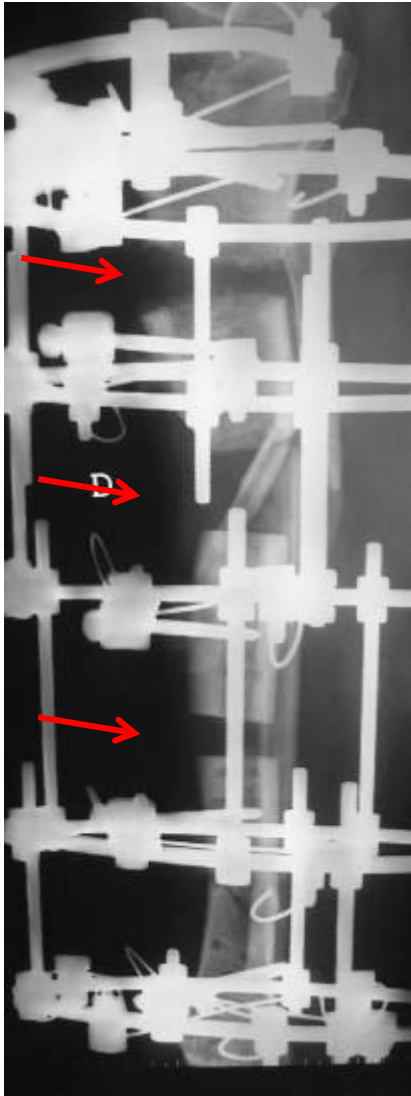
B3 – limited contact with anatomic shortening



Type B1: Monolocal distraction



Type B1: Polylocal distraction

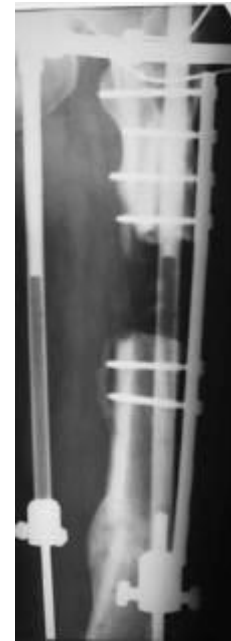
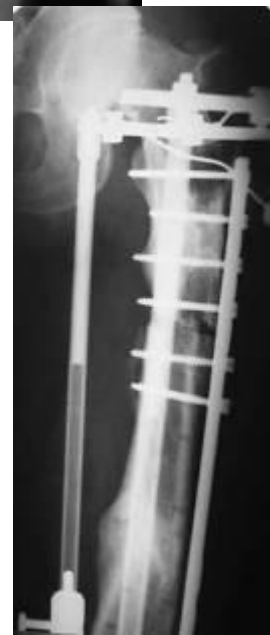


Automatic high fractional
distractor



Type B1: Lengthening over nail (LON)

