

Principles, violation of principles. Delayed union, mal-union og non-union

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AO-Basic, April 2024



Ikke som forventet

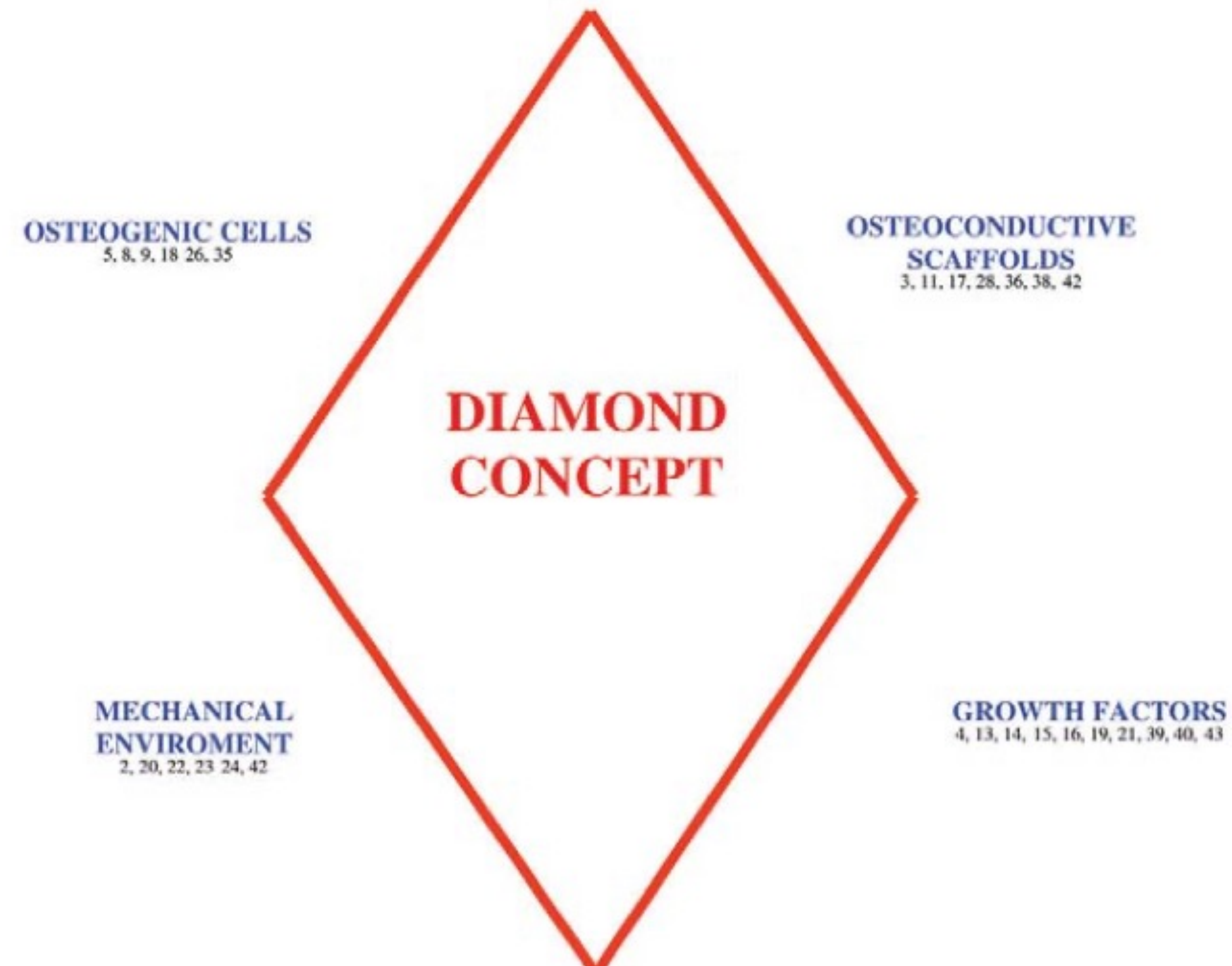


Betingelser for knoglehealing

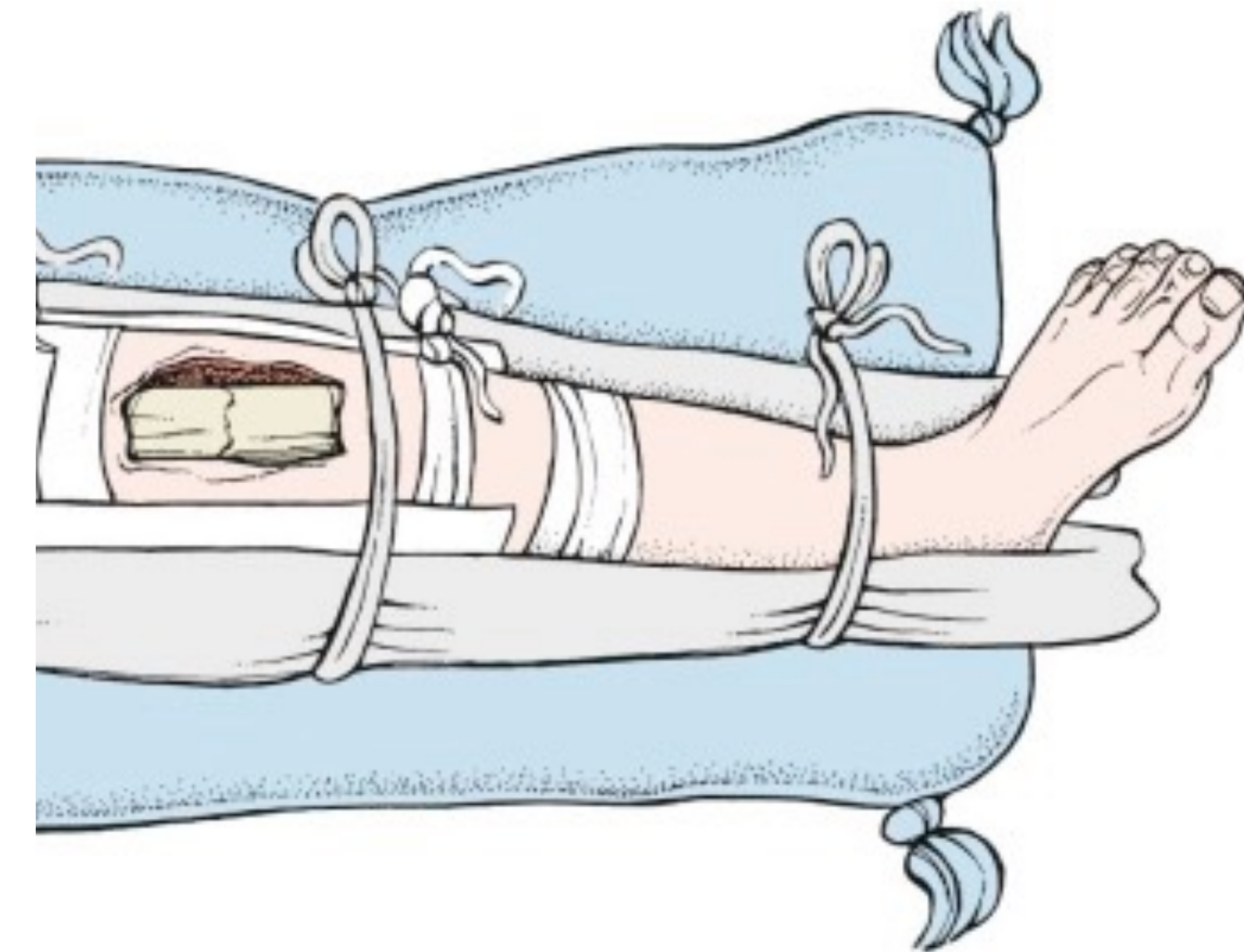
Fracture healing: the diamond concept



Vitalitet



Stabilitet



Can we accelerate fracture healing?
A critical analysis of the literature

Peter Giannoudis¹, Spyridon Psarakis¹, George Kontakis²

Mechano-biology

ability of the body's physiological
processes to respond to the mechanical environment

Physical and Biological Aspects of
Fracture Healing with Special
Reference to Internal Fixation

