Fractures of the fingers

Thierry Dubert

Recent Fractures

Definitions

large bone fragment

Delay < 3 weeks

The more frequent complications :

Stiffness

Pain

PIP Stiffness = global hand disability

Young patients → impairement

Functional and professional

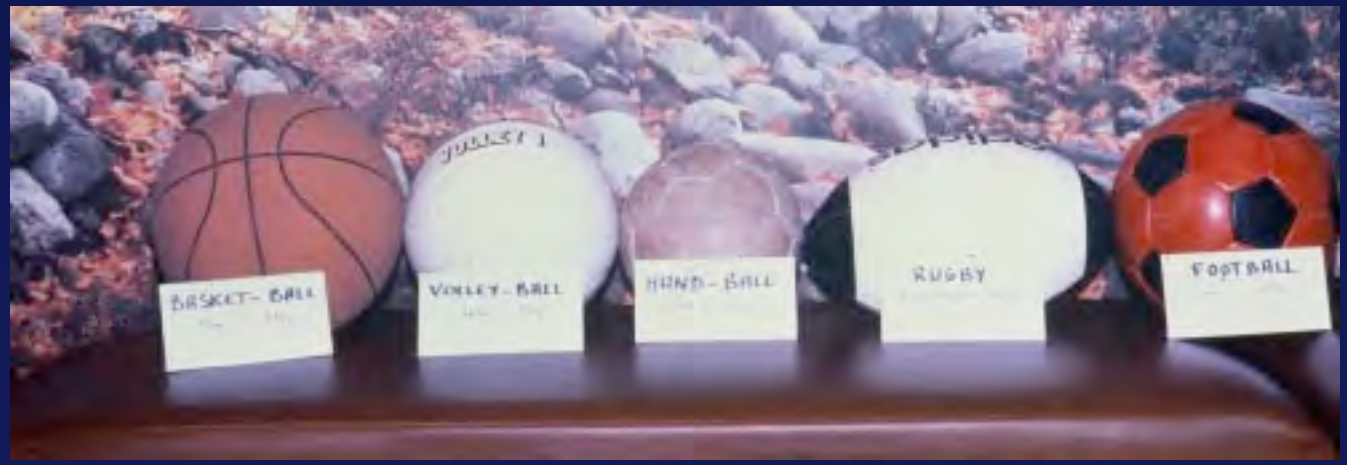
Early mobilization

Synovial fluid nutrition
Tendon gliding
Removal of waste products

Salter 1980

Mecanism of injury

- Flexion/ extension
- Lateral stress
- Compression
- Temporary dislocation



Clinical examination

Observation

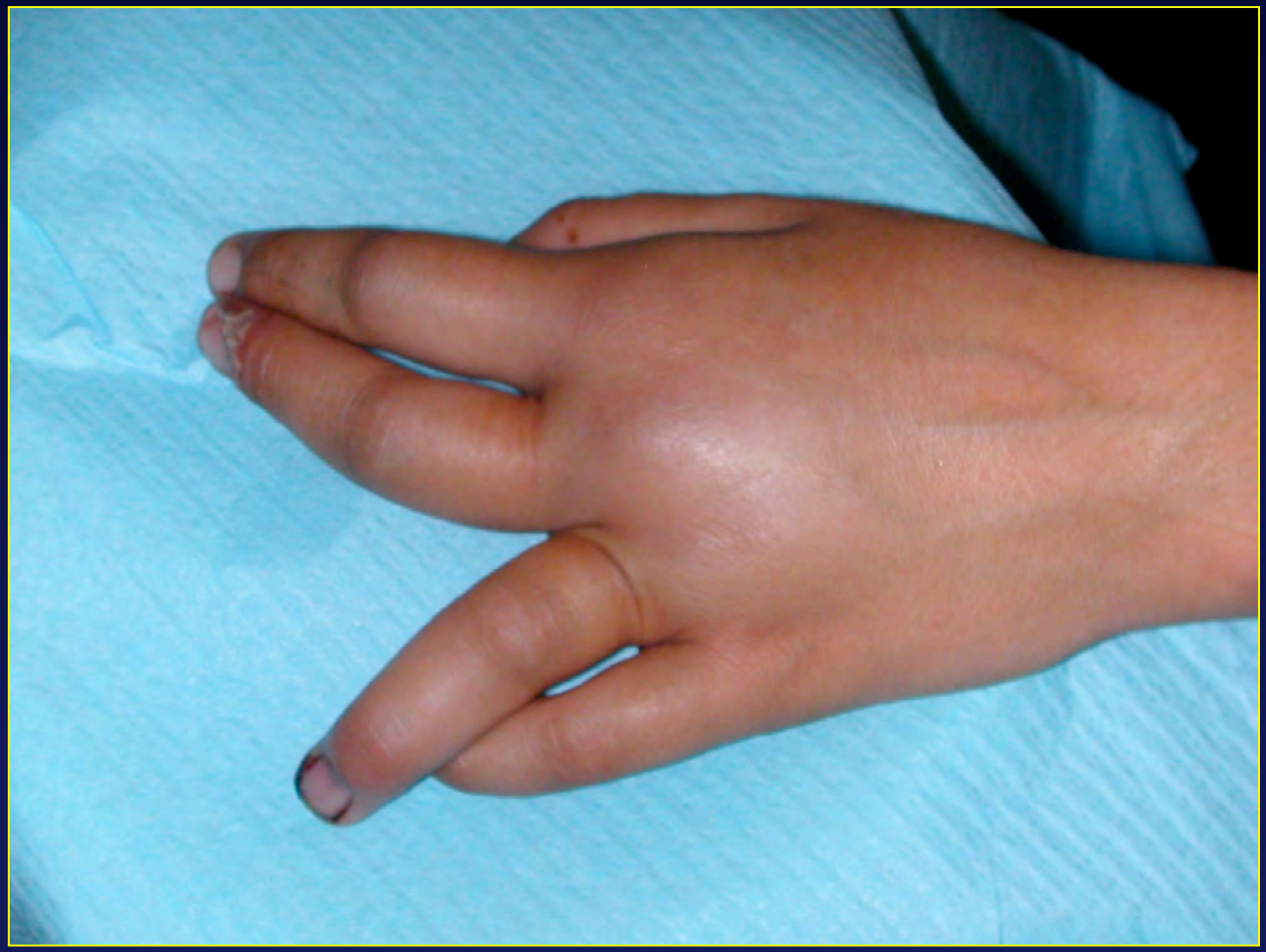
- Deformity
- Swelling
- Ecchymosis
- Range of motion
- Associated injury
  (skin, tendons, multilevel)

Stress Testing ?

–After X-Ray

–Under Local Anesthesia

Clinical examination



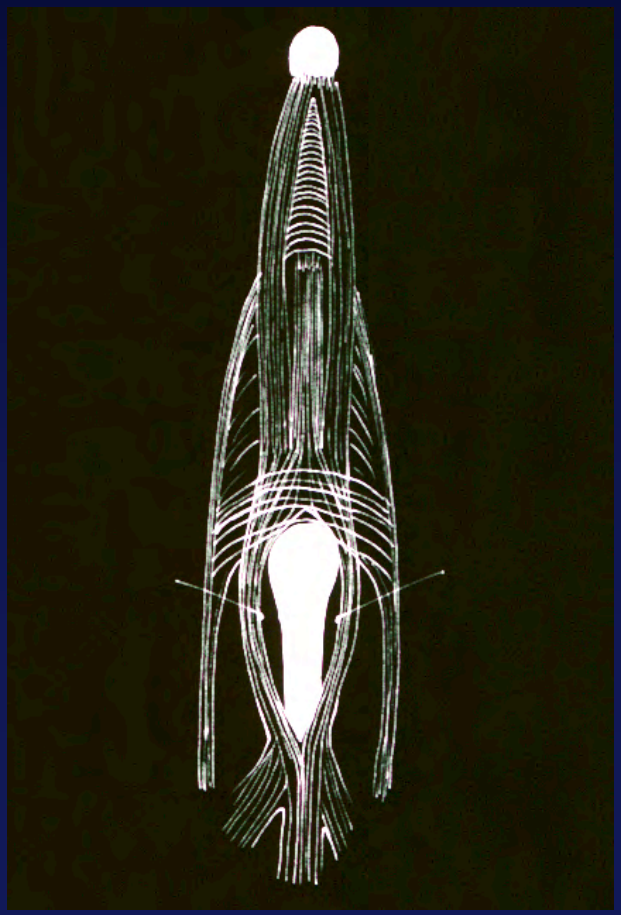
X Ray examination

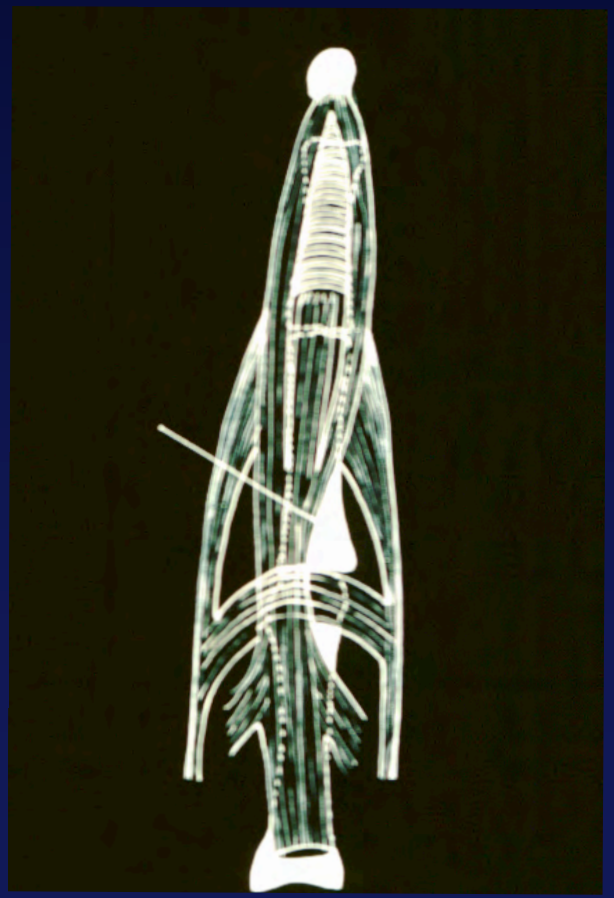
AP
True Lateral
3/4
CT Scan ?