... and LOP

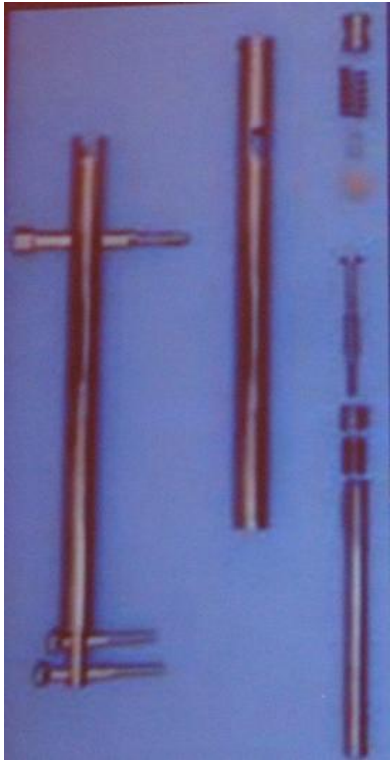


Type B1: LATN and LATP



Type B1: Internal distractors

Albizza Nail



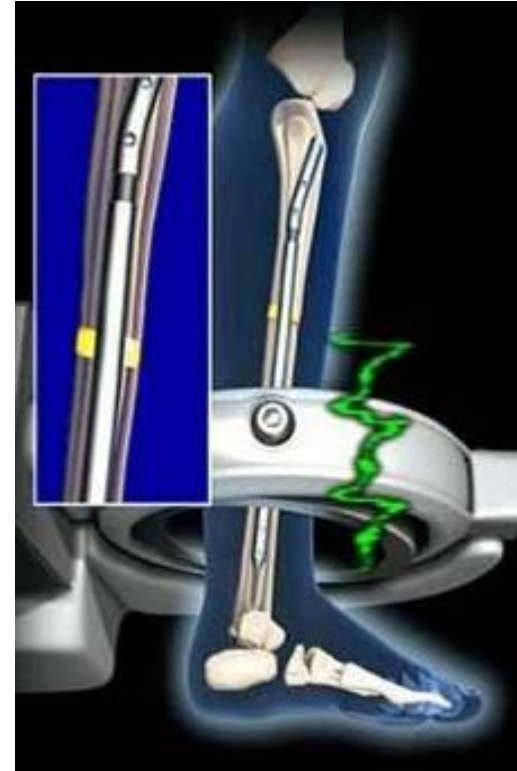
Fit-bone Nail



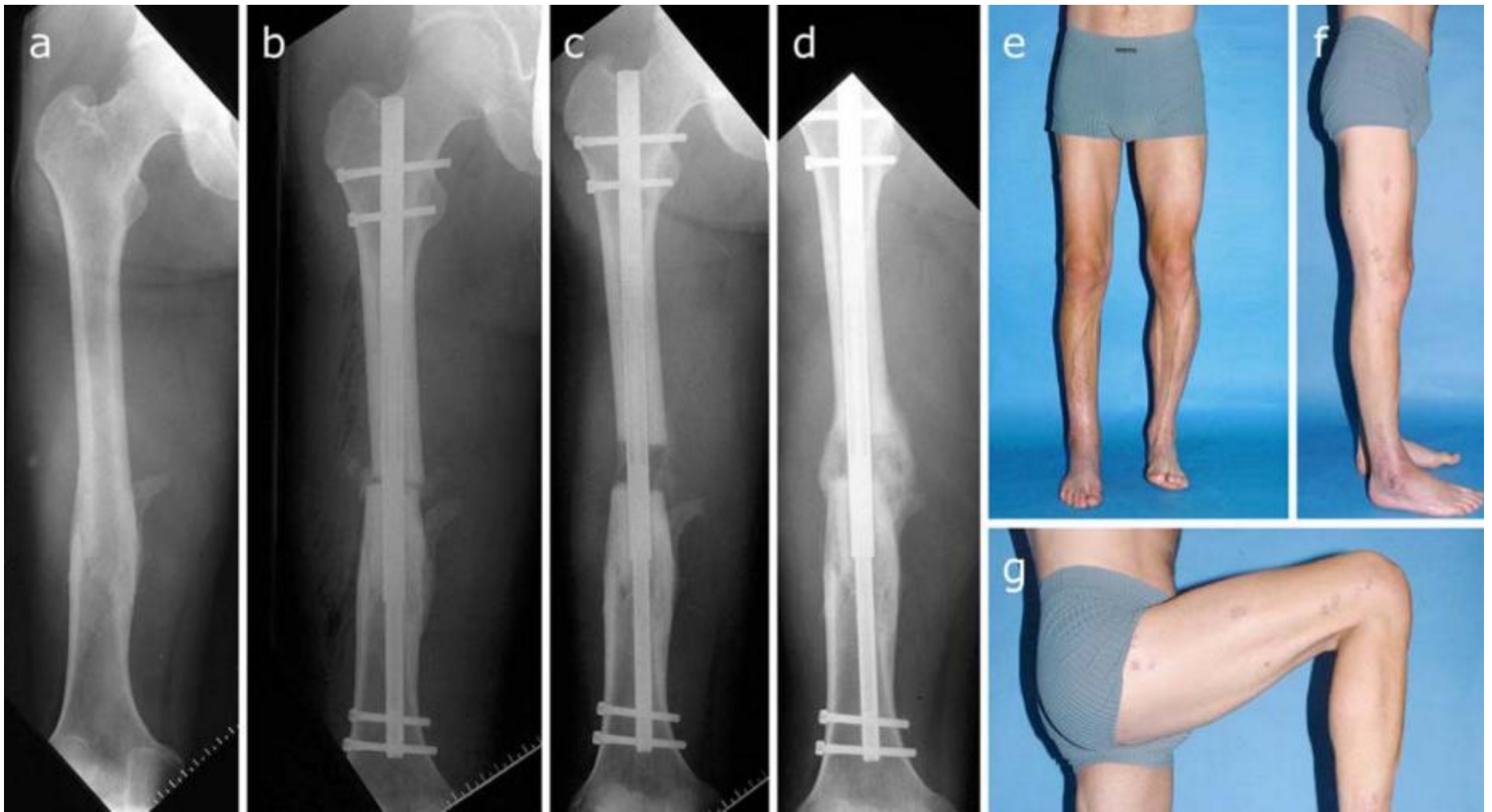
ISKD



Precise Nail



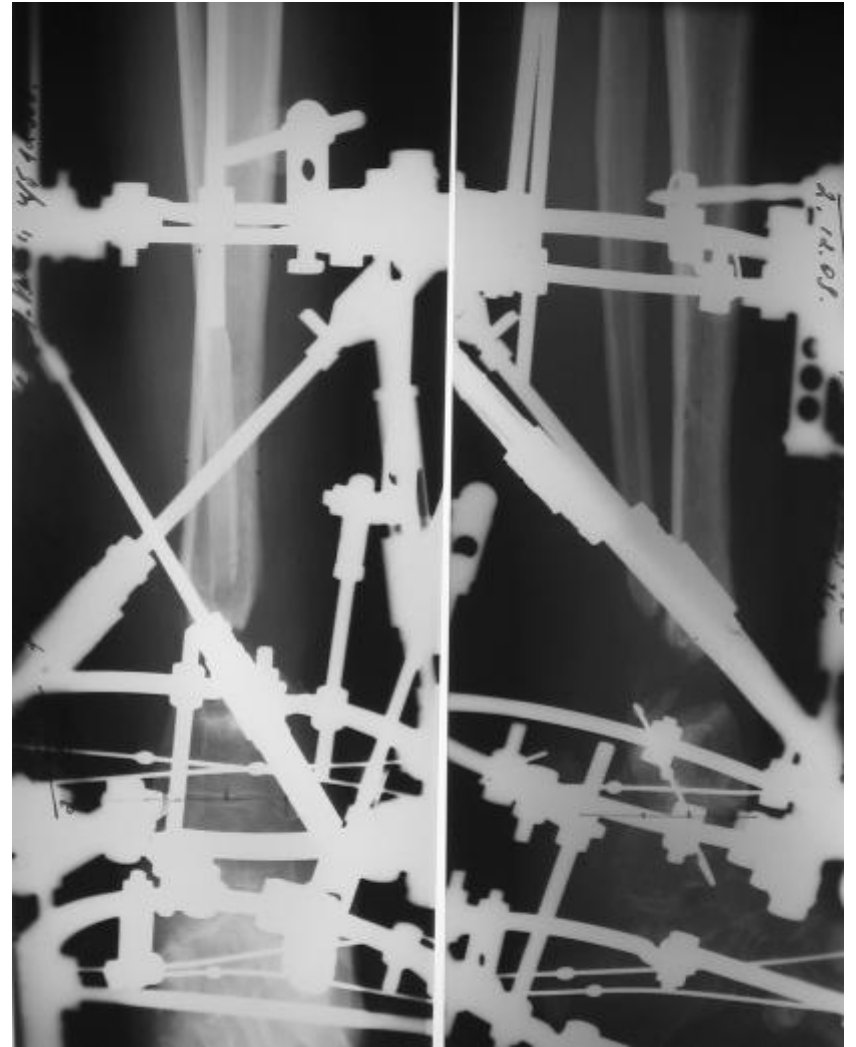
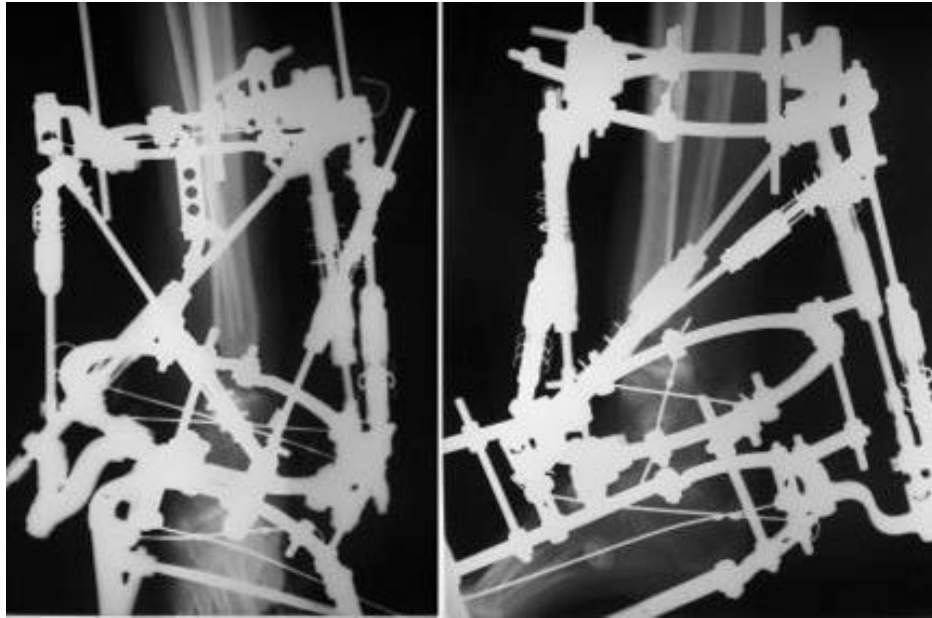
Use of internal distractor



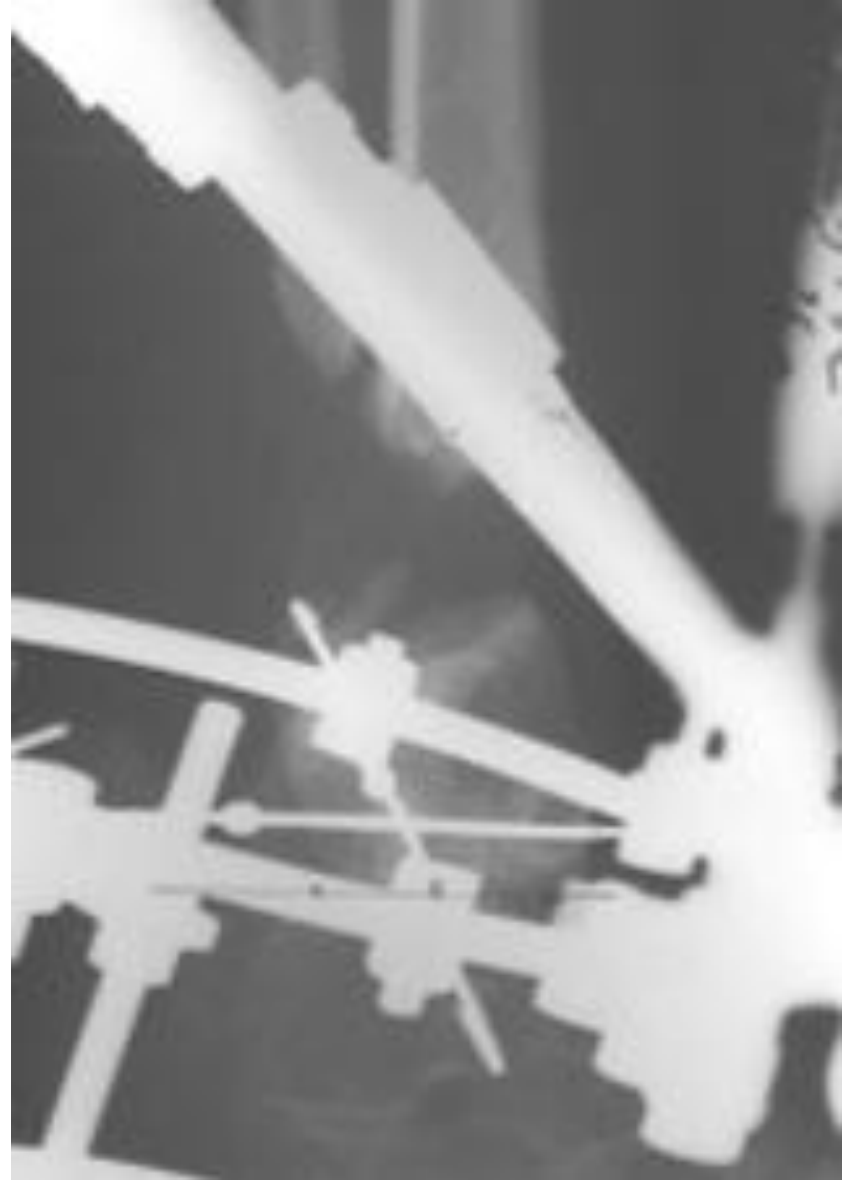
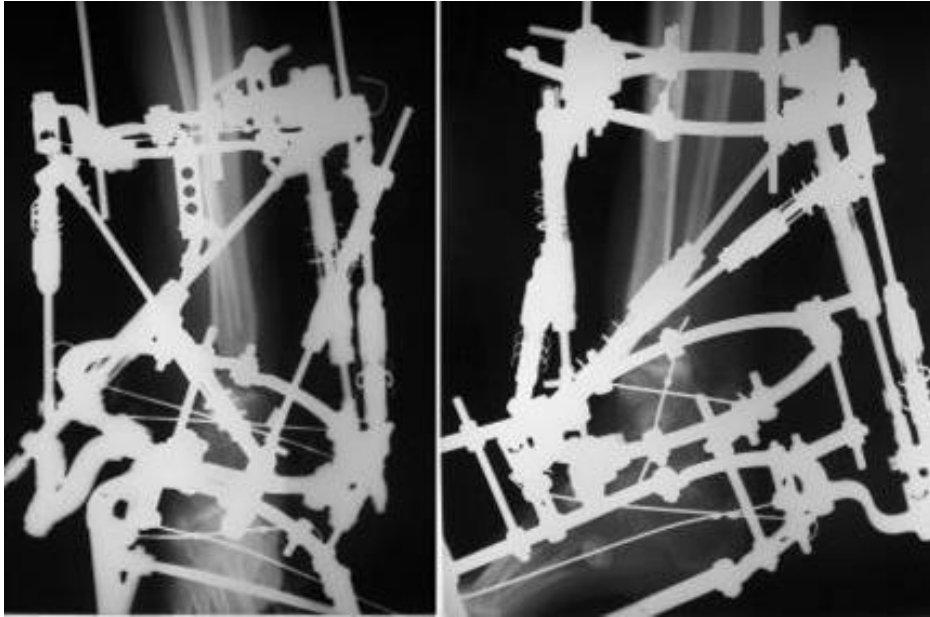
Type B2: ExFix + grafting