S. M. PERREN, M.D.

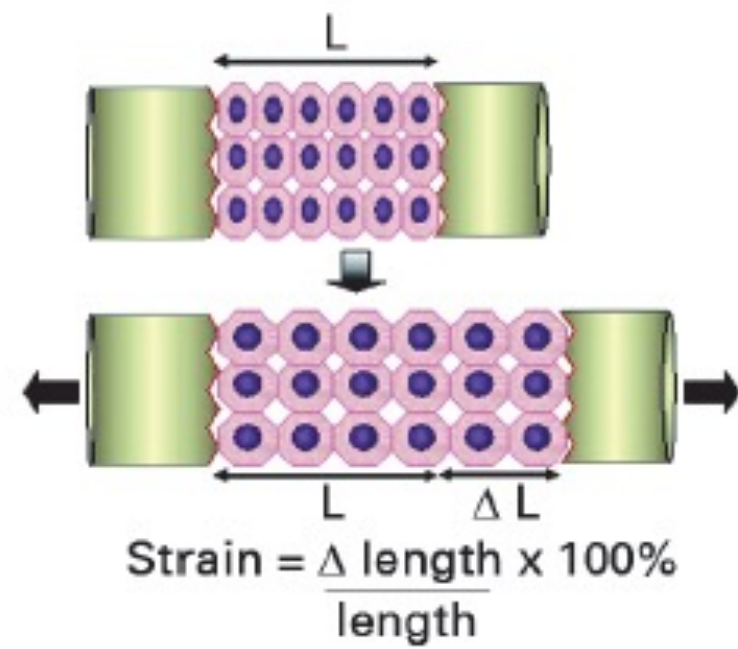


Fig. 1a

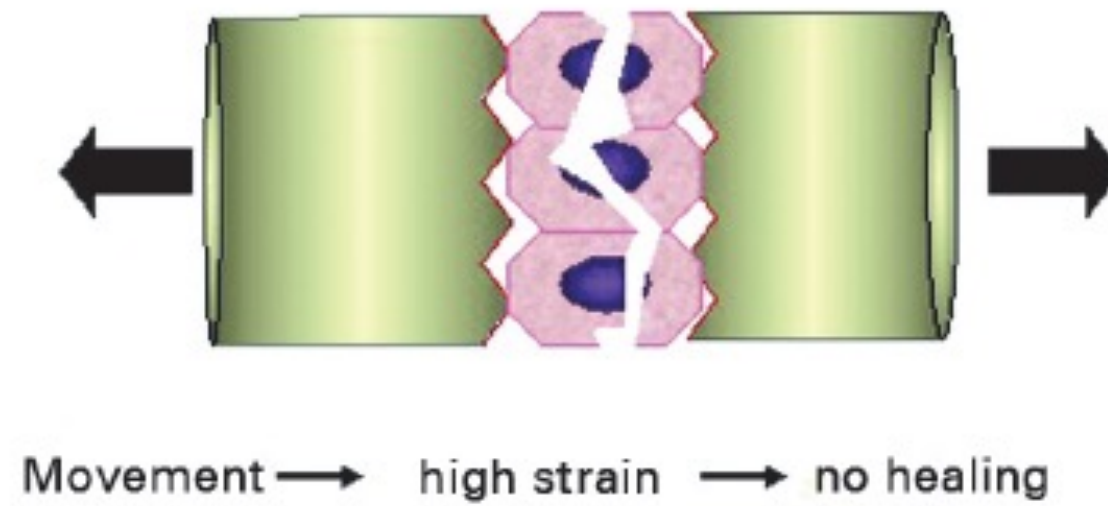
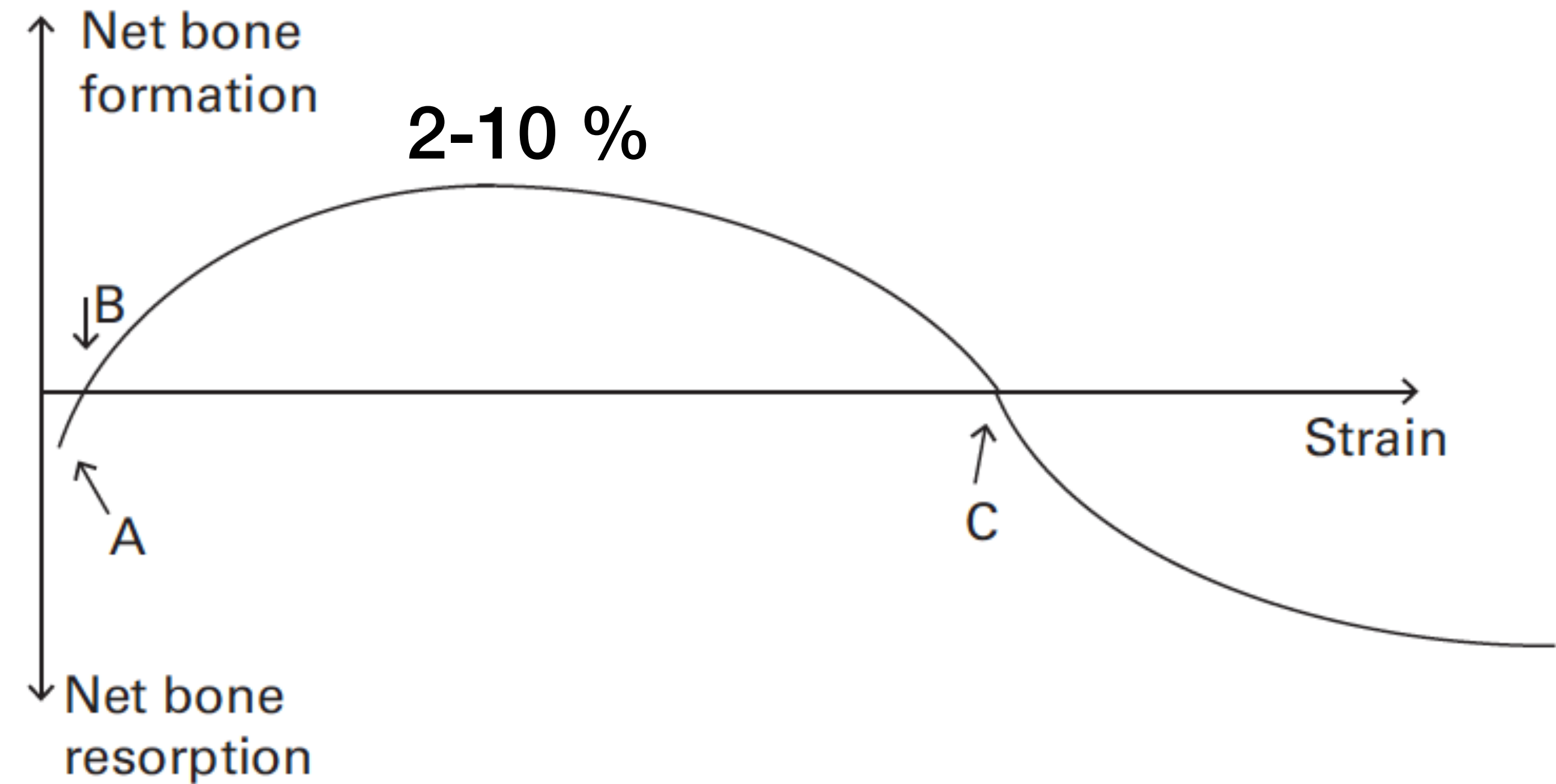
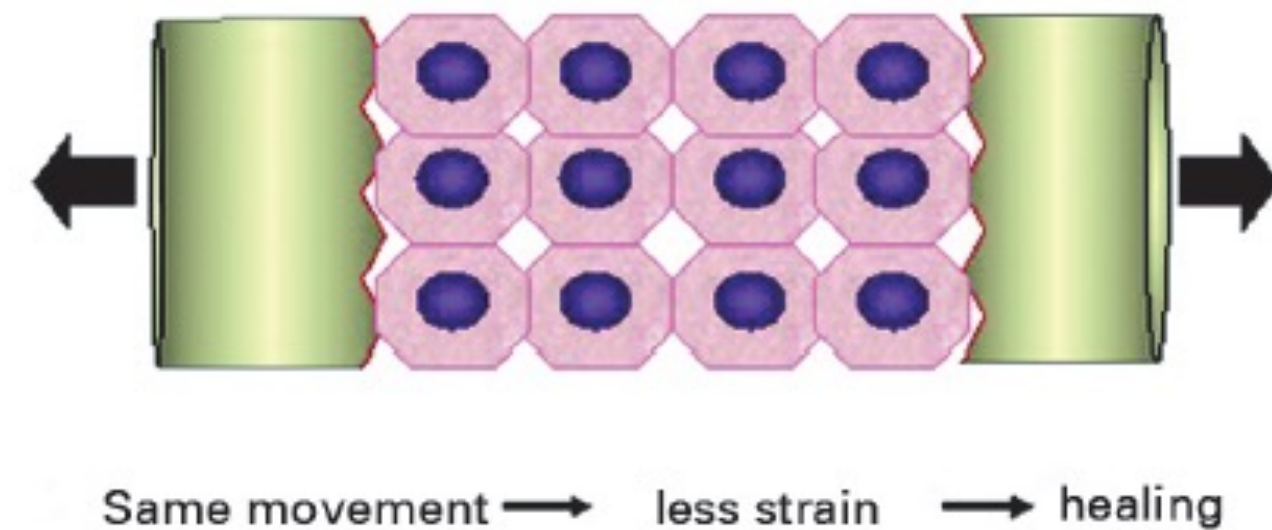