- Fracture lines
- Displacement
- Impaction
- Articular congruency

Fractures of the Base of the Proximal Phalanx

- Surgical approach : dorsal or palmar

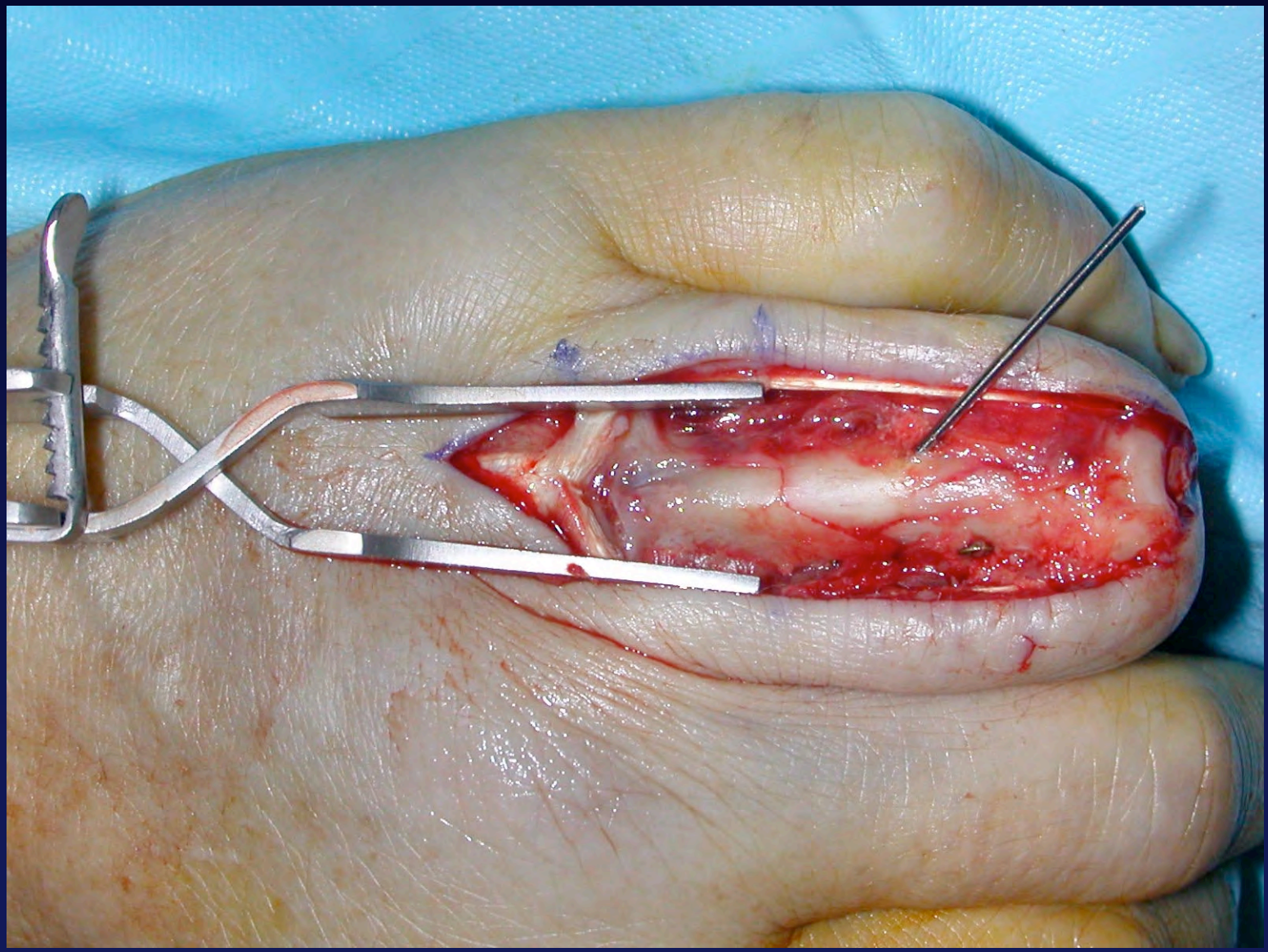




Fractures of the base of the Proximal Phalanx

Fractures of the base of the Proximal Phalanx

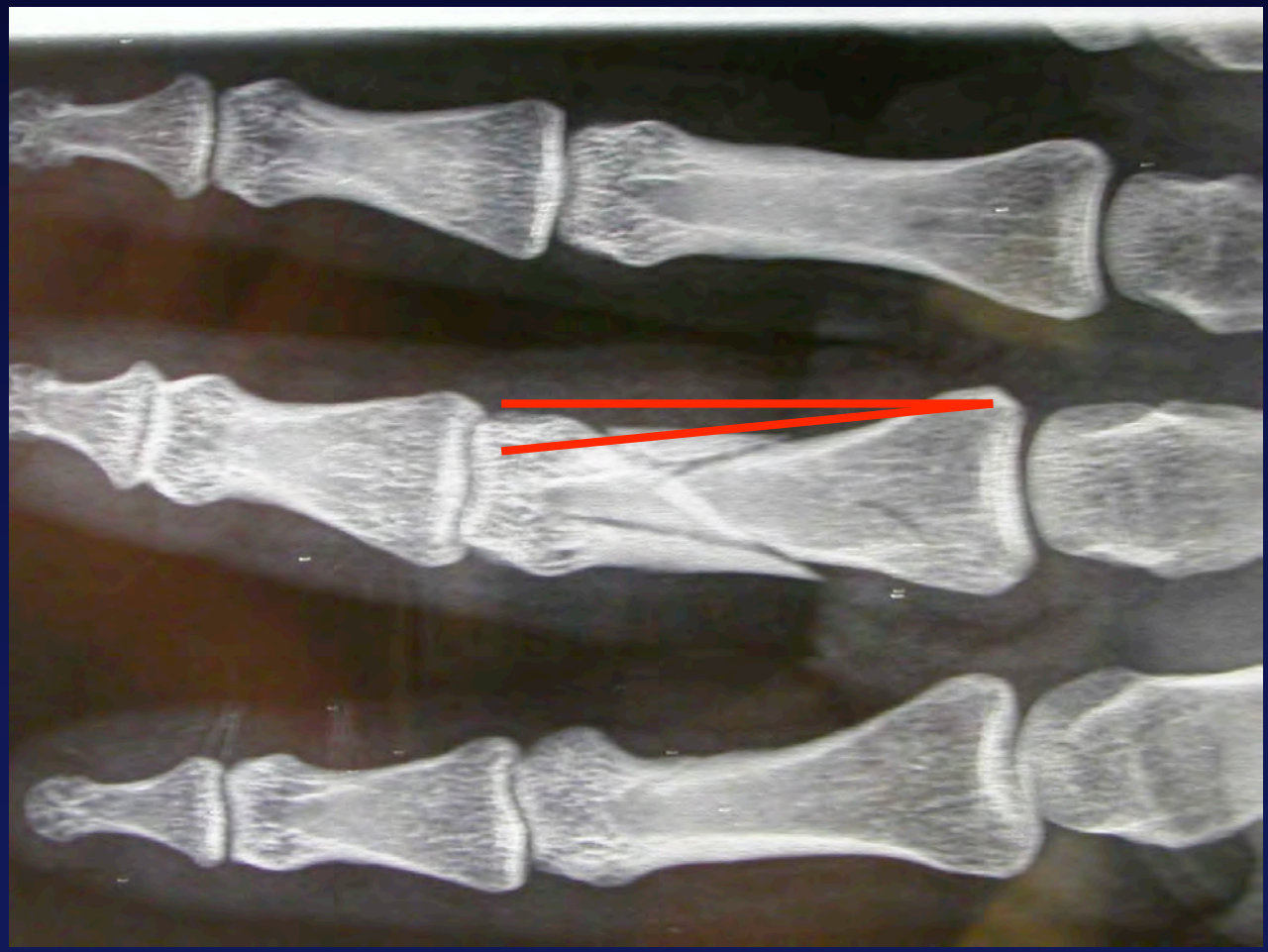
Fractures of the Proximal Phalanx



Fractures of the Proximal Phalanx

Fractures of the Proximal Phalanx

De quel côté mettre la plaque?