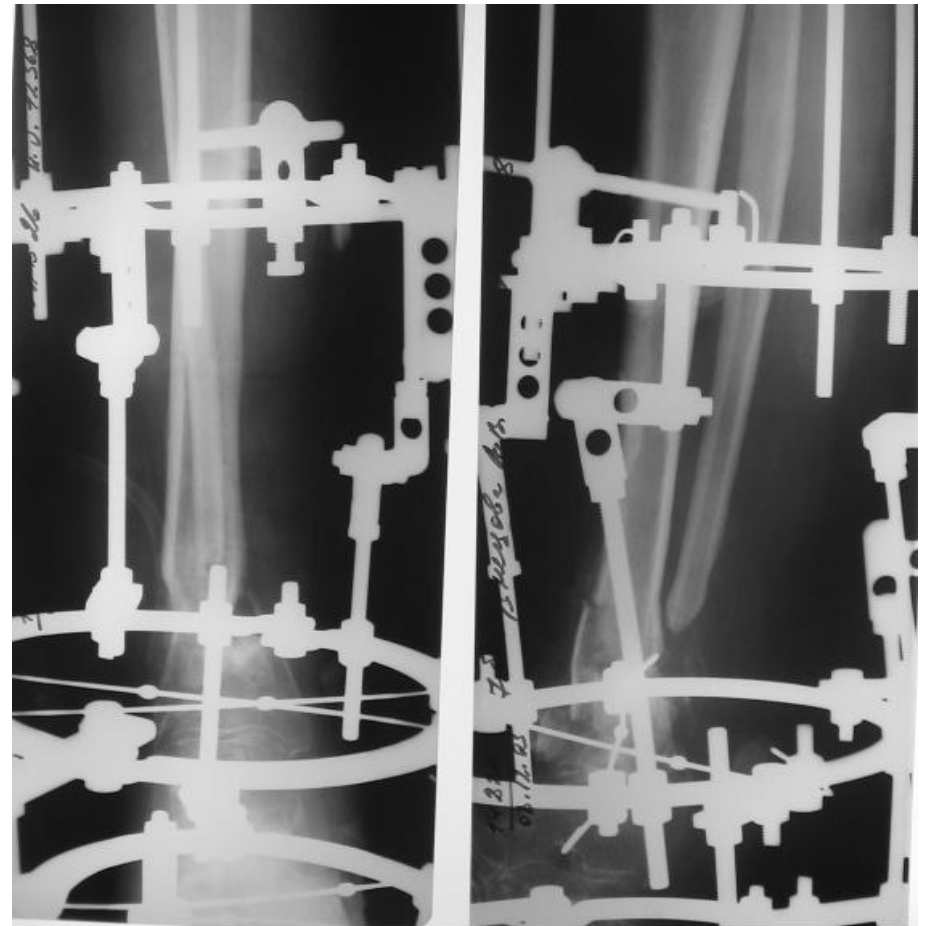
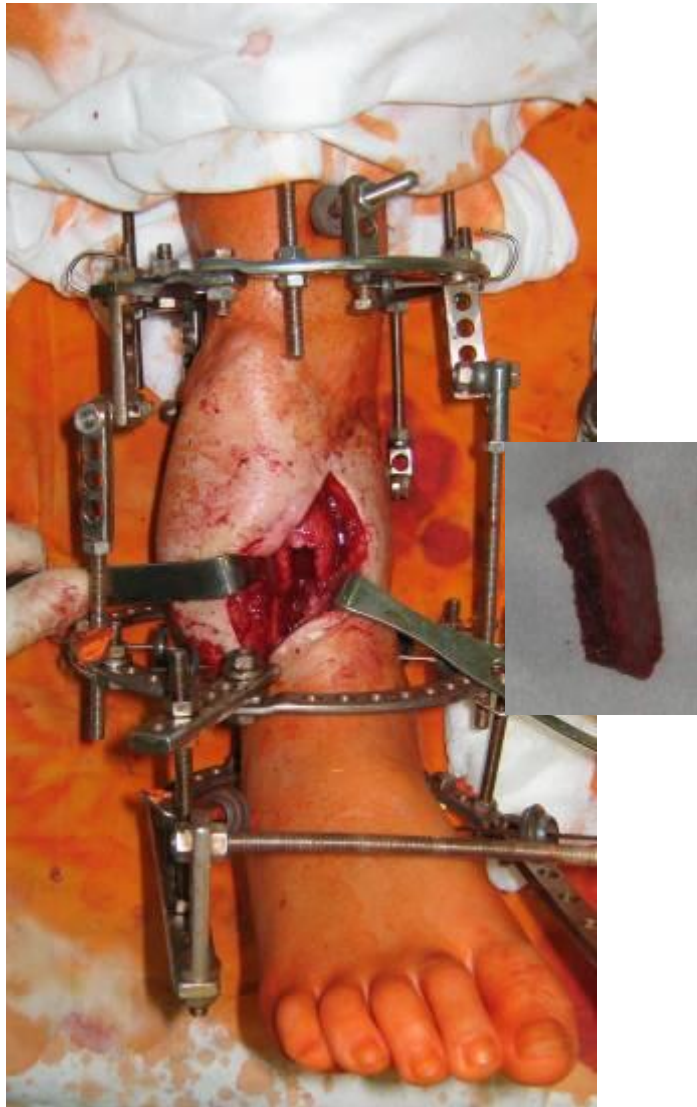
Type B2: ExFix + grafting



Type B2: ExFix + grafting



Type B2: ExFix + grafting



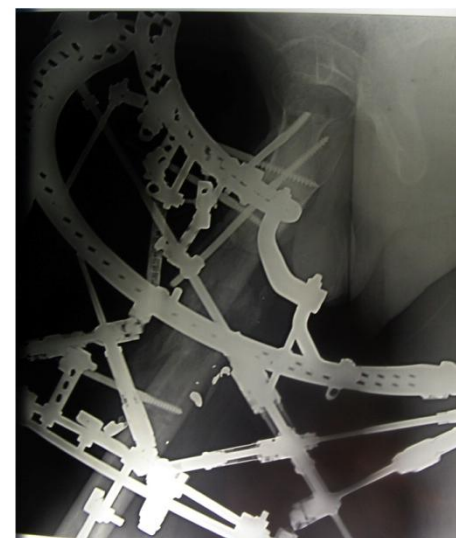
Type B2: ExFix + grafting



Type B3: ExFix + grafting or SEFaN



Type B3: ExFix + grafting or SEFaN



Type B3: ExFix + grafting or SEFaN



Type C

C – bone fragments have no contact (segmental defects, “defect-diastrase”)