Fig. 1b



Brud på osteosynteseprincipper



kan føre til non-union

Dårlige bløddele
(kirurgisk frilægning)

Dårlig stabilitet

Dårlig alignment

Dårlig knoglekontakt

...dårlig økonomi

Take home messages

Violation of principles

- Bløddele = vaskularitet
- Frakturponering = akse og kontakt
- Osteosyntese
 - Simpel fraktur - absolut stabilitet
 - Complex fraktur - relative stabilitet
- Mobiliseringen/Fysioterapi = funktion

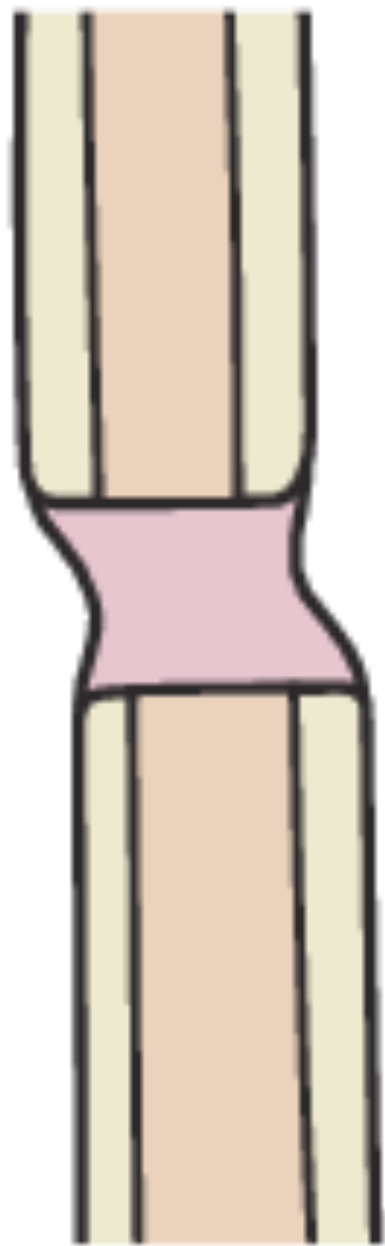


Non-unions typer (Weber-Cech)