Fractures of the Proximal Phalanx

Fractures of the Proximal Phalanx

Fractures of the Proximal Phalanx

Fractures of the Proximal Phalanx

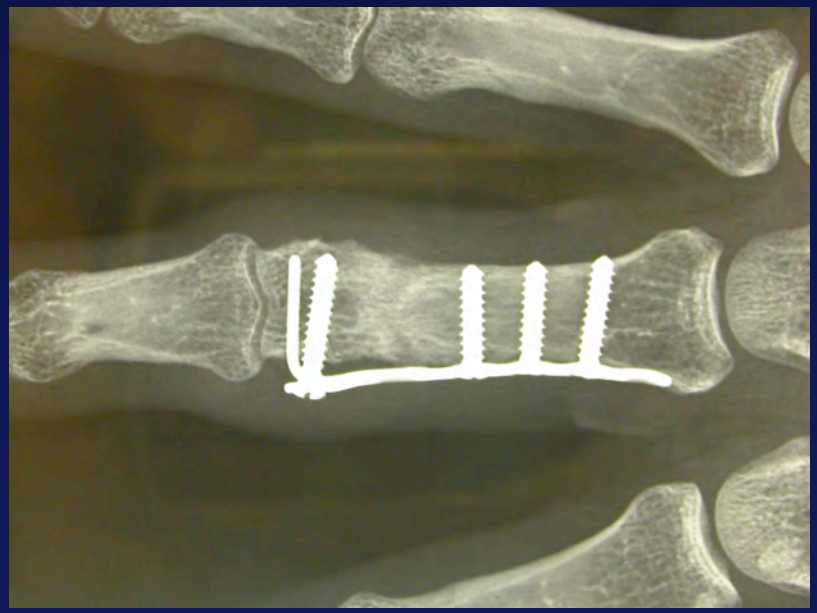
Vis

- Large abord
- Meilleure tenue
- Pas d'ablation

Combinaisons de circonstance…

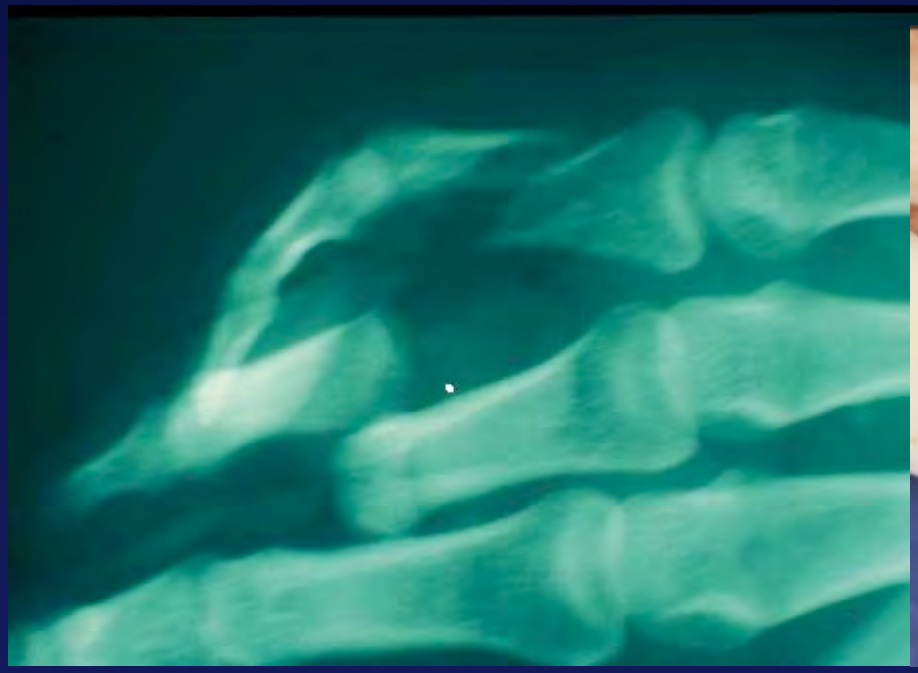
CLOUS-PLAQUES

Pour les fractures distales

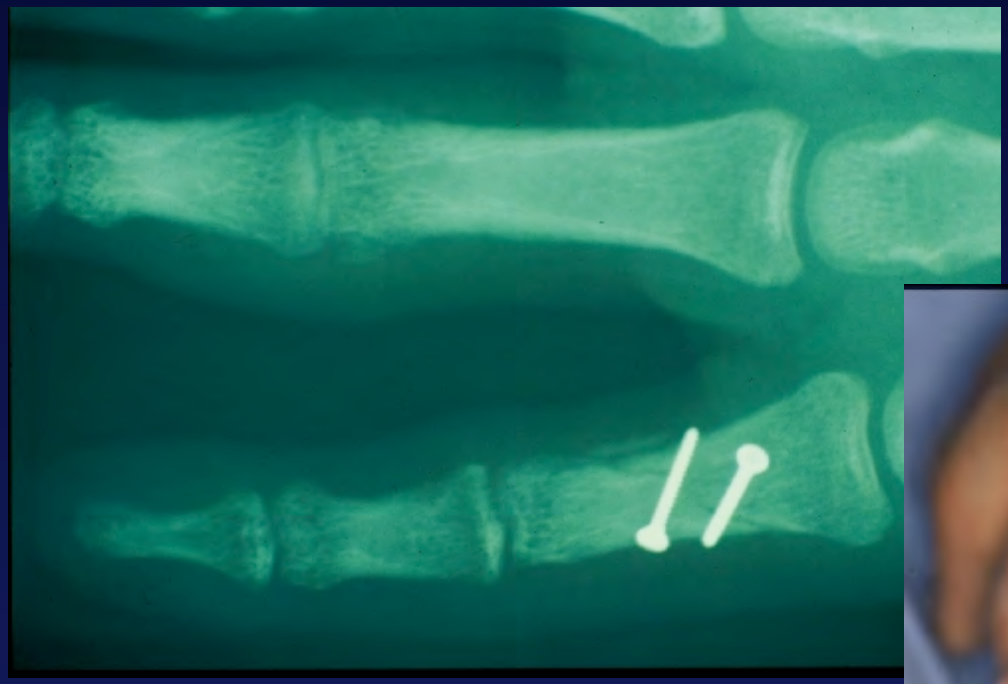


Fractures fermées avec lésions associées

- Fracture spiroïde de P1
- Section complète de l'appareil extenseur



Fracture fermée
avec
Section de l'appareil extenseur



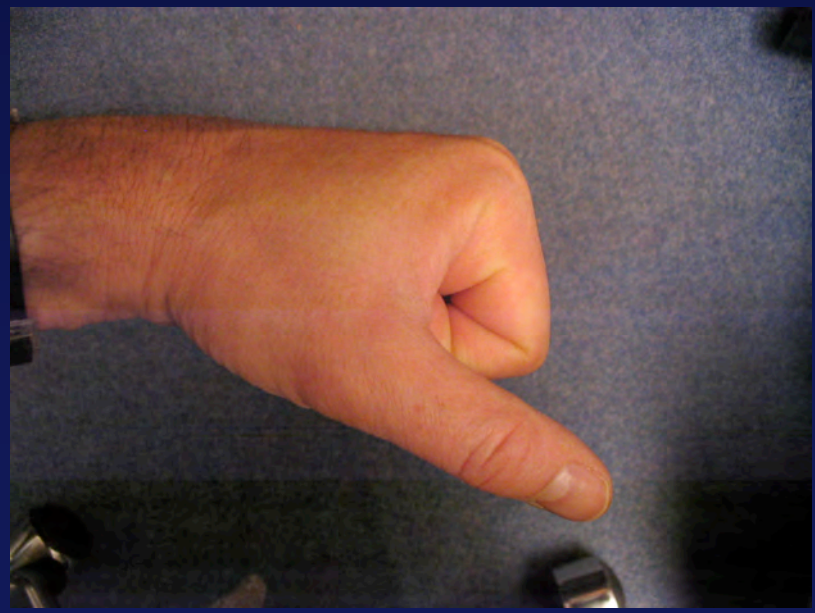
Fractures fermées avec lésions associées

Amputations trans P1

- Unidigitale : Pas de replantation
- Pluridigitales

Fractures of the Proximal Phalanx
Conservative treatment

- Cast of Thomine



Traitement orthopédique des fractures de P1

Appareillage de Thomine

Appareillage de Thomine

MP en flexion

IPP libres

Syndactylie dynamique

Appareillage de Thomine

MP en flexion

IPP libres

Syndactylie dynamique

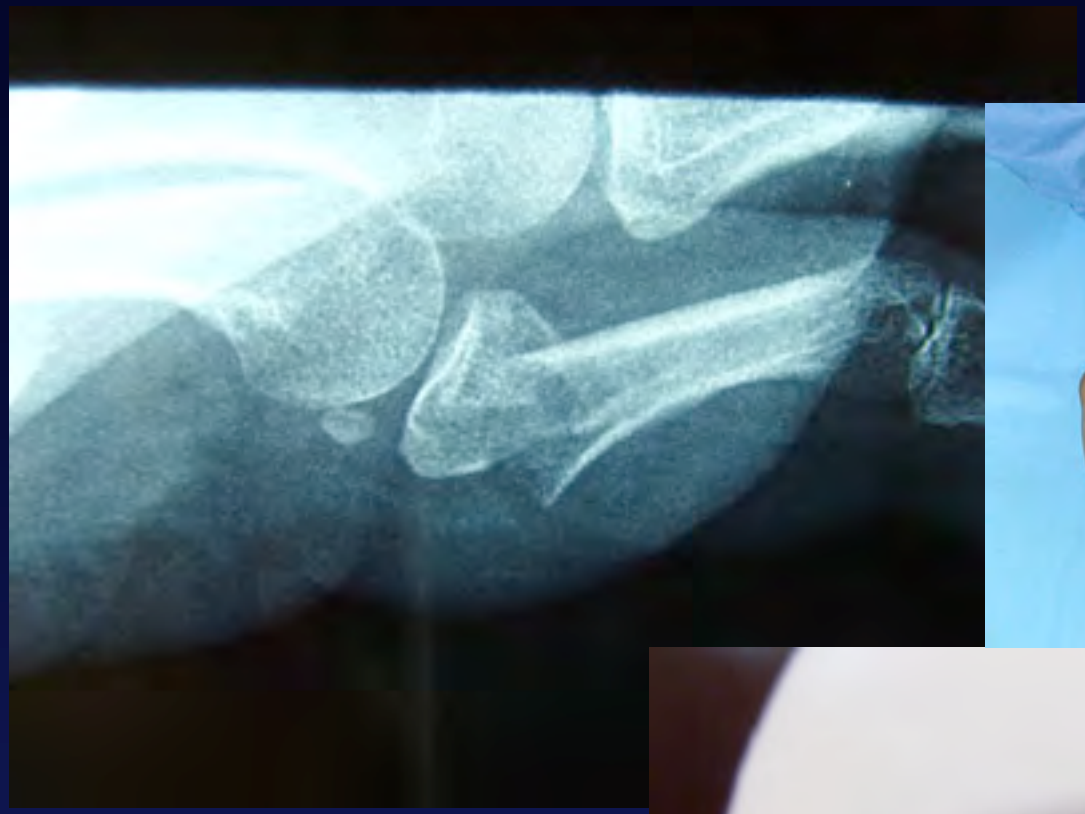
Fracture diaphysaire comminutive et ouverte