C1 – segmental defects without shortening



C2 – segmental defects with shortening

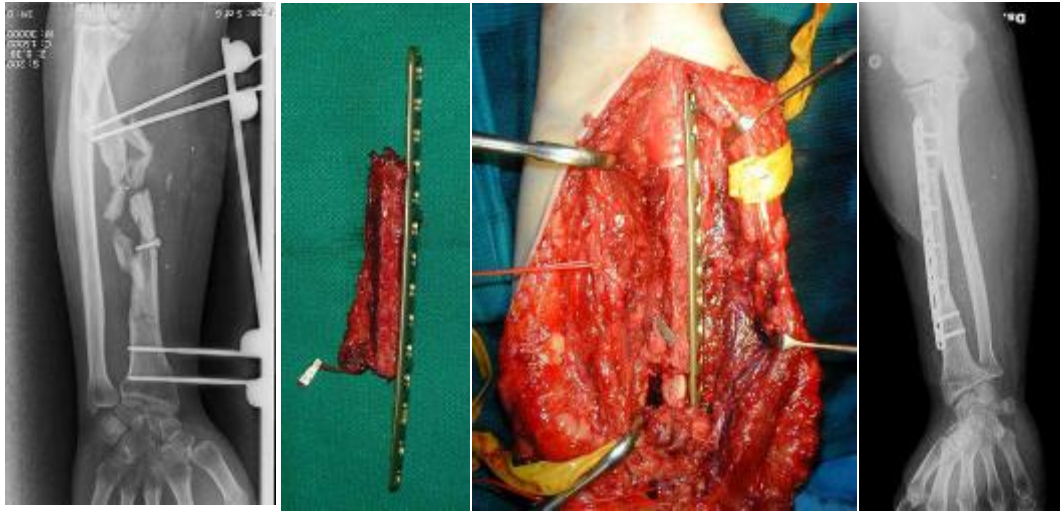


C3 – subtotal (large) defects



Type C

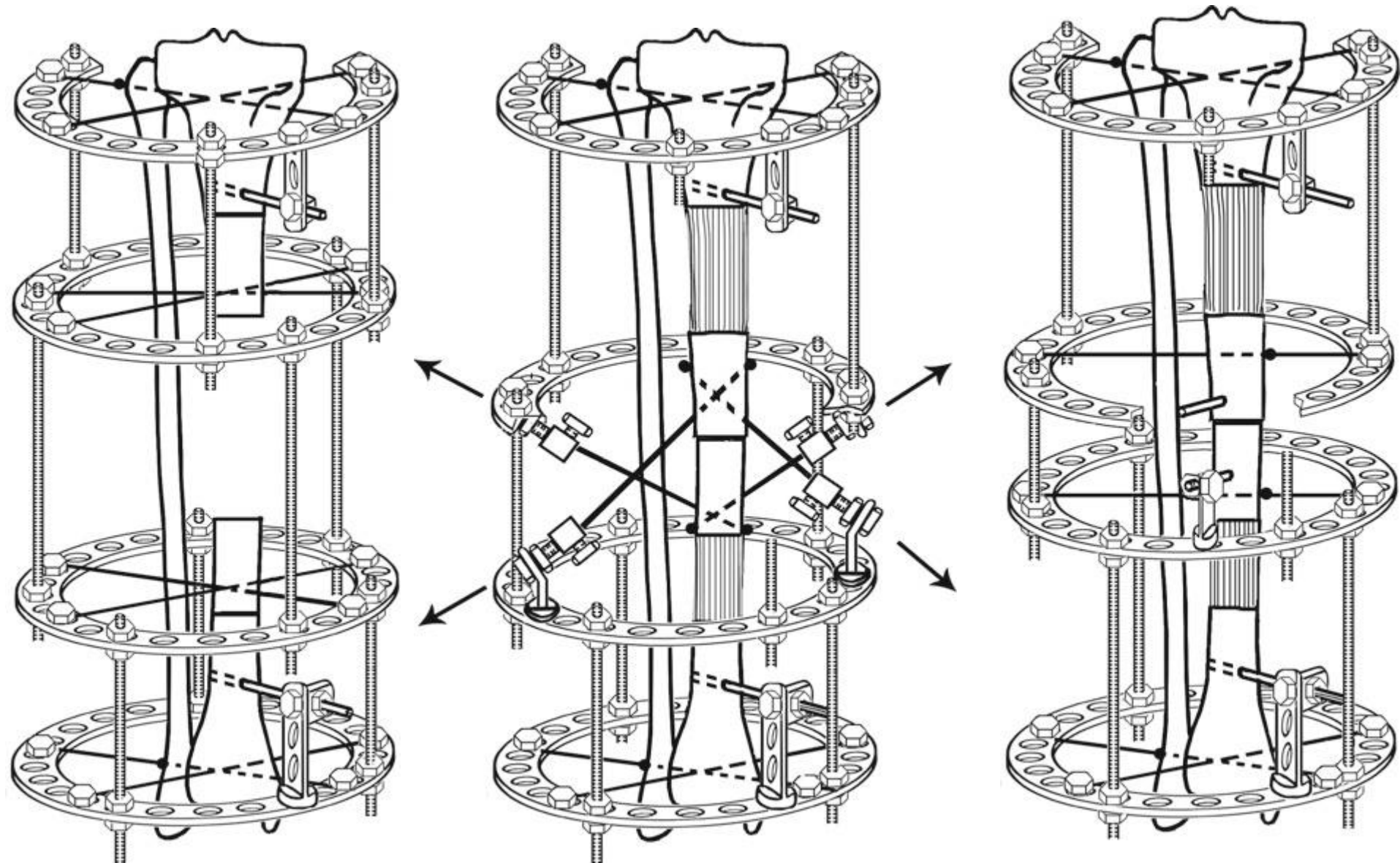
Grafting by free perfused grafts



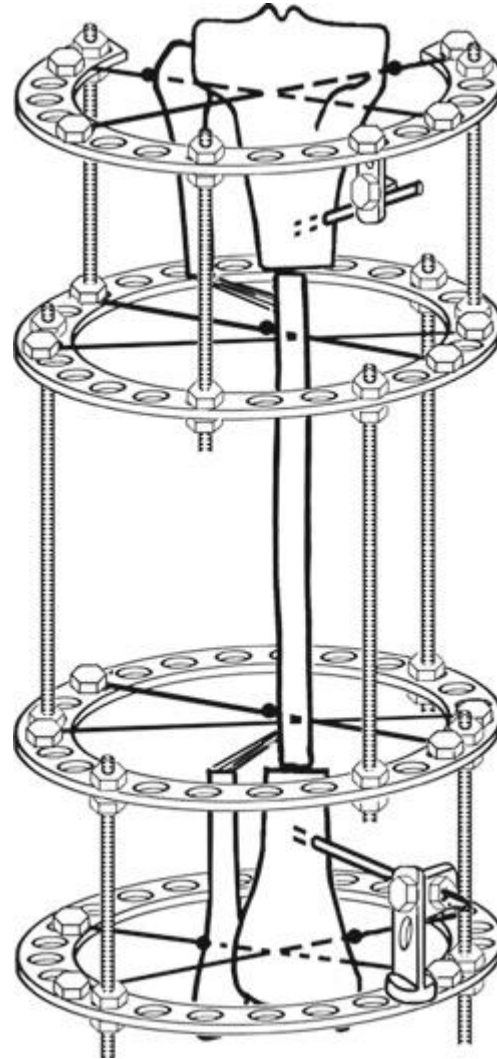
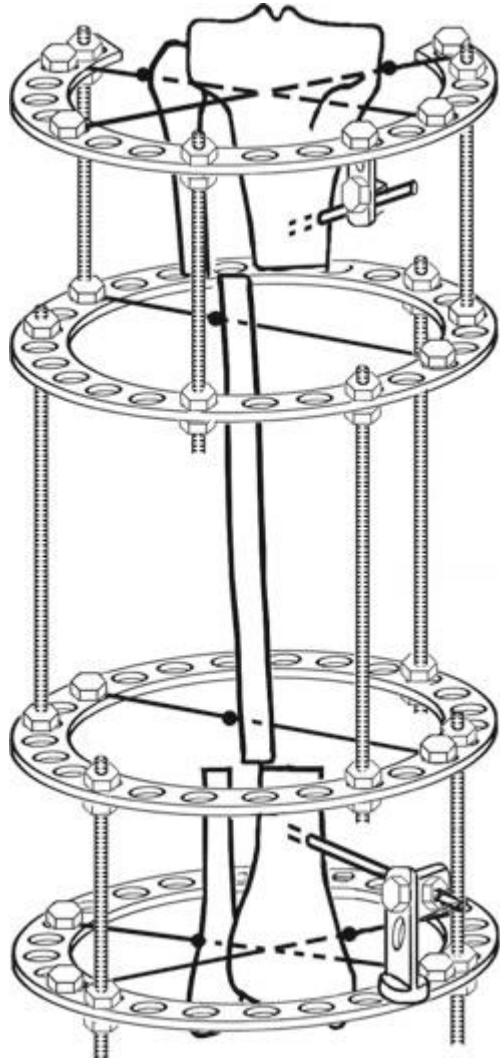
Type C: Masquelet's technique