Dårlig biologi = Atrofisk non-union

Dårlig stabilitet = Hypertrofisk non-union

Oligotrophic

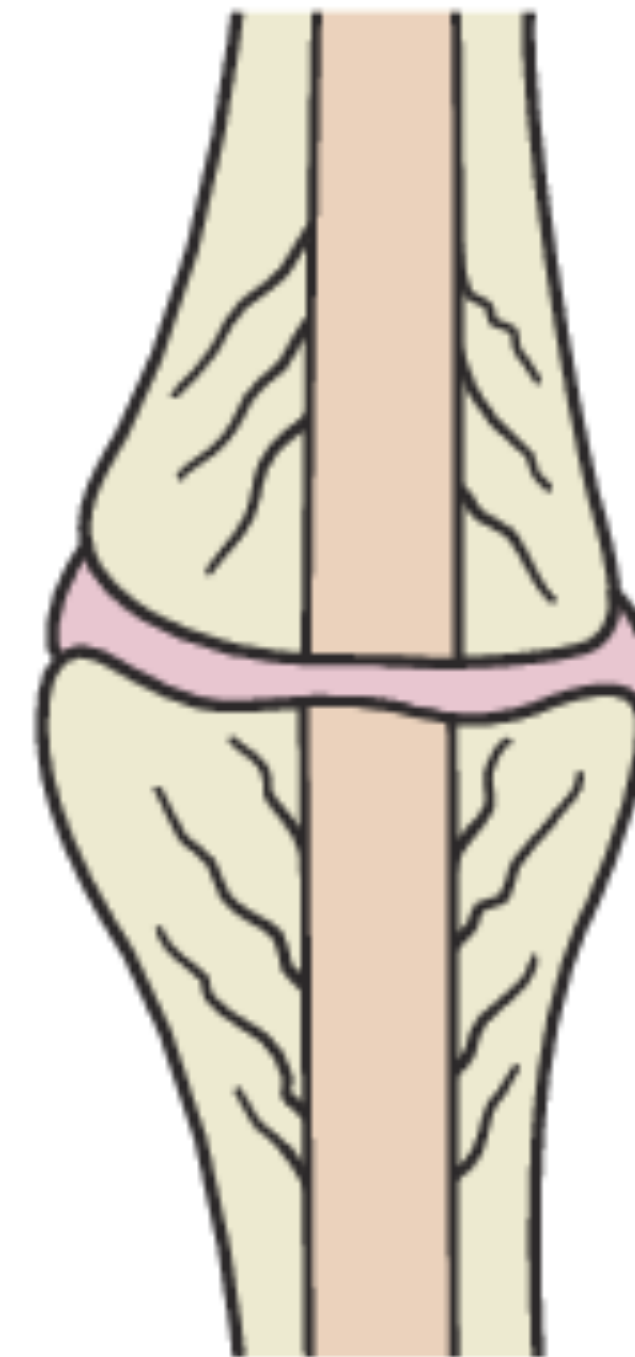


Atrophic



Hypertrophic

Elephant
foot

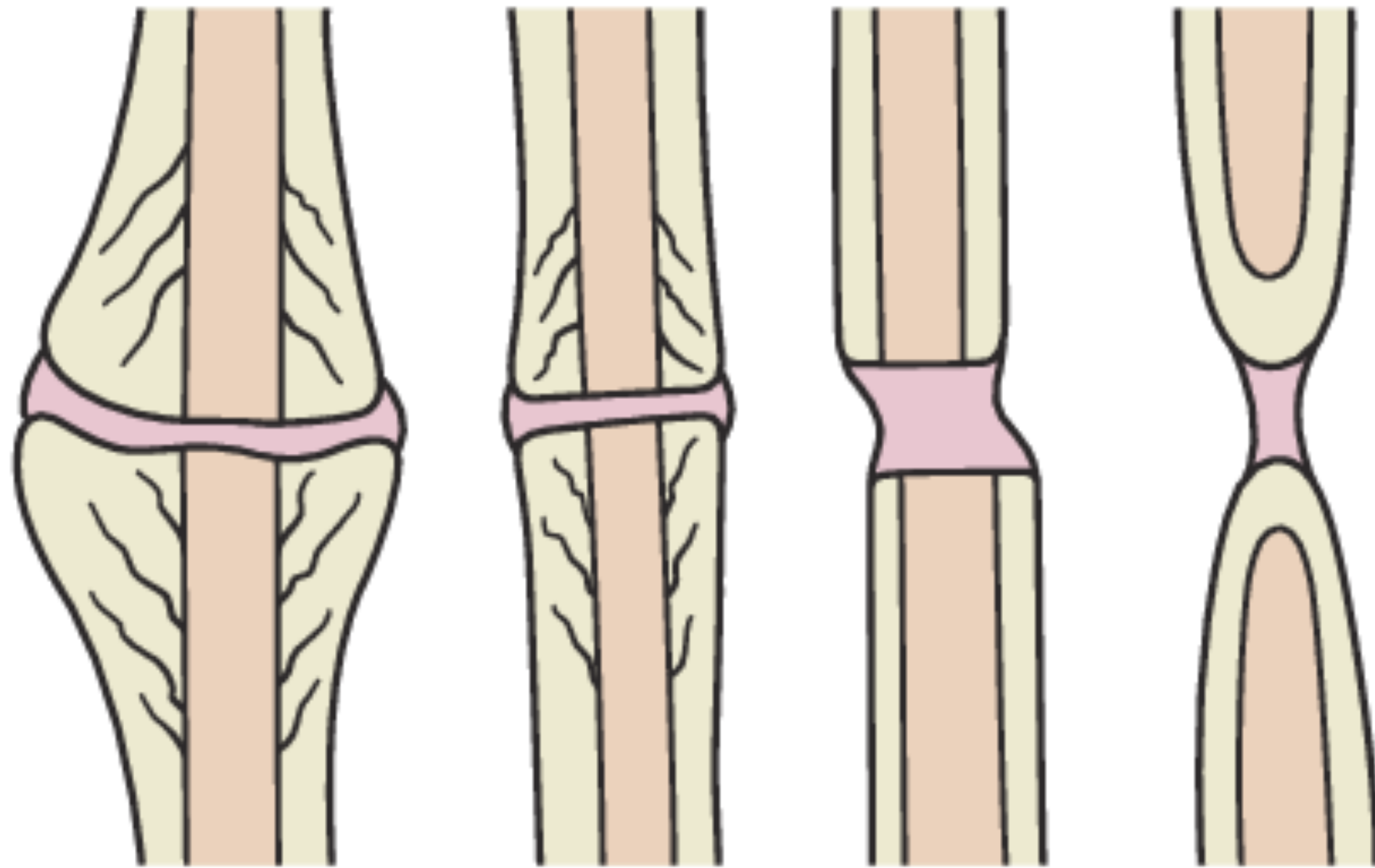


Horse
hoof

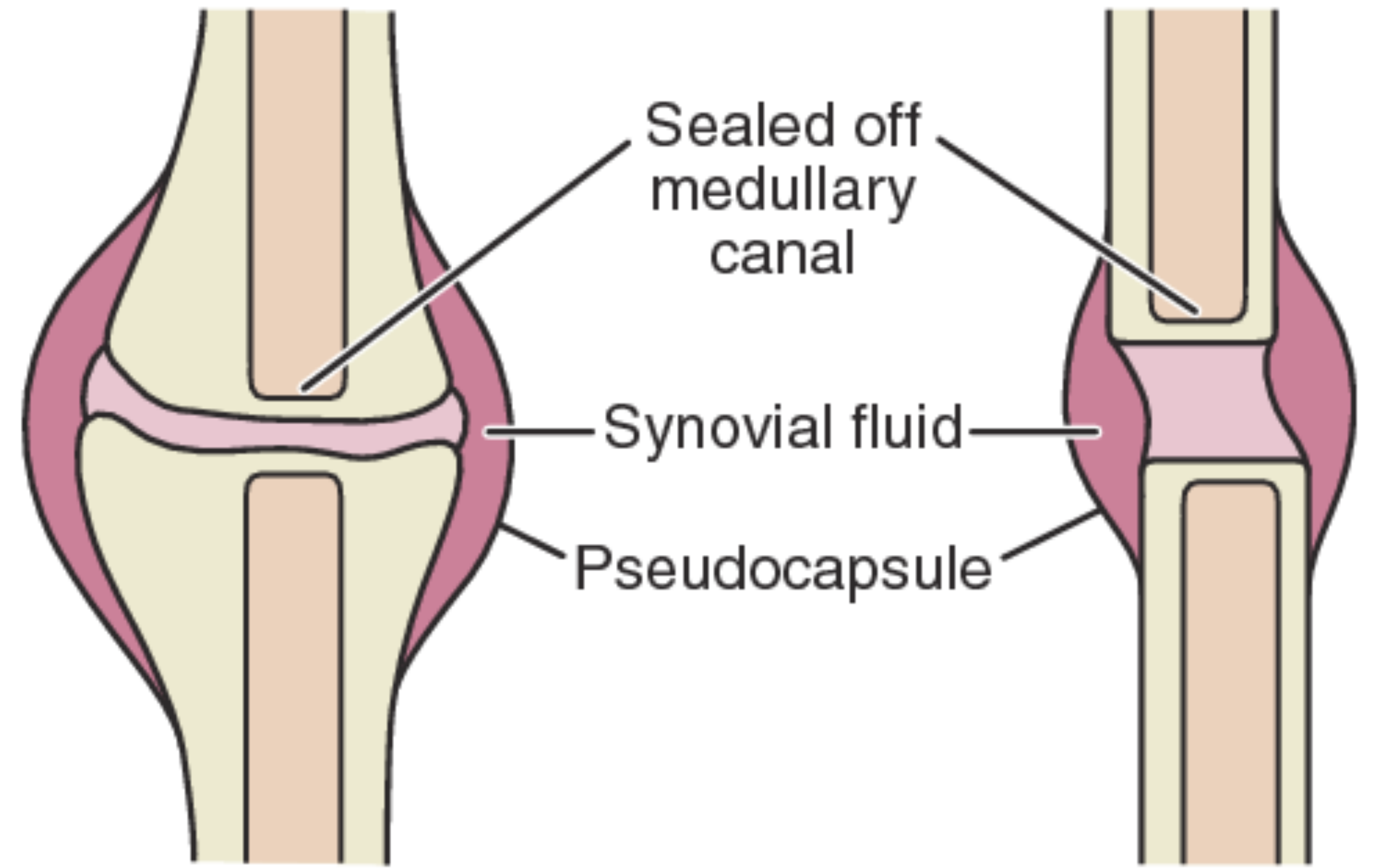


Inficeret/Ikke inficeret/Pseudoartrose

Infected



Synovial Pseudarthrosis



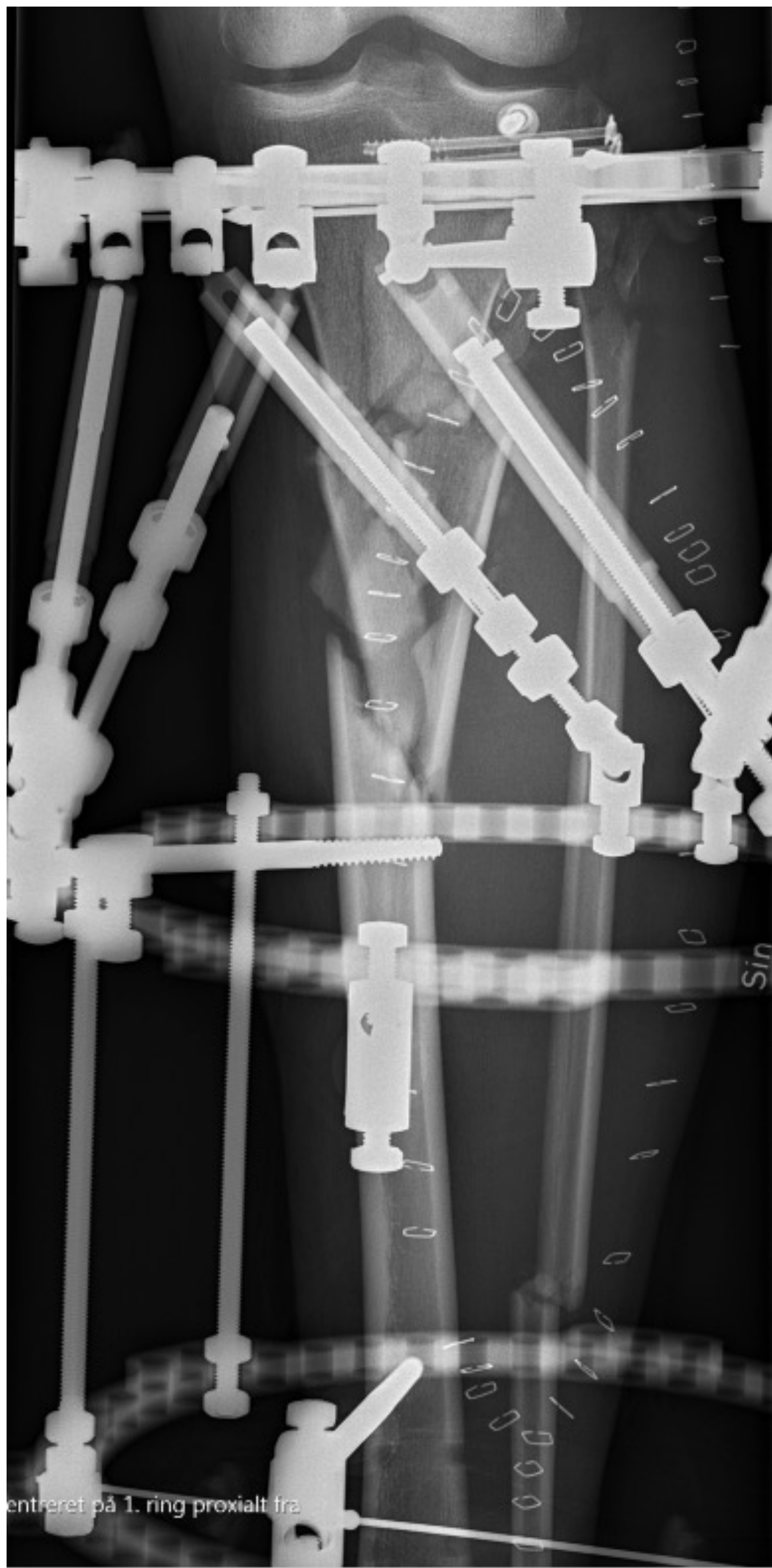
Hvornår er det så non-union???