Instabilité majeure
Surveillance cutanée

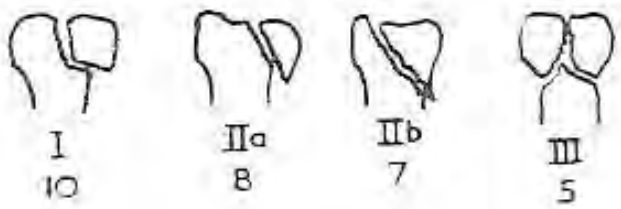
Brochage temporaire MP en flexion

Equivalent de
l'appareillage de Thomine

Résultat du brochage temporaire MP en flexion



Classification
of
P1 condylar fractures



London 1971

- Grade I : little displacement
  no instability
- Grade II : unstable fractures
  - Type IIa : small fragment
  - Type IIb : large fragment
- Grade III : Comminutive - Pilon

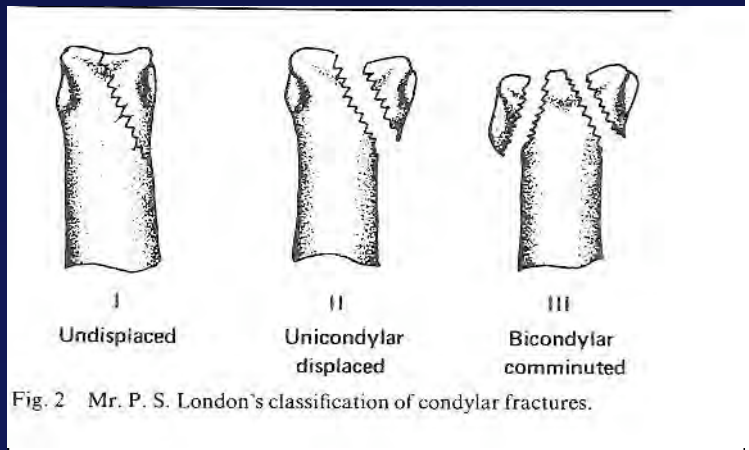


Fig. 2 Mr. P. S. London's classification of condylar fractures.

O'Rourke 1989

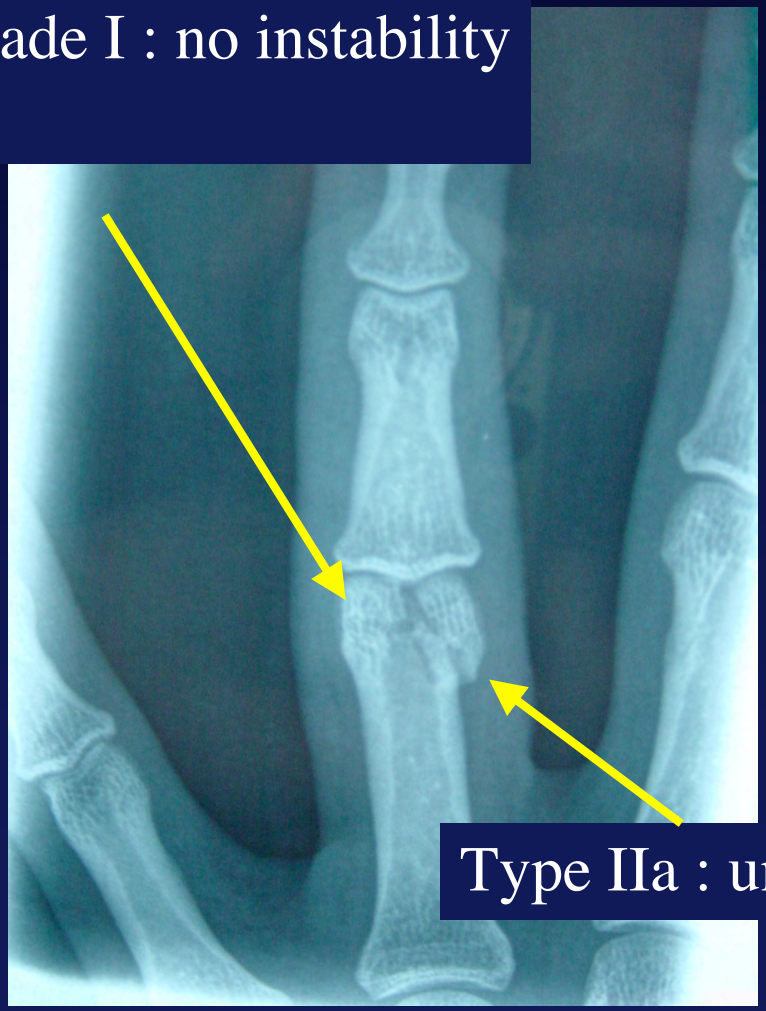
Classification

of

P1 condylar fractures

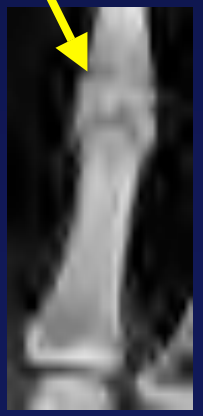
Grade I : no instability

London (1971)



Type IIb : unstable large fragment

Type III

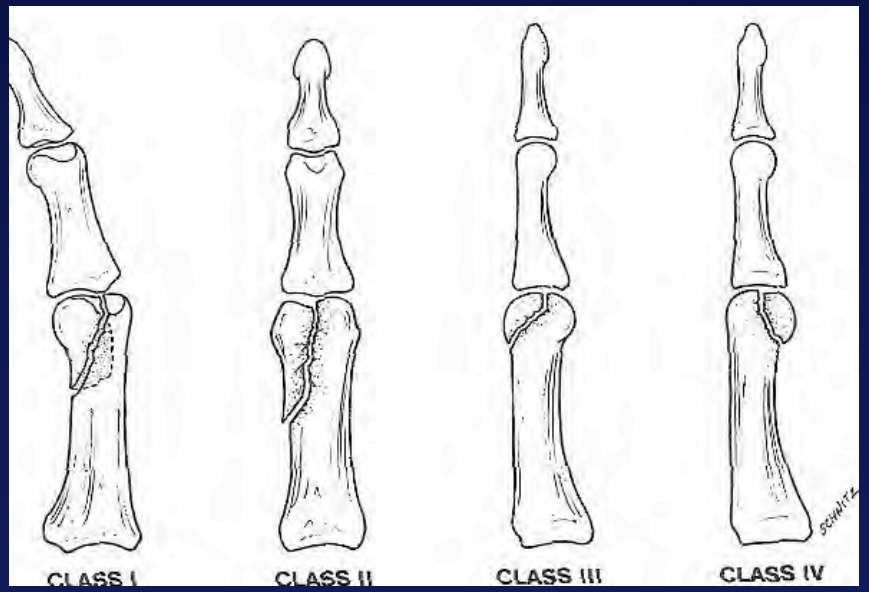


Type IIa : unstable small fragment

Another classification of P1 condylar fractures

Weiss & Hastings 1993

- Class 1 : oblique volar
- Class 2 : long sagittal
- Class 3 : dorsal coronal
- Class 4 : volar coronal



60% 20% 10 % 10%

Class 1 : oblique volar

Weiss et Hastings 1993

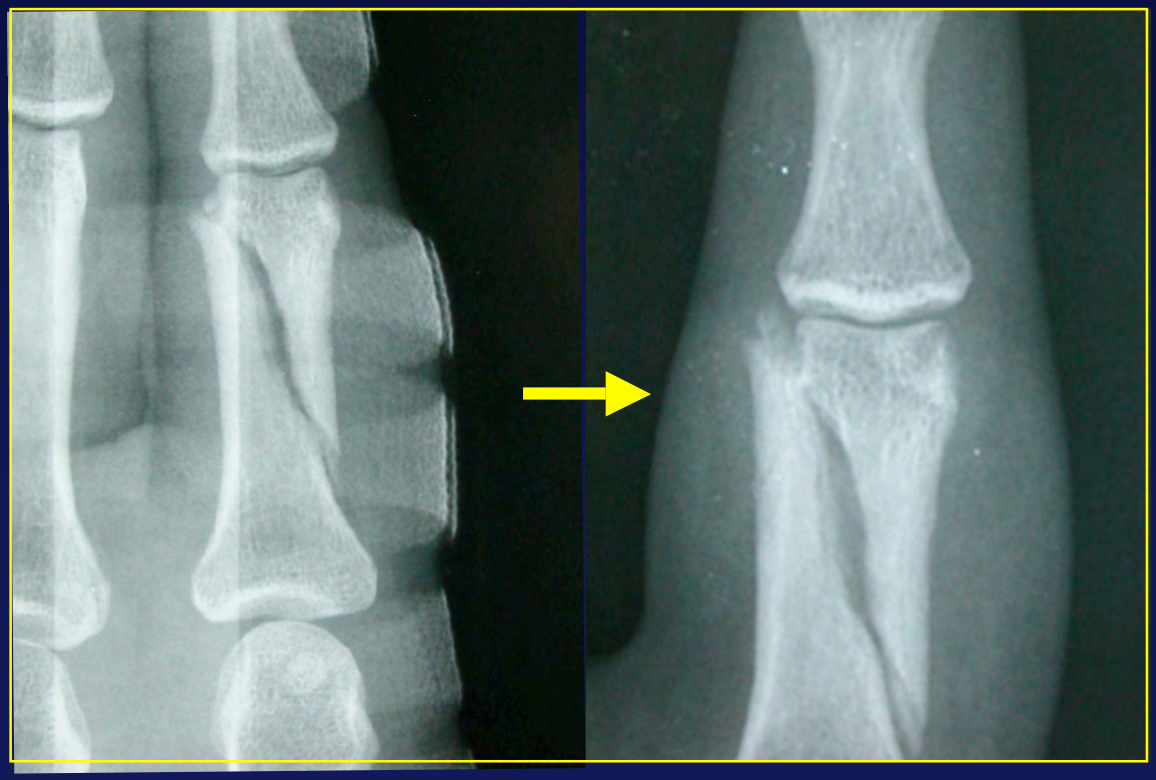
Distraction force

Through collateral ligament

With an element of rotation

But, Juxta condylar ...