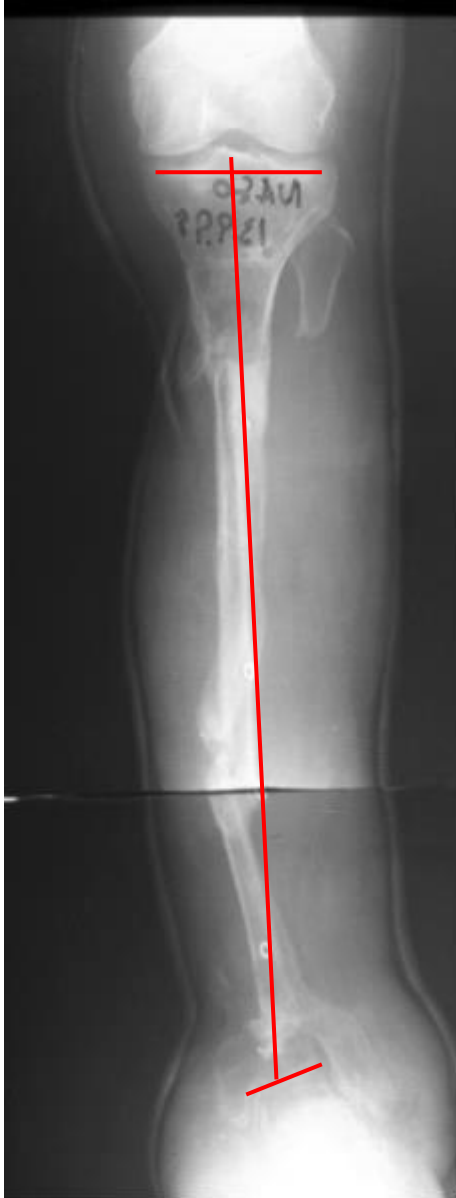
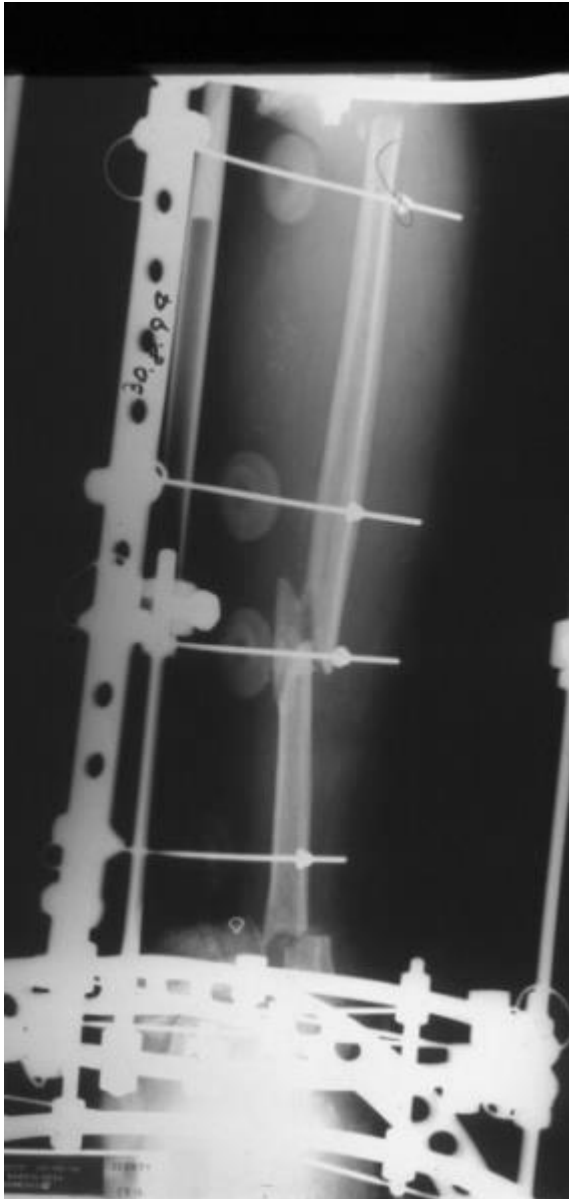
Type C: bone transport



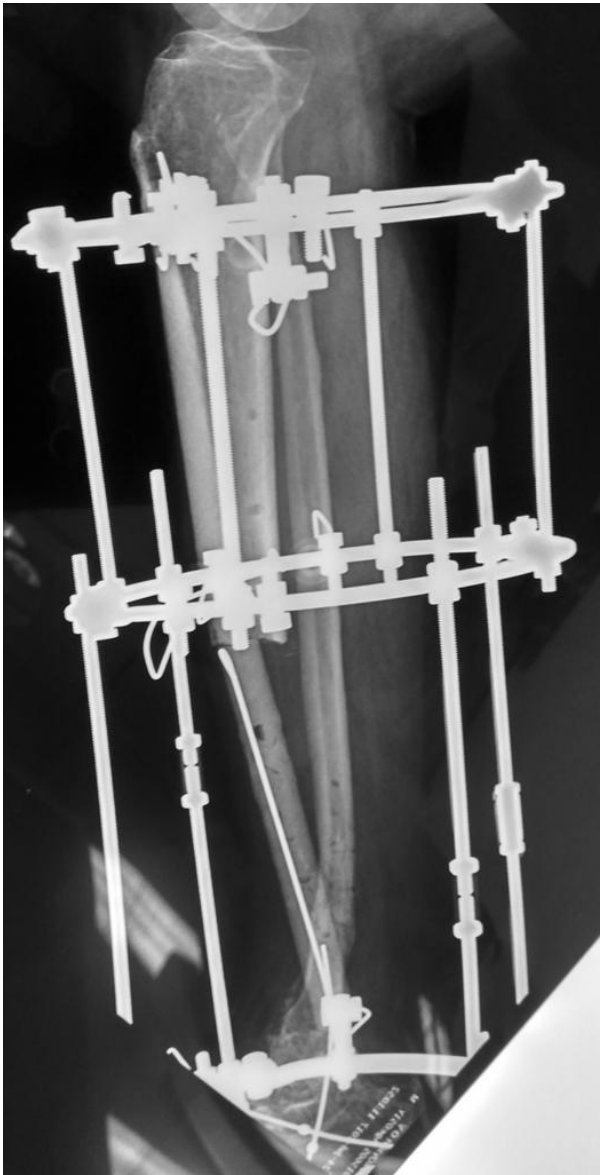
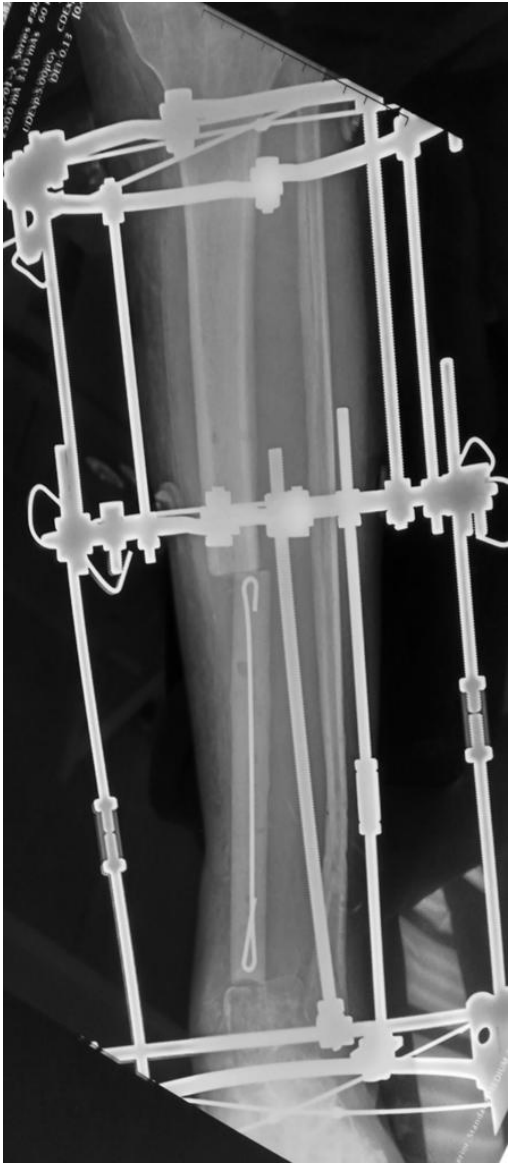
Type C: transverse bone transport



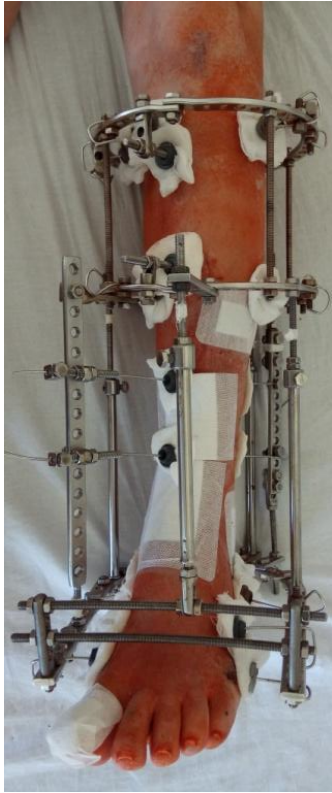
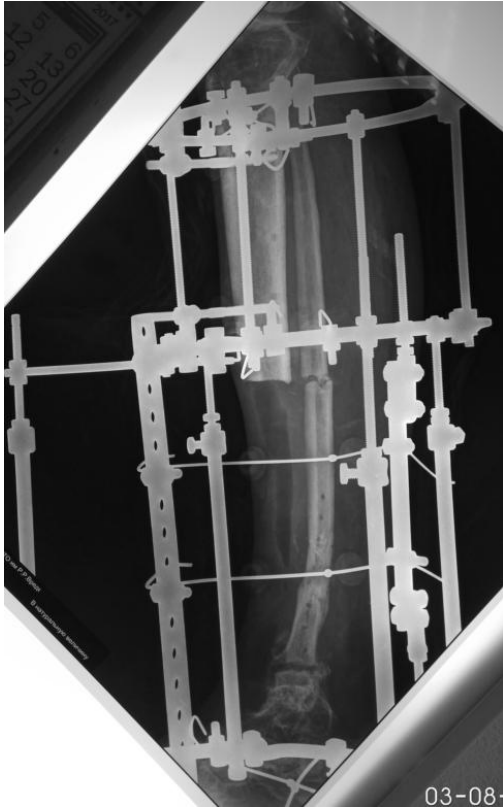
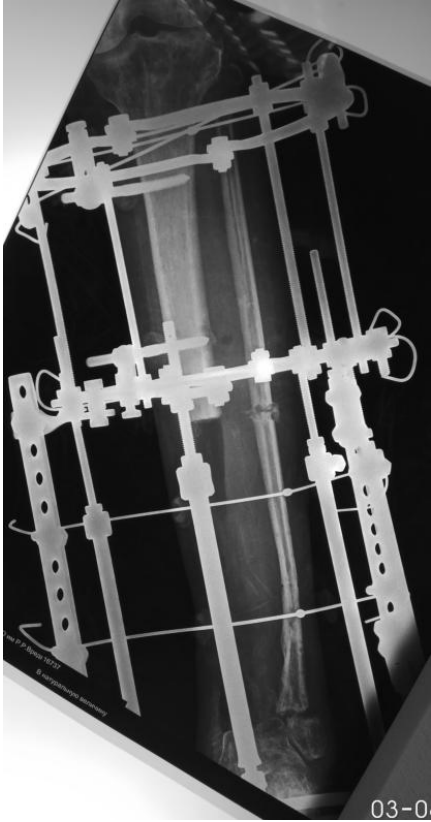
Type C: fibula transport