- FDA definition:

Brud, der ikke helet efter minimum 9 måneder uden tegn på heling i tre måneder

- eller mere praktisk definition:

Når fremskridt i helingen ikke vil ske uden operation



Forsinket heling

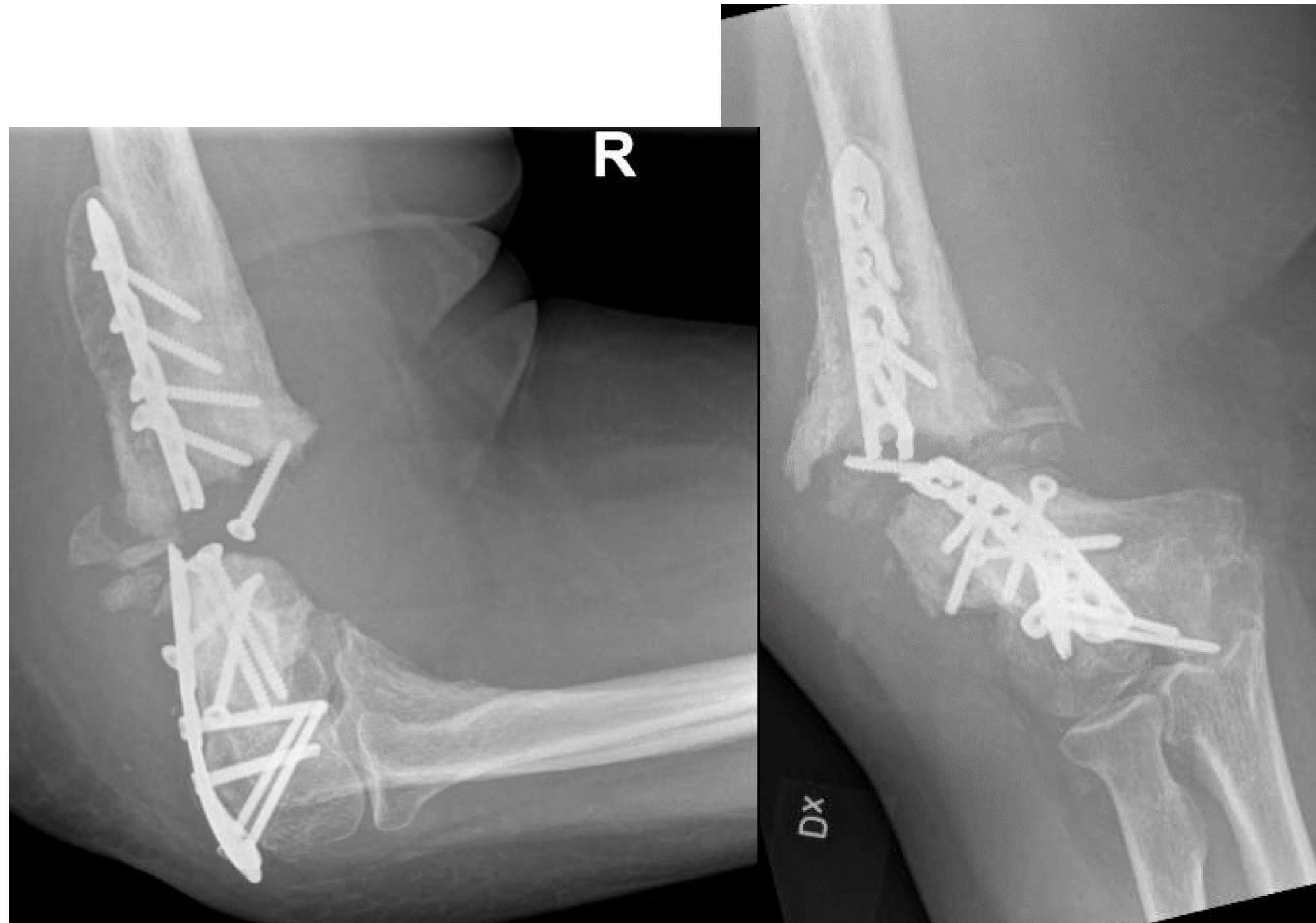
- Heling efter 6-9-12mdr?
- Aftagende symptomer
- Positiv udvikling på rtg-billeder
- Stabilt osteosyntesematerialet

Årsager og Risiko faktorer

Påvirker biologi/vaskularitet • Rygning, alkohol • DM • Hypothyroidismus • Vit D insuff, malnutrition • Arteriosklerose • Nyre insuff. • NSAID, steroider, kemoterapi • Åben fraktur		Patient		Påvirker stabilitet • Inadekvat osteosyntese • Dårlig frakturreponering • Intern fiksatoren af en simpel fraktur med et gab • Lokalisation (dist. tibia, Jones fr, os scaphoid) • Multifragmentær fraktur
		Biologi		
		Fraktur		
		Kirurg		

Diagnostik

- Klinisk undersøgelse
 - Smerte, hævelse
 - Deformitet
 - Løs/stift non-union
 - Neurovaskulær status
 - Ar eller sår
- Røntgen
- CT-skanning
- PET/MR (infektion)
- CRP, Leukocytter



Behandlingen

5 pillars of non union management

- Rygning
- DM
- Hypothyroidism
- Vit. D insuff
- Arteriosklerose
- Nyre insuff.
- NSAID, steroider