...Can become intra-articular



Classifications of the fractures of the middle phalanx

Based on

- Localisation
- Degree of comminution
- Number of fragments
- Impaction
- Subluxation

Lateral X Ray :

false negative

Proximal phalanx
Classification of Seno *(1997)*

- Type 1 : fragment on the palmar side
- Type 2 : fragment on the dorsal side
  (extensor tendon insertion)
- Type 3 : « Pilon fracture » dorsal and palmar fragments
- Type 4 : Extra-articular
- Type 5 : Not classifiable

Type 1 :

Seno 1997

One fragment on the palmar side

(Continuity of the fragment with the palmar plate)

Type 2

Seno 1997

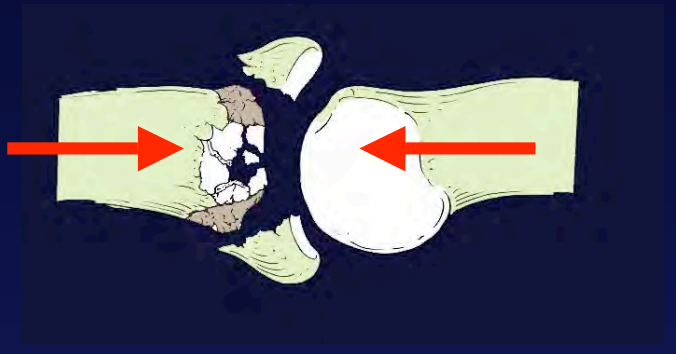
Fragment on the dorsal side
(proximal extensor tendon insertion)

Type 3

Seno 1997

Pilon fracture

High energy Axial loading



Two main fragments

On palmar and dorsal sides
No continuity with the shaft
Widening of the base
Central impaction

Stern 1991

Bipolar avulsion

Seno 1997

Pilon ?

Classification of Seno

Seno 1997

Sub-classification

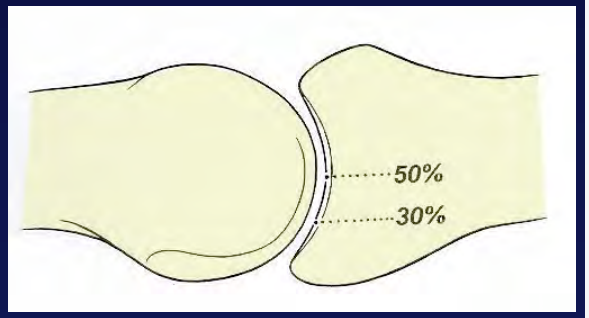
- a : avulsion
- b : separation
- c : impaction

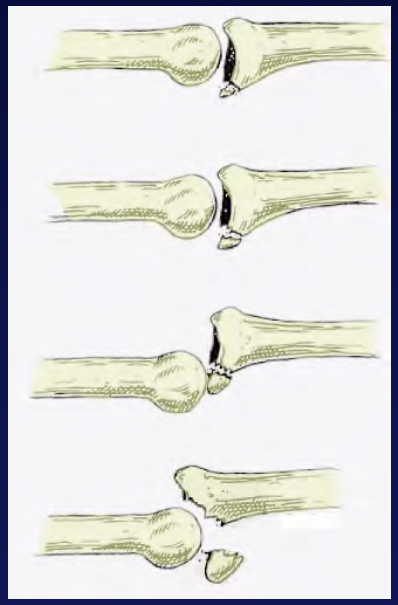
Percentage of articular impaction (type 1c)

< 30 %

30 to 50 %

> 50 %





Dorsal instability is directly proportional to the degree of impaction

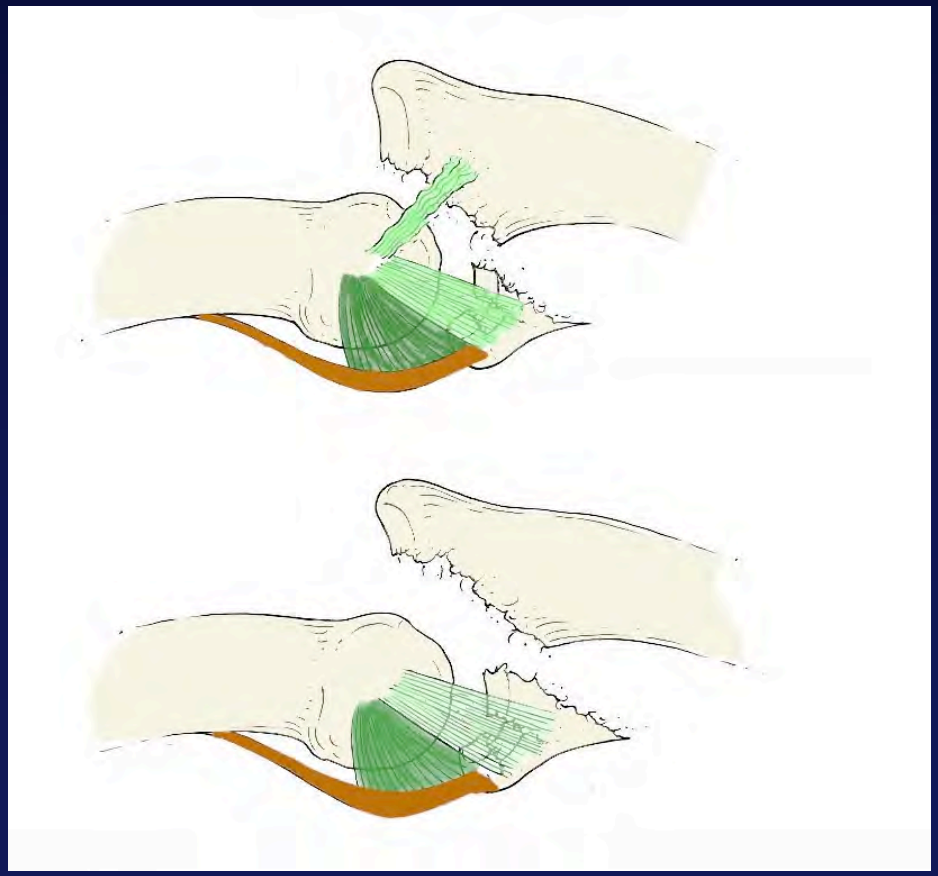
The joint is <u>always unstable</u> <u>over > 40%</u>