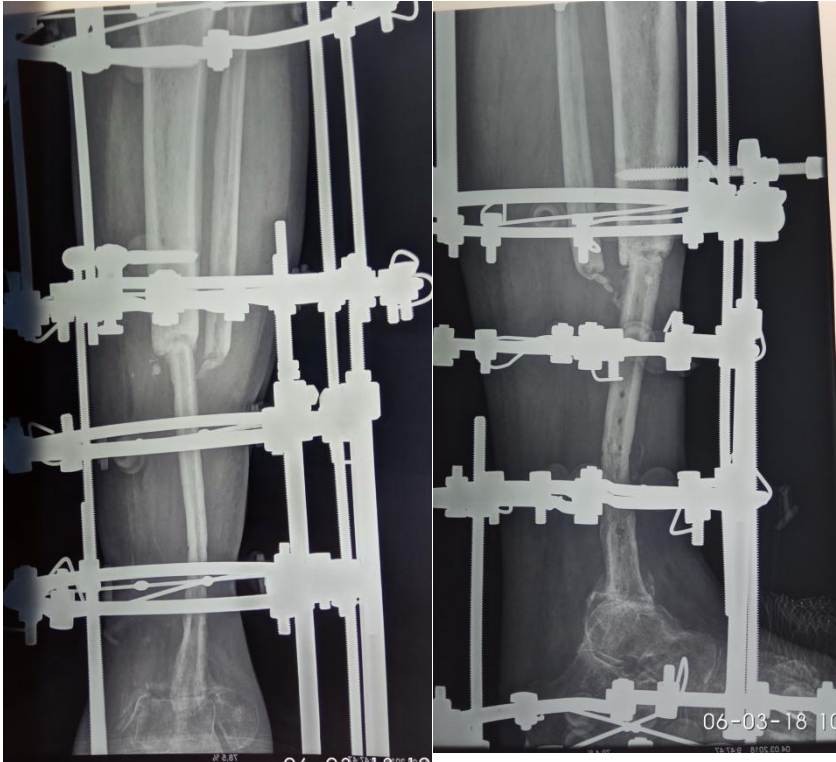
Type C: fibula transport



Type C: fibula transport



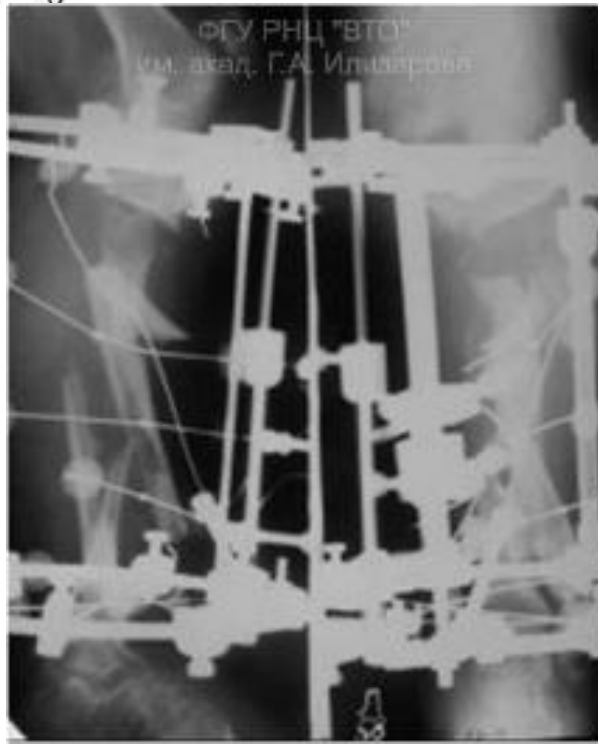
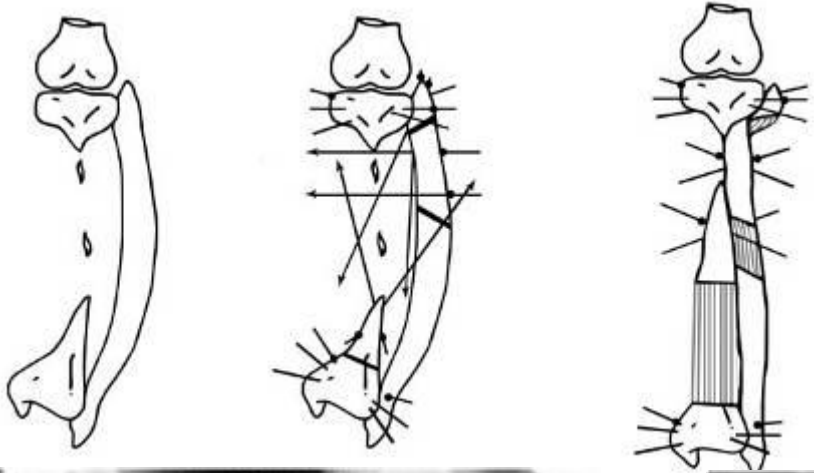
Type C: fibula transport



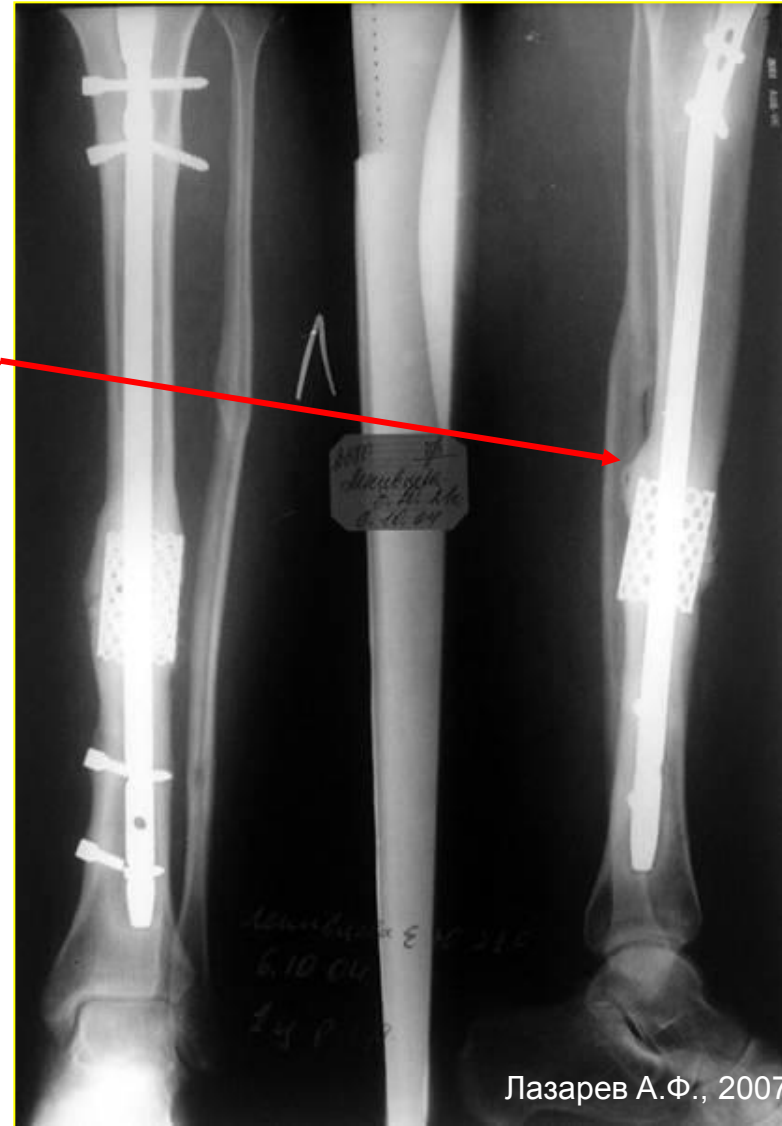
Type C: fibula transport



Type C3: Ilizarov reconstructions



Type C: Prosthetics (by titanium cage)