Optimisation of host factors

Mechanical alignment

Functional rehabilitation

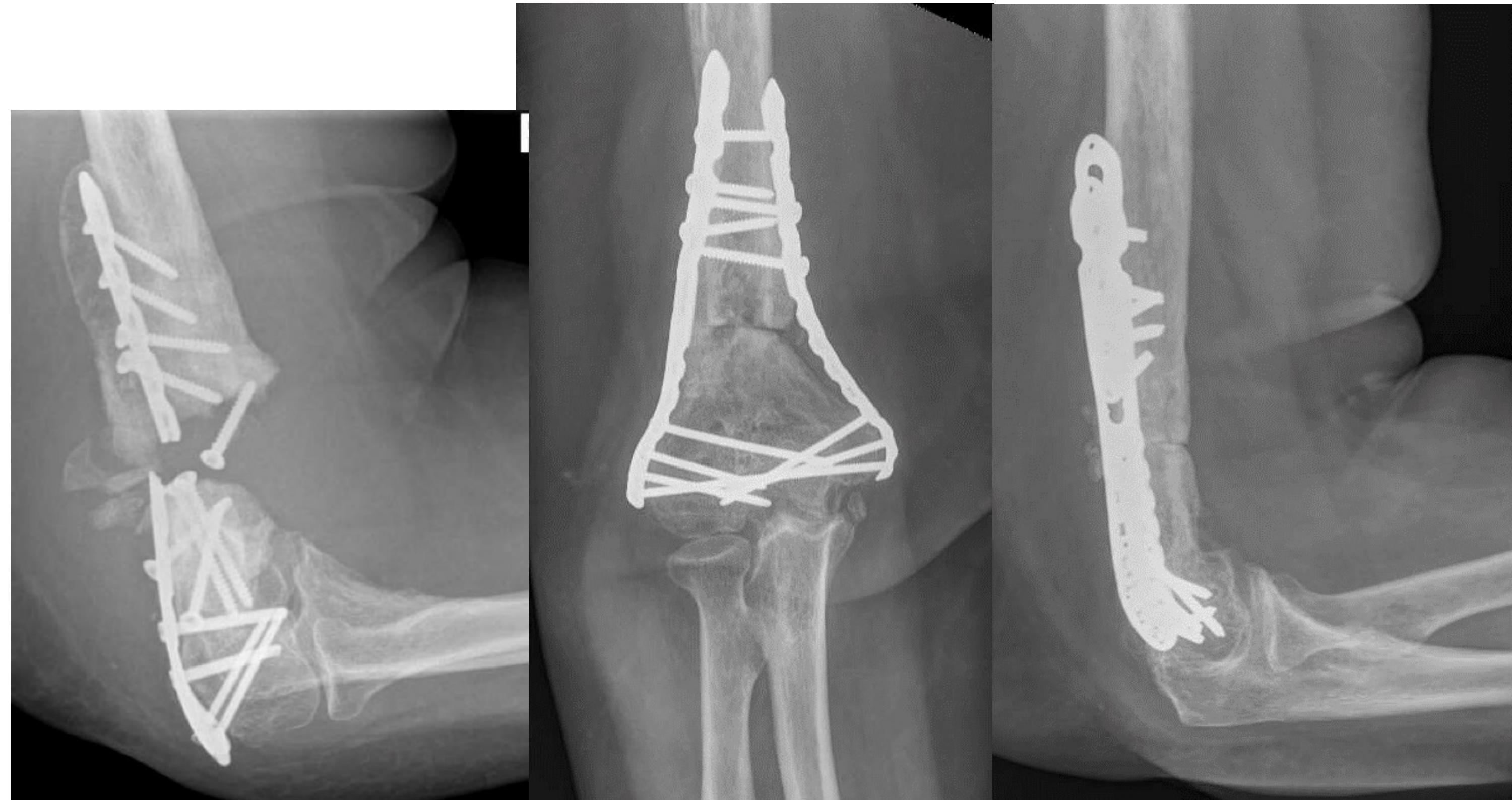
Stable fixation

Biological stimulation



Mechanical problems – mechanical solution!

- Re-etabler alignment/akse
- Neutraliser deformerende kræfter
- Genskab stabilitet
 - tykkere & længere søm
 - længere skinner
 - overvej en anden implantat



Mechanical problems - reduce the strain !

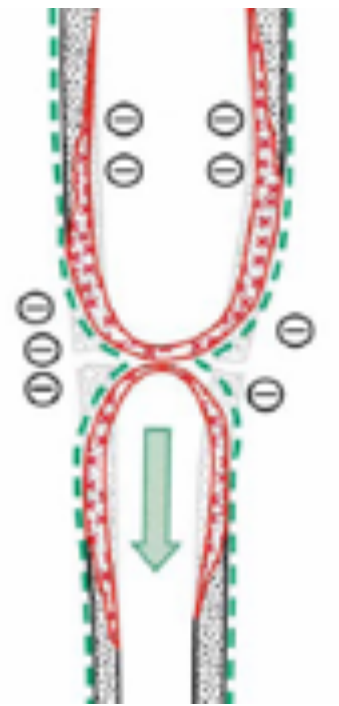
Distractions osteogenese $S \downarrow = \Delta L / L \uparrow$



Biologisk stimulation

Osteoinductive/osteogenic/ (osteoconductive)

- Autograft (gold standard)
- Bone transport
- Masquelet
- BMP/BMA(C)
- Mechano-biology
- Vascularized bone graft
- Free flap (vascularity)



Inficerede non-unions/Pseudoartroser

Behandling

Resektion og knogletransport

Masquelet

Arthrodesse

Alloplastik

Amputation



Take home message

Behandling af non-unions

- Følg de basale osteosynteseprincipper
- Løs mekanisk problem
 - Aligment
 - Stabilitet
- Optimer systemiske faktorer
- Udeluk infektion
- Autograft



Malunion

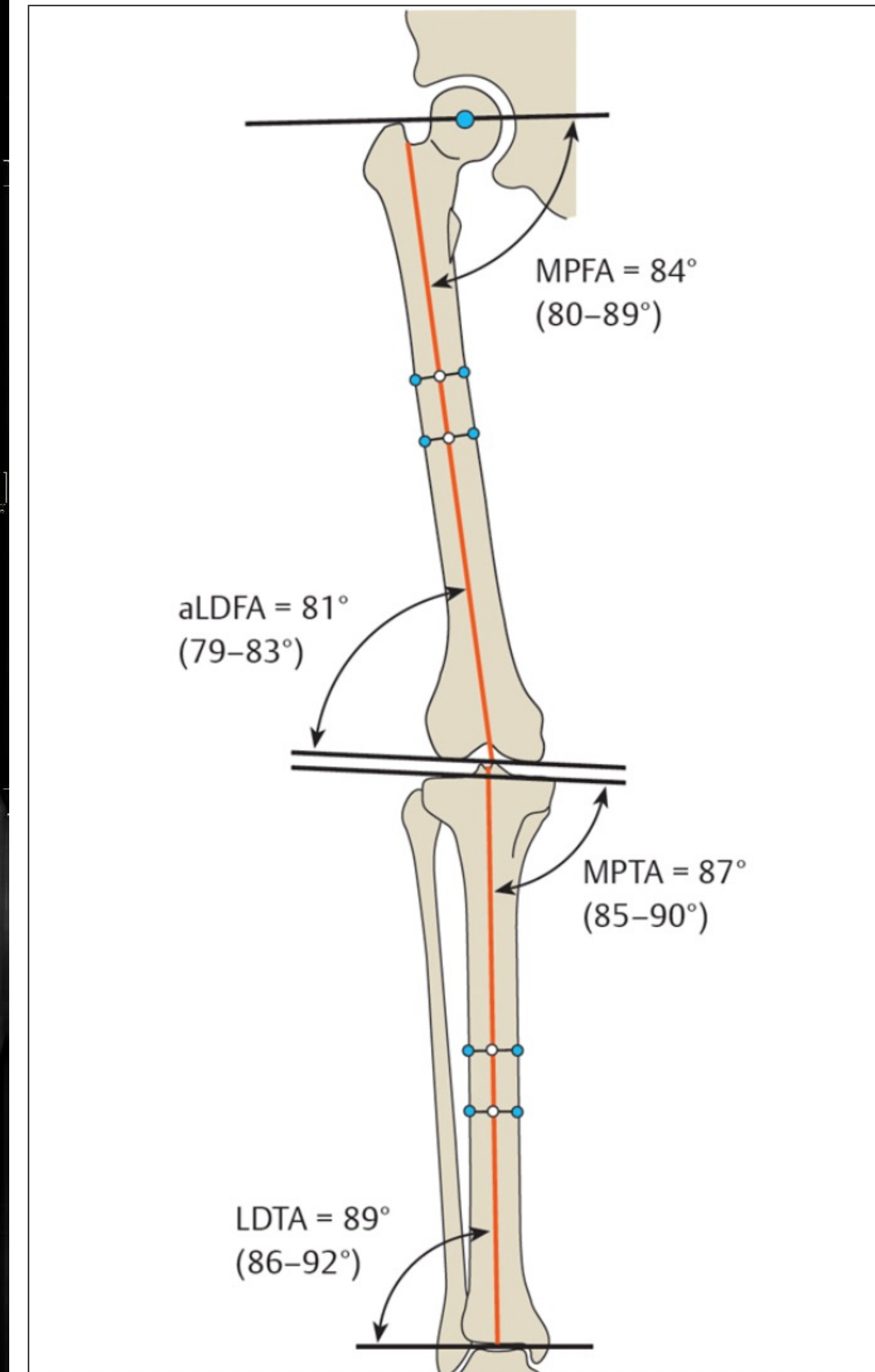
Bone doesn't heal correctly = deformity

Valgus/Varus

Recurvatum/Procurvatum

Limb length discrepancy (LLD)

Rotational



Diagnosis

???