Loss of

<u>Ligamentous support</u>

and

<u>Articular buttress</u>



Bony loss of substance

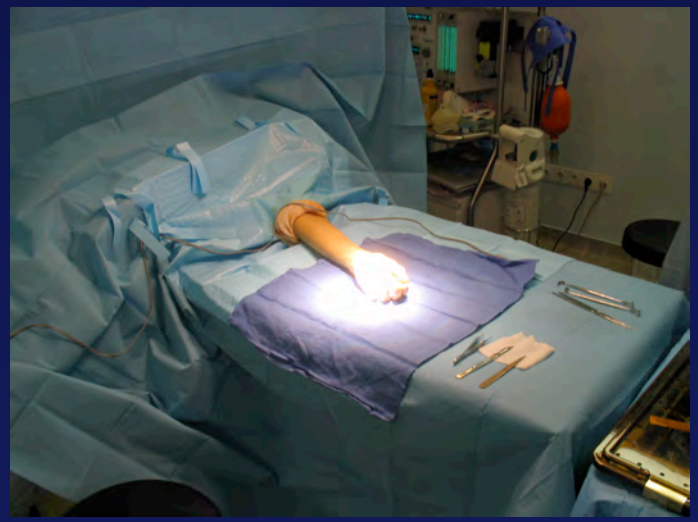
Associated lesion

- Skin loss
- Extensor tendon
- Multilevel injuries

Anesthesia

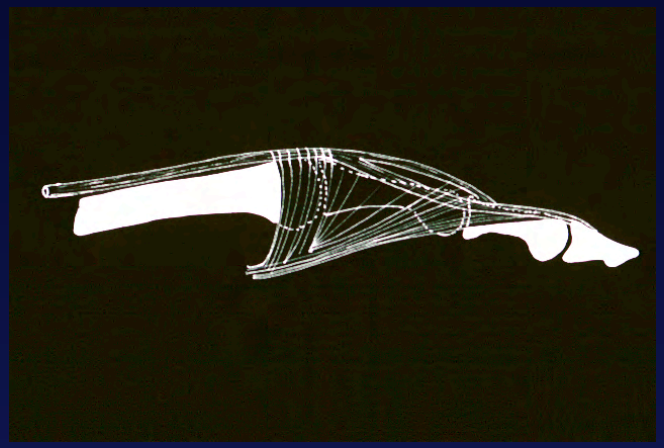
Prefer Axillary bloc

- Arm tourniquet
- Sensory and motor bloc



Surgical approach

- Dorsal or Lateral approach
  - More direct
  - Trough extensor tendon

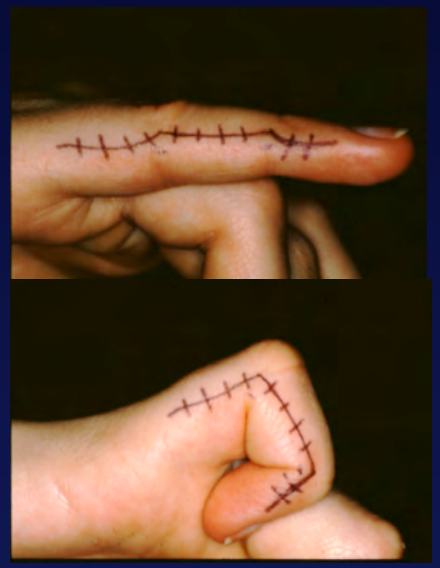


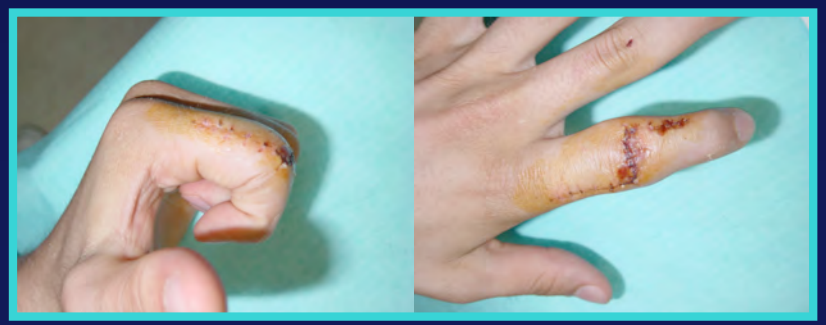
- Palmar approach
  - More distant
  - Spares flexor tendons

Dorsal or Lateral approaches

Lateral skin incision : Avoid

- radial side of the index finger
- ulnar side of the little finger





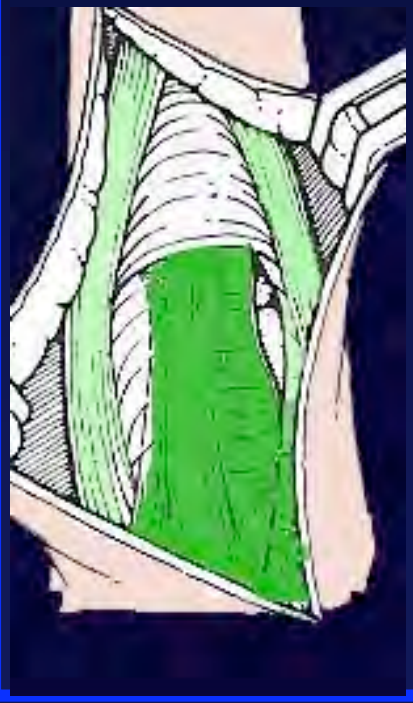

Avoid Lazy S

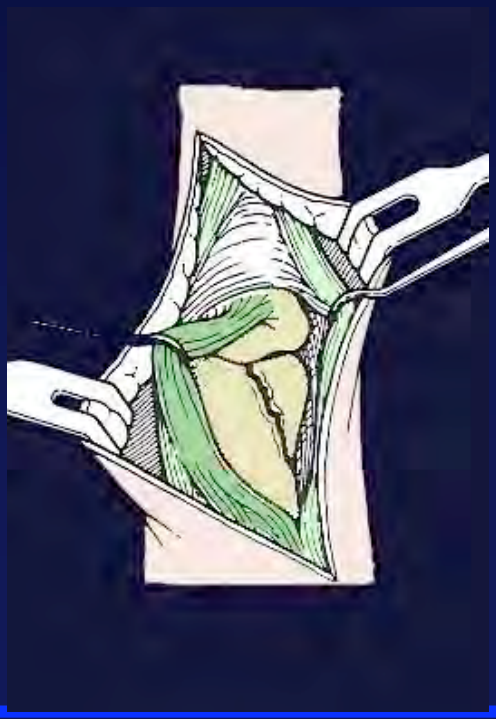
Dorsal skin incison

Prefer Longitudinal

Crossing extensor tendon

Between lateral and central slip



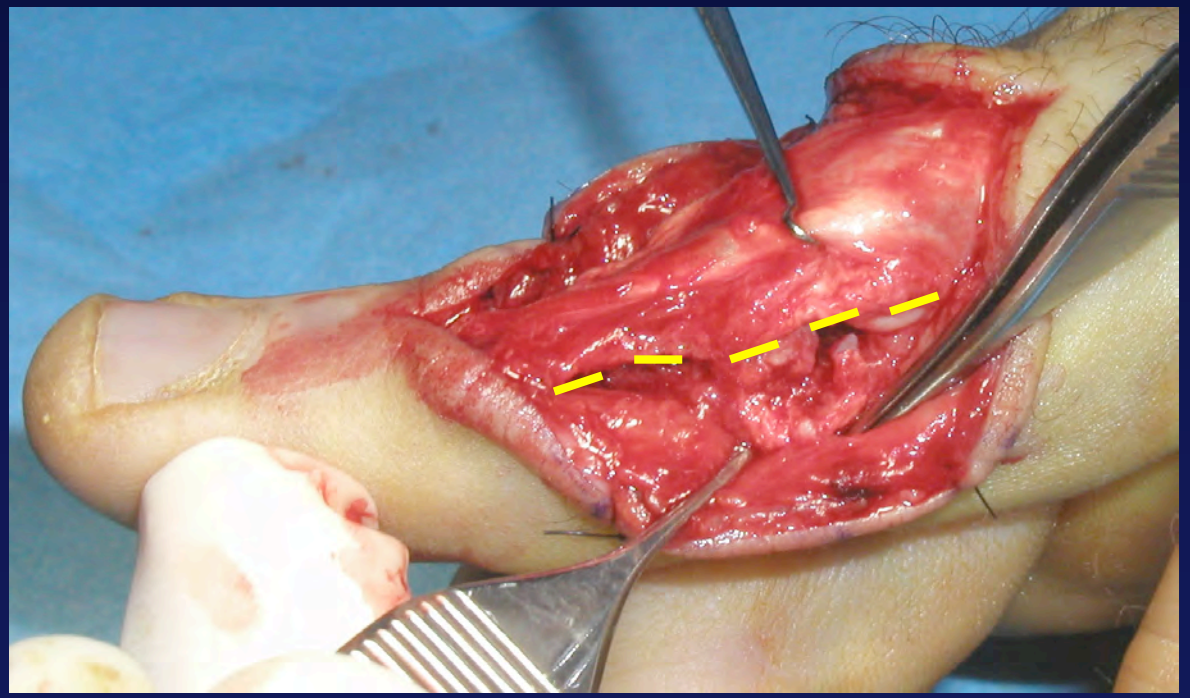


Through the central slip
(Chamay's approach)

Stronger repair than transverse section

Crossing extensor tendon

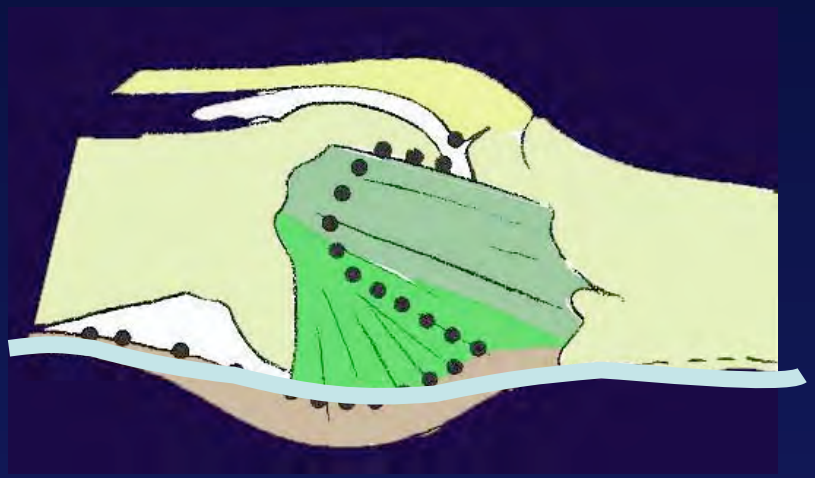
Through the transverse retinacular ligament