Type D

D – complete articular defects

D1 – epiphyseal

D2 – epimethaphyseal

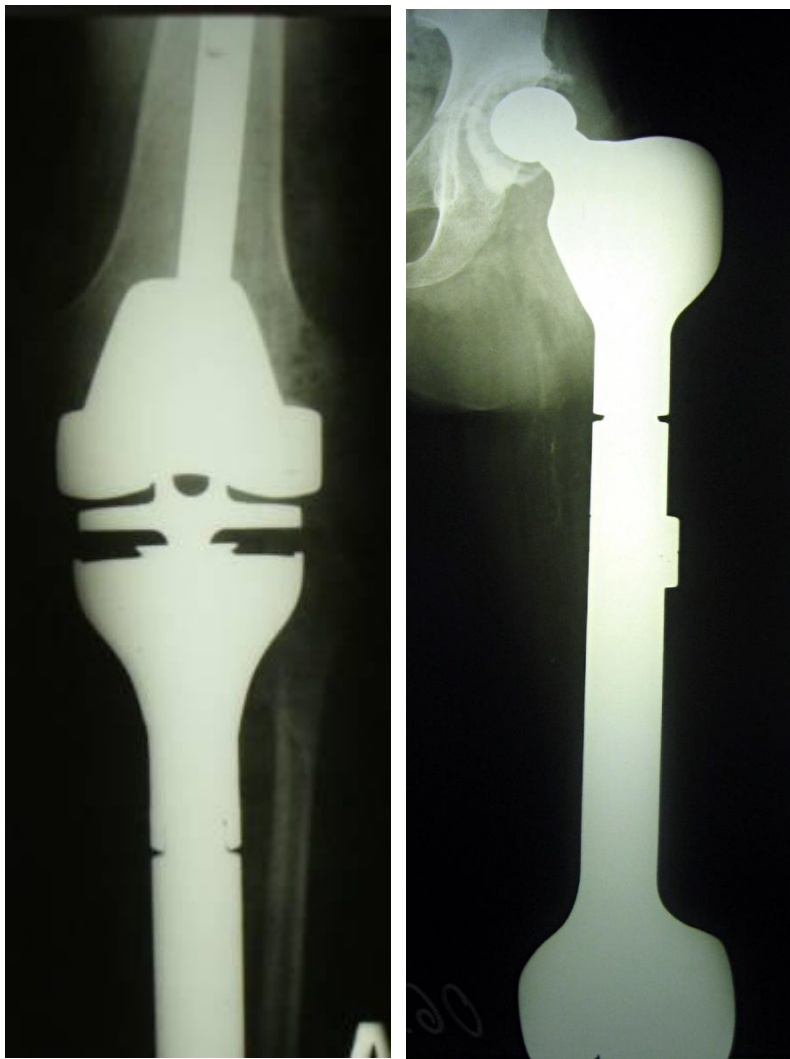
D3 – epimethadiaphyseal

D4 – amputation



Type D: Arthroplasty

Prosthetics

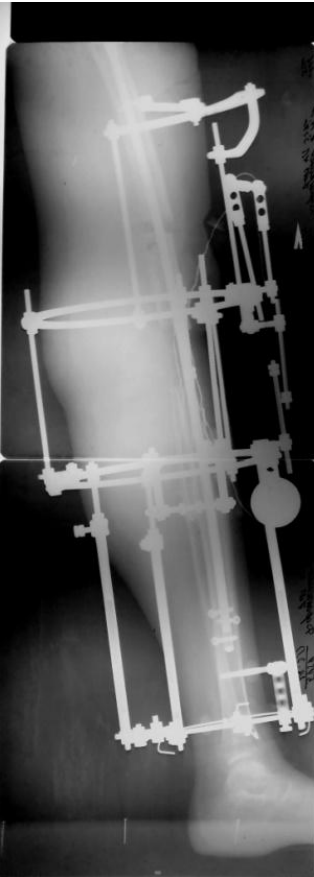


Type D2: Reconstructive surgery



Type D3: BTON

(D→B1)

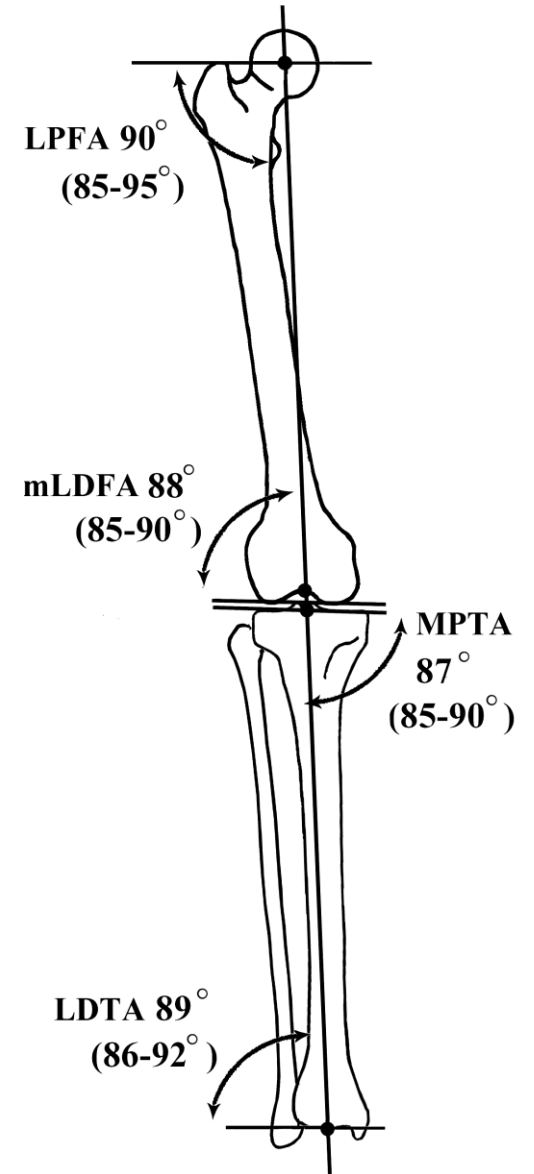
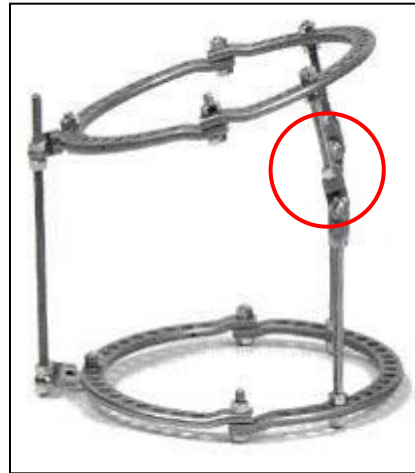
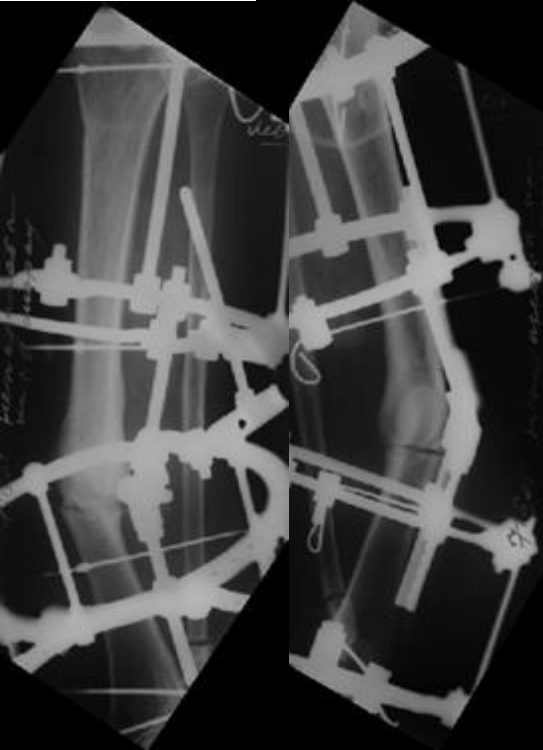


What we have not discussed ...