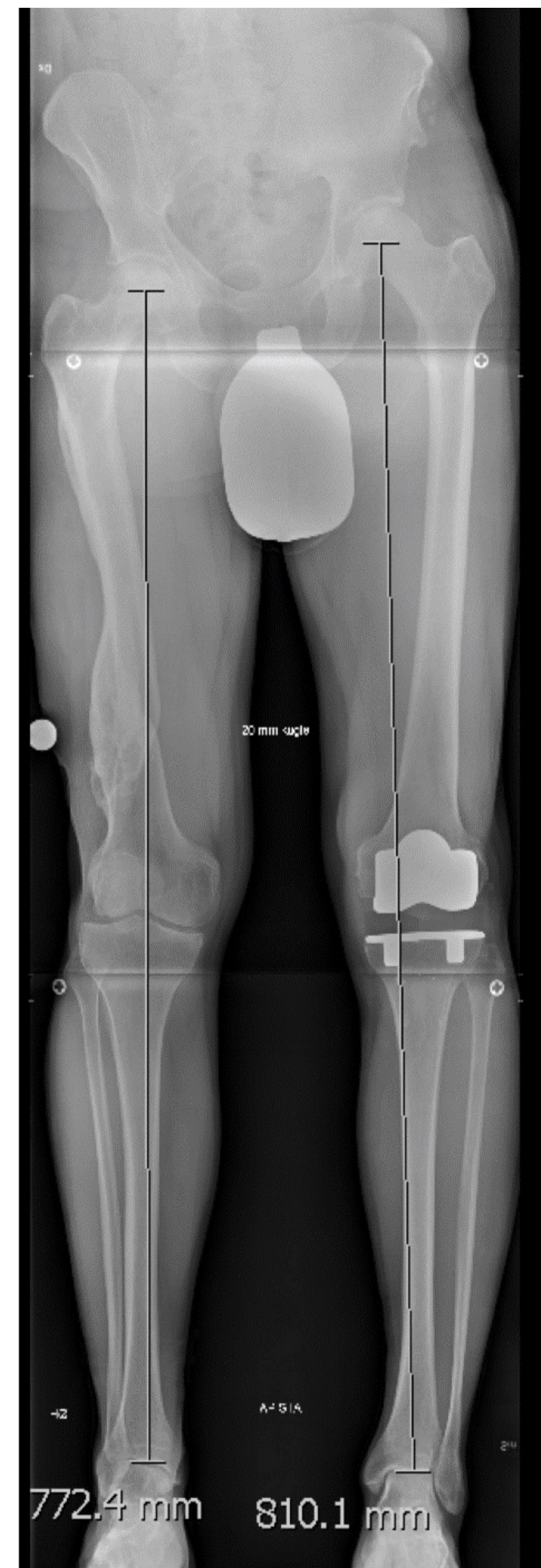
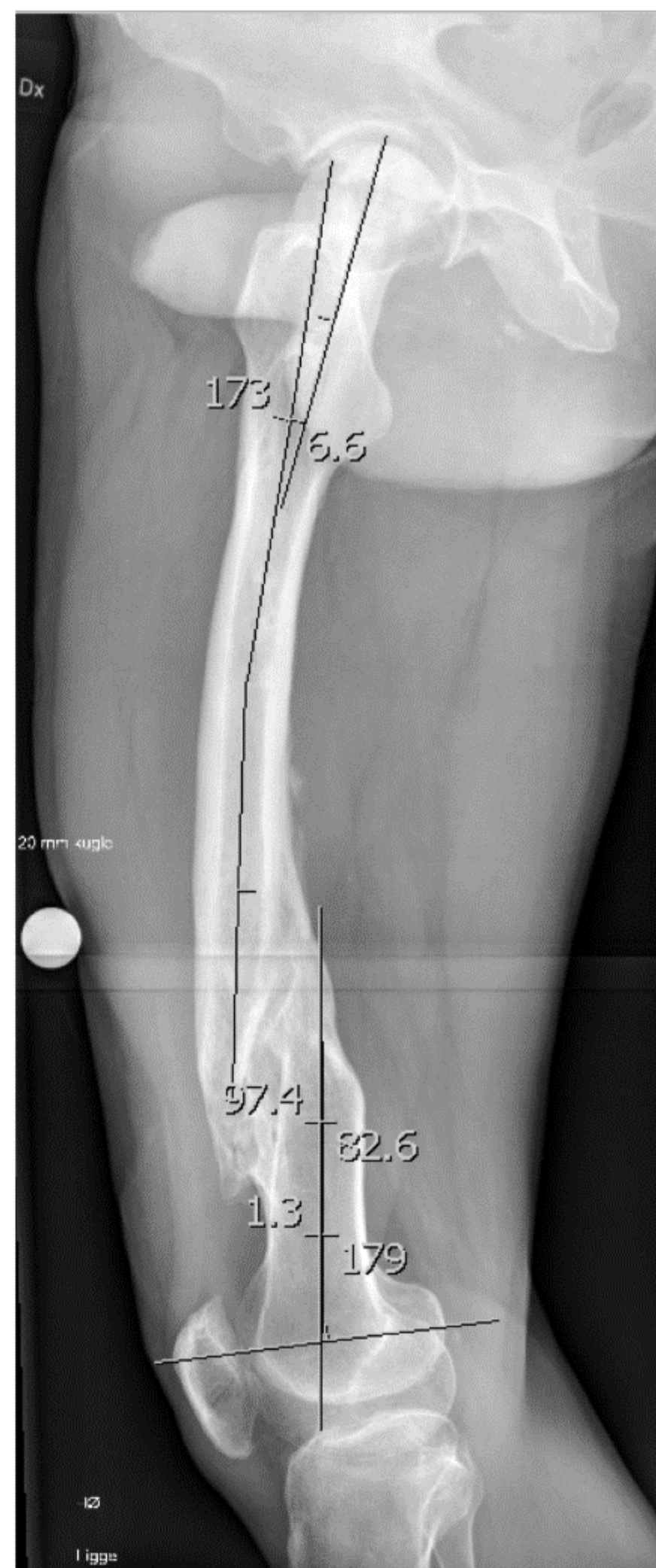
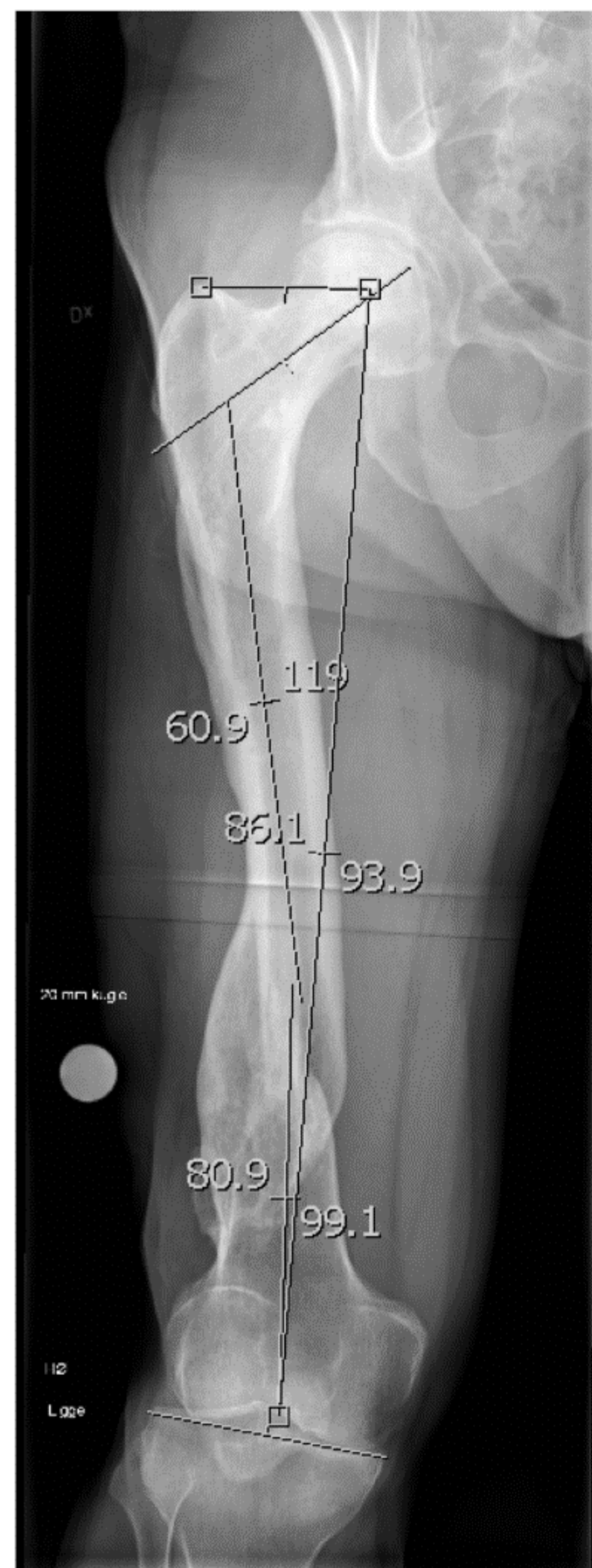
51-year-old man