Dorso-lateral approach
Intra-articular exposure

Proximal release of

- Collateral ligaments
- Palmar plate



Büchler 1996

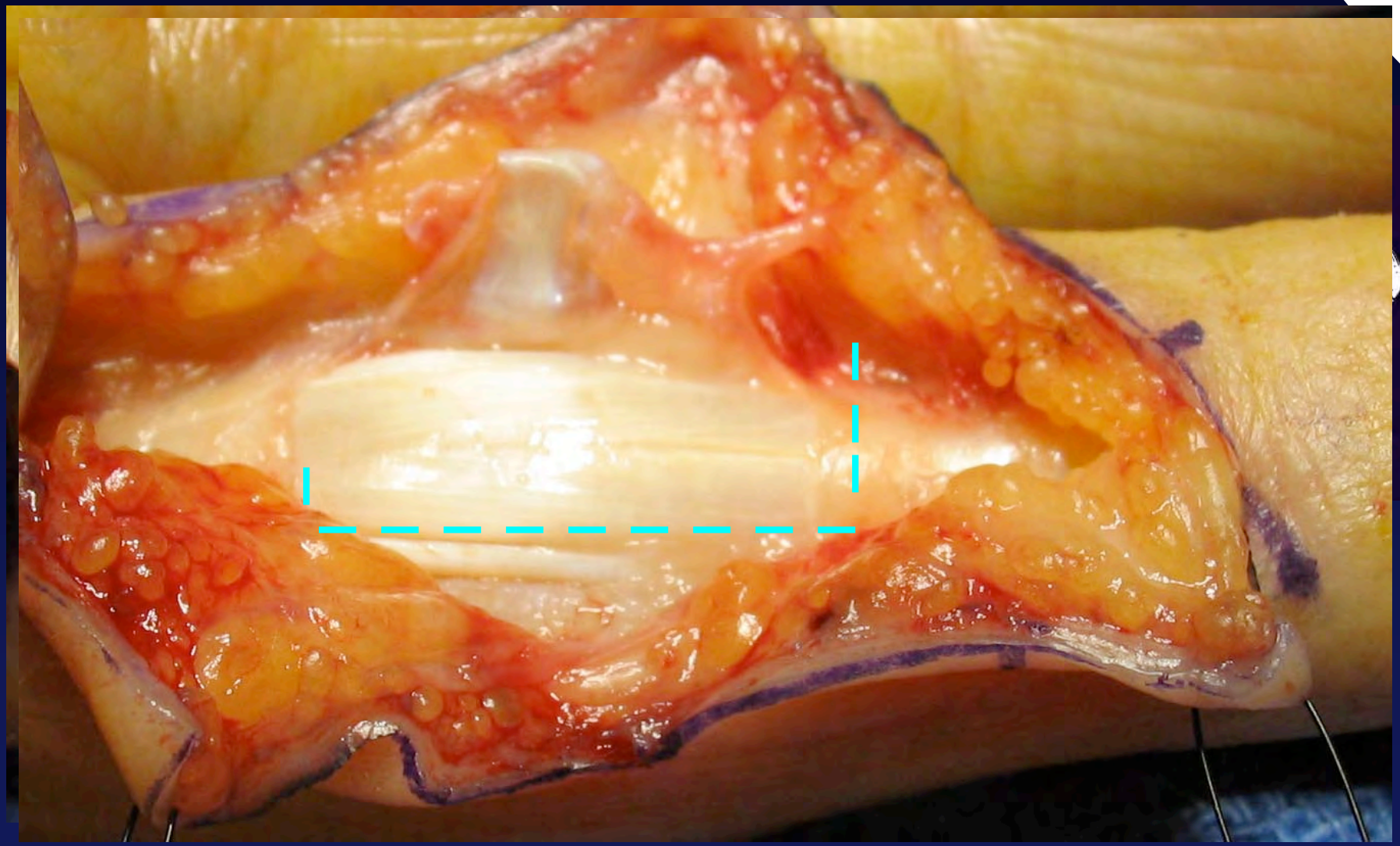
TATA approach ?

Saffar 1983

Anterior approach : Shotgun

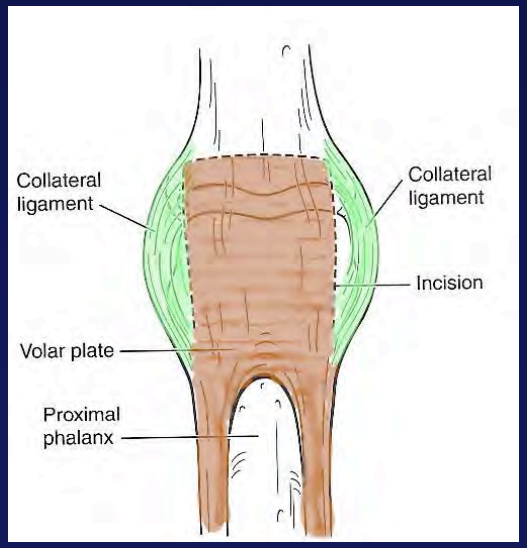
Brüner type incision centered on the PIP joint

Anterior approach : Shotgun



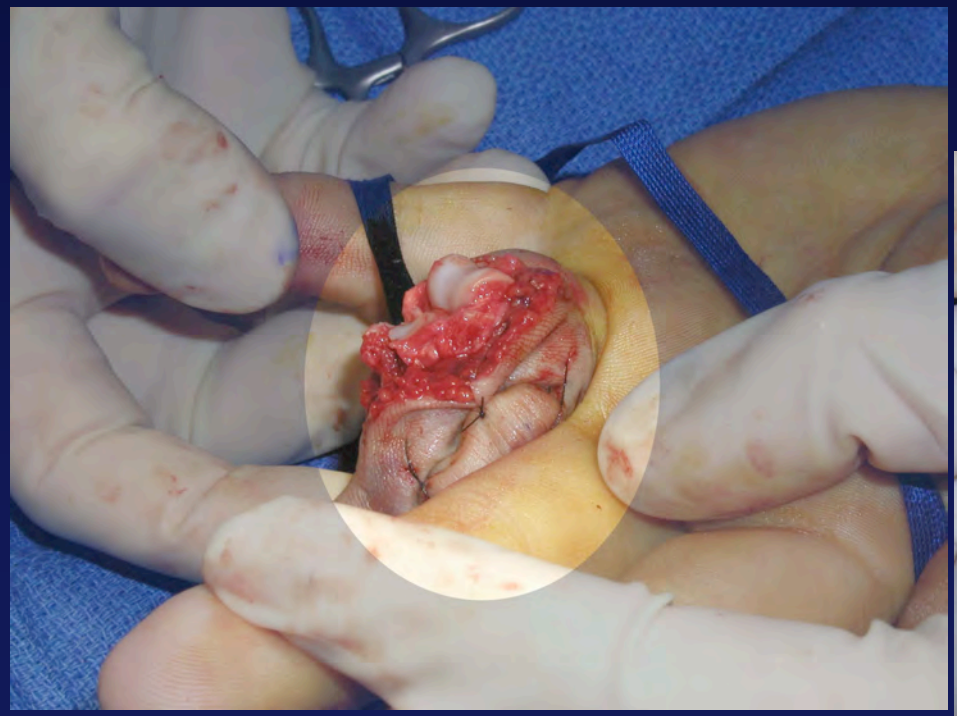
Anterior approach : Shotgun

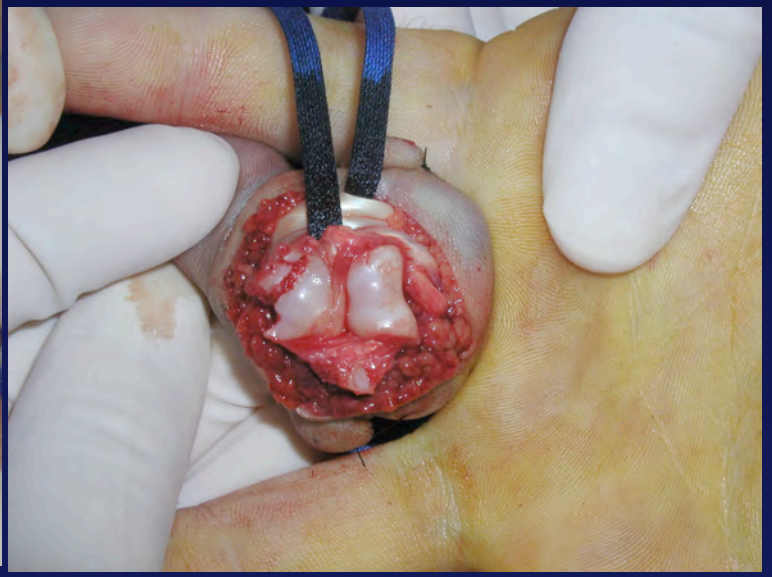
- Release
  of the palmar plate
- Excision
  of the lateral ligaments



Anterior approach Shotgun

The middle phalanx is « Shoe-horned » over the head of the proximal phalanx





Shotgun Anterior approach

Closure

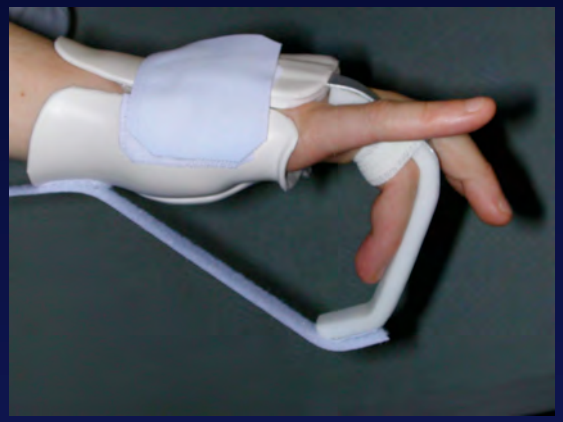
Treatment modalities for PIP fractures

- Extension-Block splinting
- Extension-Block pinning
- Temporary K wire fixation
- Internal fixation
- Volar plate arthroplasty
- Dynamic external fixator
- Vascularized transfer
- Radical procedures

Extension-Block splinting

Extension-Block splinting

- Dorsal splint
- Incorporated in a gauntlet
  - Metacarpo-phalangeal flexion
  - Progressive PIP extension