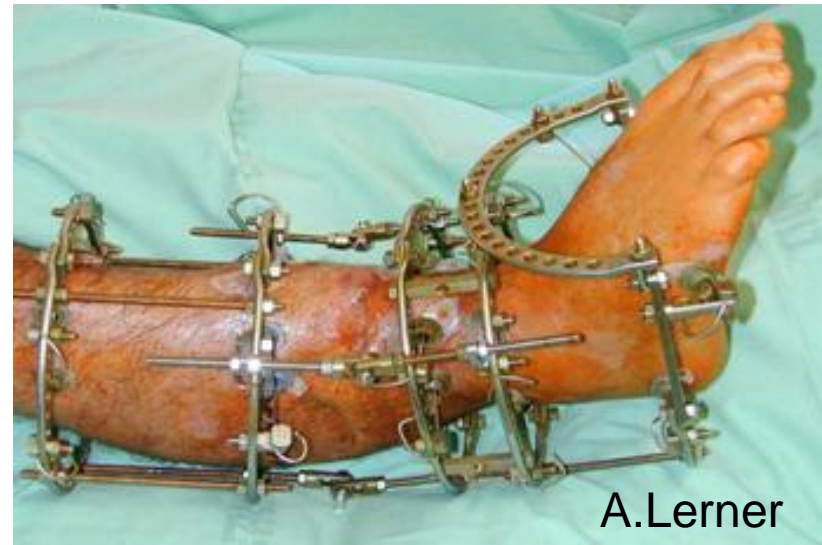
... but what so affects the choice of method



Deformation + Defect



Bone defect + soft tissues defect



Bone defect + soft tissues defect + knee stiffness



Take-home message

AO principles based LBDC can provide:

- comparison of the effectiveness of different treatment options for each type and group of defects (1st step)
- selection of the best methods for each type and group of defects (2nd step)
- create *the register* of long bone defects (treatment)

Event program

AOTrauma Europe Masters Course— External Fixation

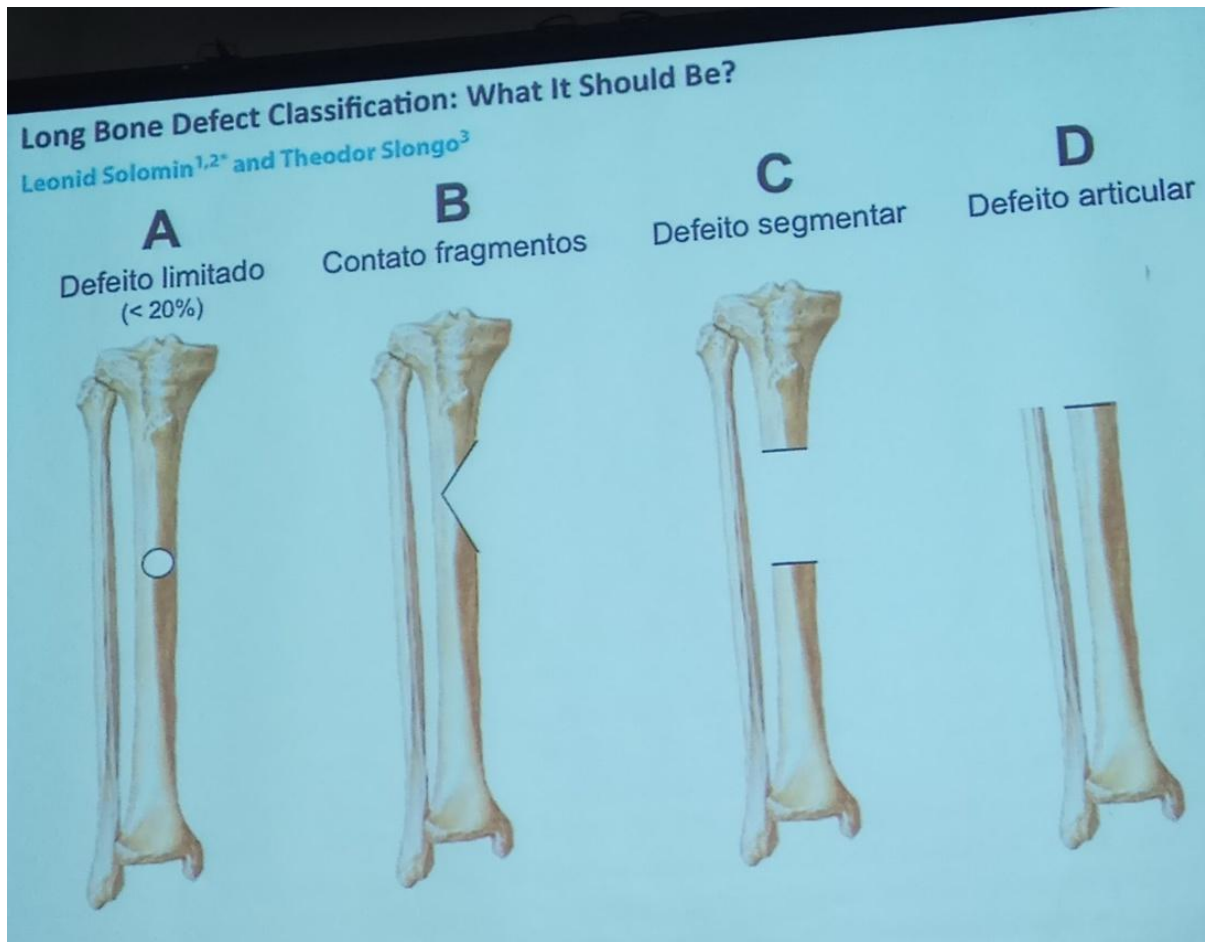
Circular Frame for Deformities and Bone Defects

September 8–9, 2017 Moscow, Russia



	conditions	
12:00–12:20	Clinical and radiographic evaluation of nonunion	M Jackson
12:20–12:35	Biology of distraction osteogenesis and can we accelerate it?	A Volna
12:35–12:55	Case-based lecture—treatment strategies for nonunion with circular frame	P Kulesh
<hr/>		
12:55–14:00	LUNCH BREAK	
<hr/>		
14:00–14:15	Case-based lecture—type B bone defects treatment (bone lengthening)—tips and tricks	F Monsell
14:15–14:30	Case-based lecture—types C and D bone defects treatment (bone transport)	A Lerner
14:30–14:45	Modulation of bone transport—the problem of bad regenerate	M Jackson
14:45–15:00	Case-based lecture—circular external fixation in the management of bone infection	S Reid
15:00–15:10	Reflection and discussion	F Monsell
15:10–16:25	Discussion group 1 Complex nonunion and bone defect treatment	All faculty

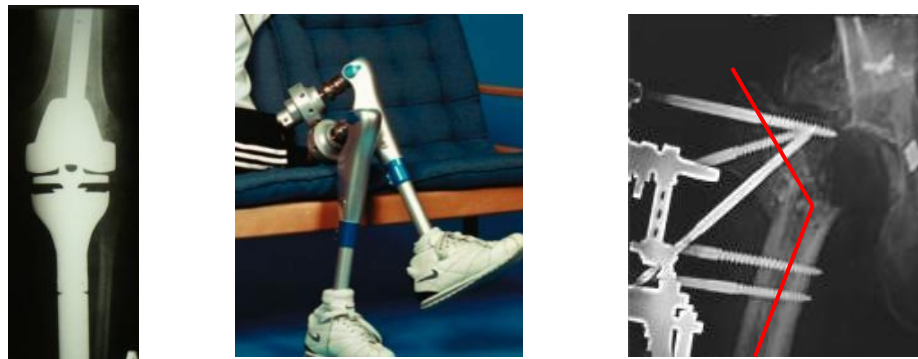
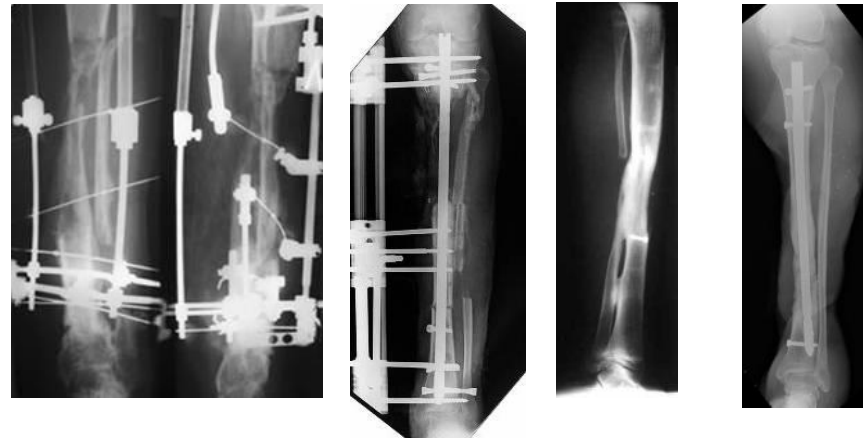
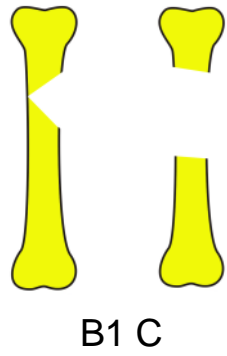
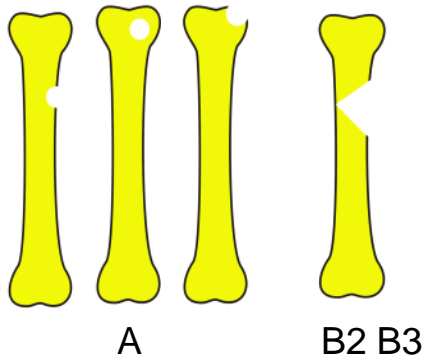
Accepted



São Paulo, Brazil

July 31, 2018.

Take-home message





Thank You!