Previously open fracture of
distal diaphysis and
femoral neck in 1986

Postraumatic LLD $\approx$ 3 cm

ROM of hip:
External rotation 90°
Internal rotation $\div 30^\circ$

ROM of knee:
 $0-125^\circ$



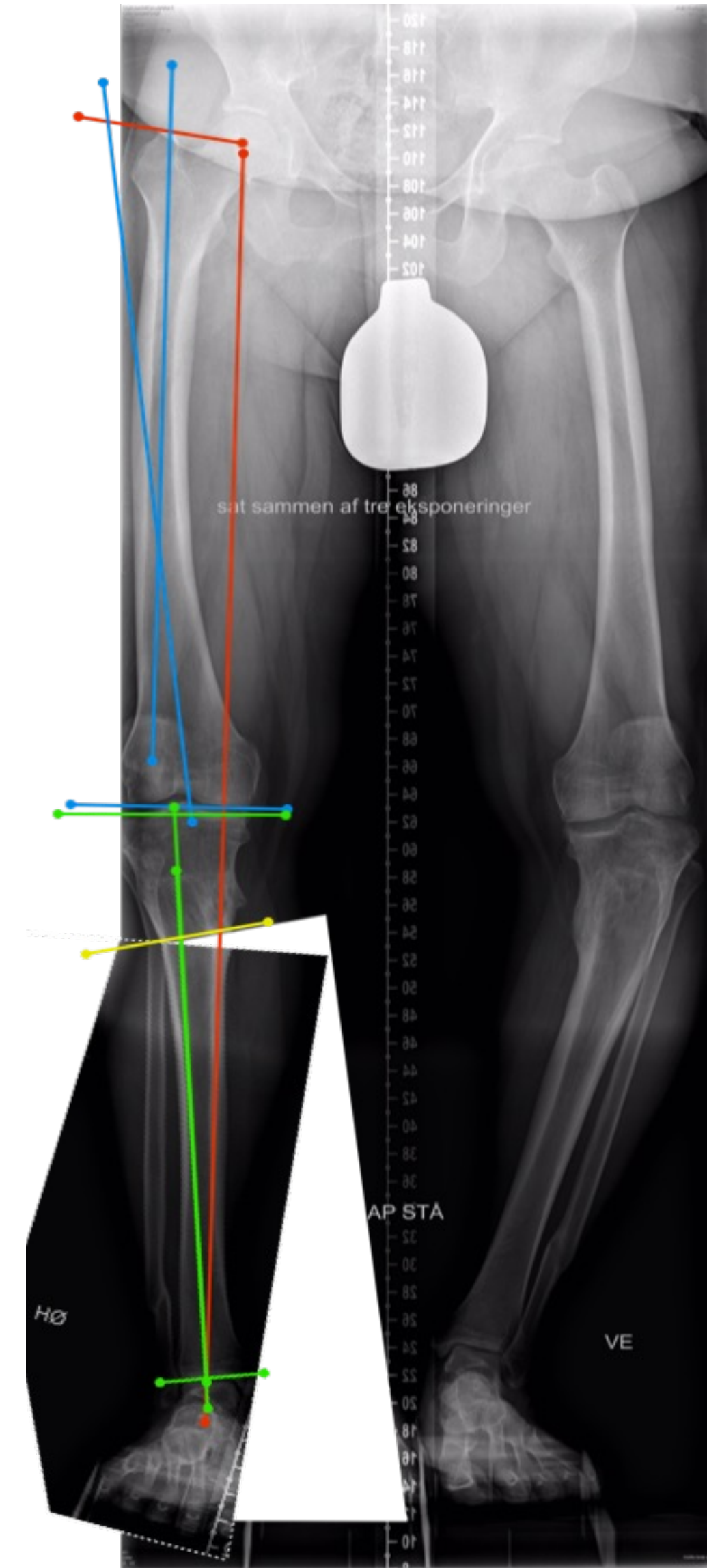
Indications for surgery

- Pain:
 - Osteoarthritis
 - Limp
- Functional deficit:
 - Joint instability
 - Joint incongruency
 - Rotational deformities
 - Shortening



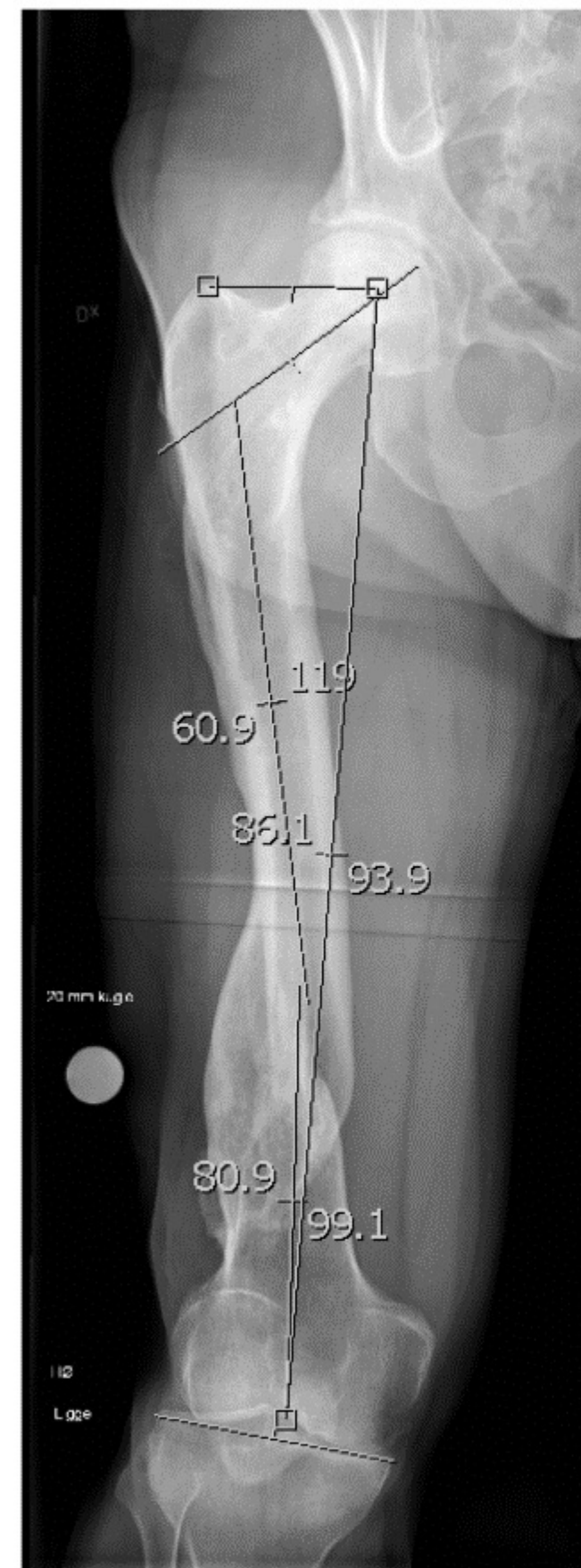
No absolute values of the deformity exist that indicate surgery

- > 5 degrees in coronal plane
- > 10 degrees in sagittal plane
- > 10 degrees rotation
- > 2 cm shortening



Considerations

- Symptoms
- Age
- Activity level
- General medical condition (smoking, nutrition)
- Compliance
- Prior vascular or nerve injuries (acute versus gradual correction)
- Soft-tissue contractures
 - Equinus foot (Achilles tendon lengthening)
 - Knee contractures (Quadricepsplasty)
 - Subtalar stiffness (Subtalar arthrodesis)



Pseudarthrosis:
Pathophysiology,
Biomechanics,
Therapy and Results

Weber, B. G.

Note: This is not the actual book cover

TAK!!!

Can we accelerate fracture healing? A critical analysis of the literature

Peter Giannoudis¹, Spyridon Psarakis¹, George Kontakis²

BJR



RESEARCH

The effect of smoking on bone healing

A SYSTEMATIC REVIEW

van Trikt et al. *BMC Geriatrics* (2022) 22:985
<https://doi.org/10.1186/s12877-022-03670-8>

BMC Geriatrics

RESEARCH

Open Access

Operative treatment of nonunions in the elderly: Clinical and radiographic outcomes in patients at minimum 75 years of age

Clinton H. van Trikt¹, Johanna C. E. Donders¹, Craig E. Klinger^{2*}, David S. Wellman³, David L. Helfet² and Peter Kloen¹

Trauma

EOR | VOLUME 5 | JANUARY 2020
DOI: 10.1302/2058-5241.5.190037
www.efortopenreviews.org



EFORT open reviews

Nonunion – consensus from the 4th annual meeting of the Danish Orthopaedic Trauma Society

Hagen Schmal^{1,2}
Michael Brix¹
Mats Bue³
Anna Ekman⁴
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Hans Gottlieb⁶
Søren Kold⁷
Andrew Taylor⁸
Peter Toft Tengberg⁹
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Danish Orthopaedic Trauma Society⁹

Injury, Int. J. Care Injured 45S (2014) S93–S97



Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury



Validation of the Non-Union Scoring System in 300 long bone non-unions

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Supplement

Behandling af tibia non-unions med ringfiksation

Management of tibial non-unions: Prospective evaluation of a comprehensive treatment algorithm

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