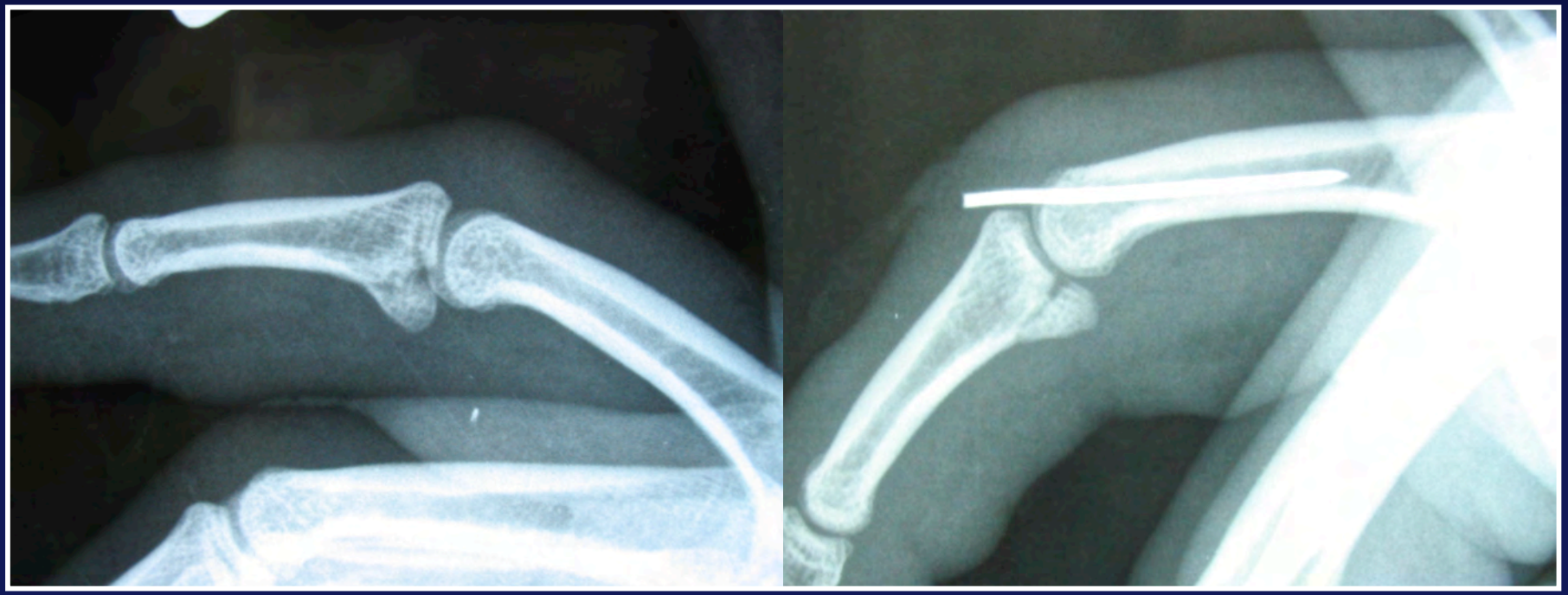


MCElfresh 1972

Extension-block pinning
« Doorstop procedure »

Sugawa 1979

- *Inoue 1991*
- *Viegas 1992*
- *Twiman 1993*

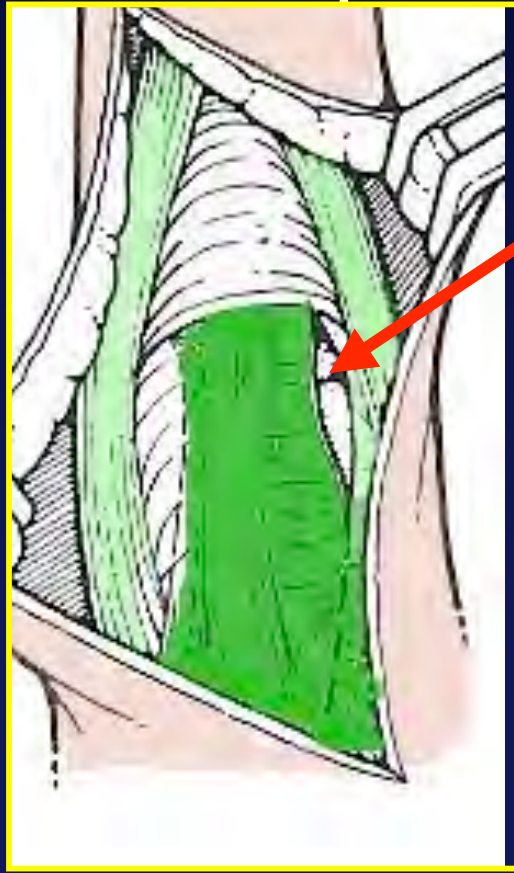


Extension-block pinning

« Doorstop procedure »

Sugawa 1979

Technique



- Under Fluoroscopy
- 1.2 mm K-Wire
- On one side of the central slip

- Full flexion
  before wire insertion
  to avoid any tenodesis effect

Extension-block pinning

Extension-block pinning
« Doorstop procedure »

Advantages

- Simple
- Poorly invasive
- Avoids recurrent subluxation (>30%)

But : infection is potentially severe (intra-articular)

Daily pin care
Regular follow-up

Removal after 3 to 8 weeks

Trans articular pin fixation

or static external fixator

Bunnell 1956
Boyes 1964
Spray 1966
Milford 1971

Stabilization in 20 to 40° flexion
Retained for 3 weeks

Propensity to stiffness

Good results at 16 years
Mean 85° *Newington 2001*

Trans articular pin fixation

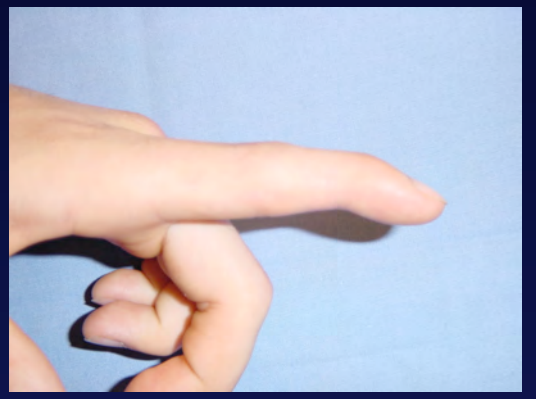
or static external fixator

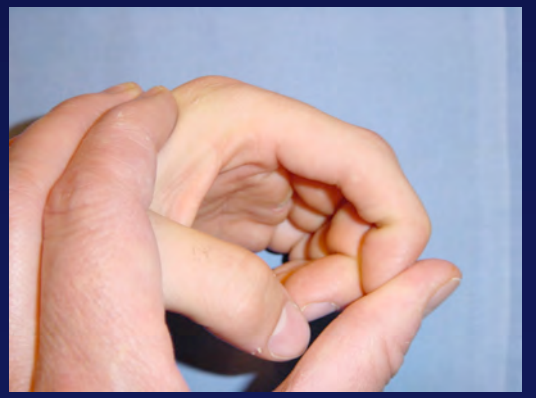
- For protection of a internal fixation

Trans articular pin fixation

or static external fixator

Pitfalls :





Incomplete reduction

Insufficient DIP mobilisation

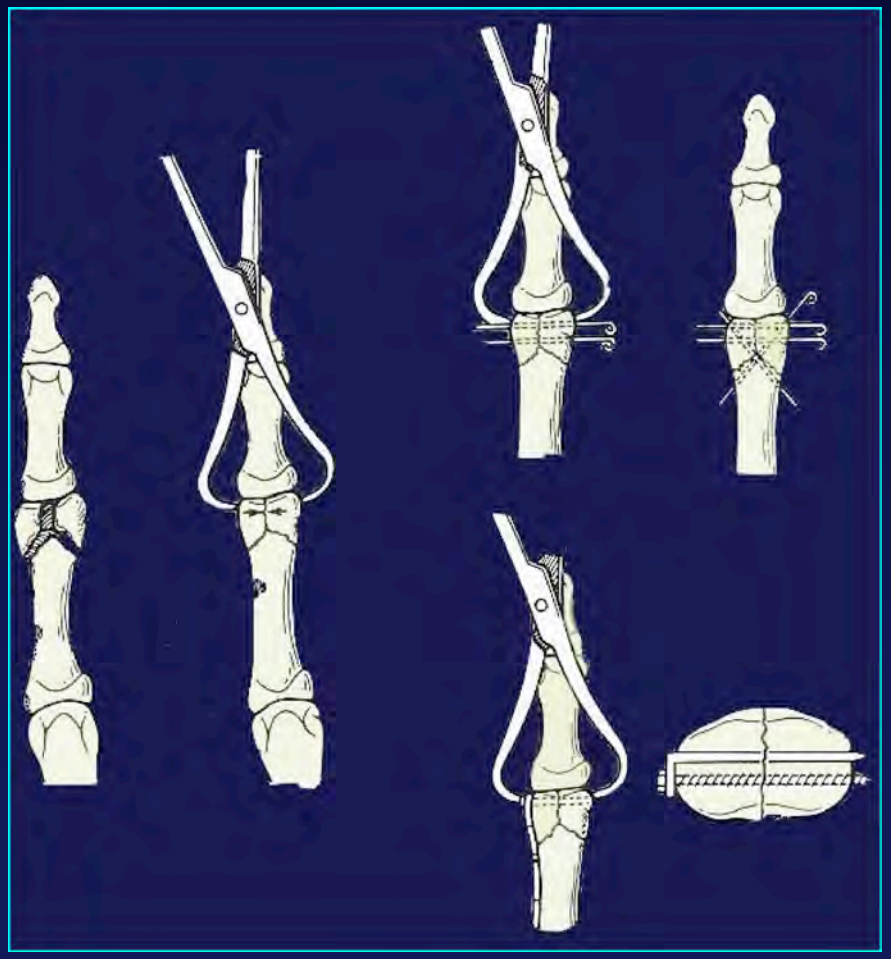
To late removal

Essential guidelines
for
Internal fixation :

- Specialized surgery
- Protection of the skin
- Protection of the extensor tendon
- Preservation of bone vascularization

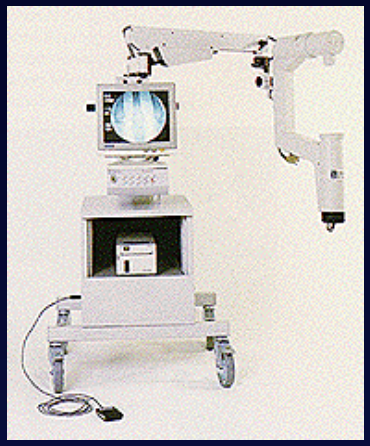
Essential guidelines
for
Internal fixation :

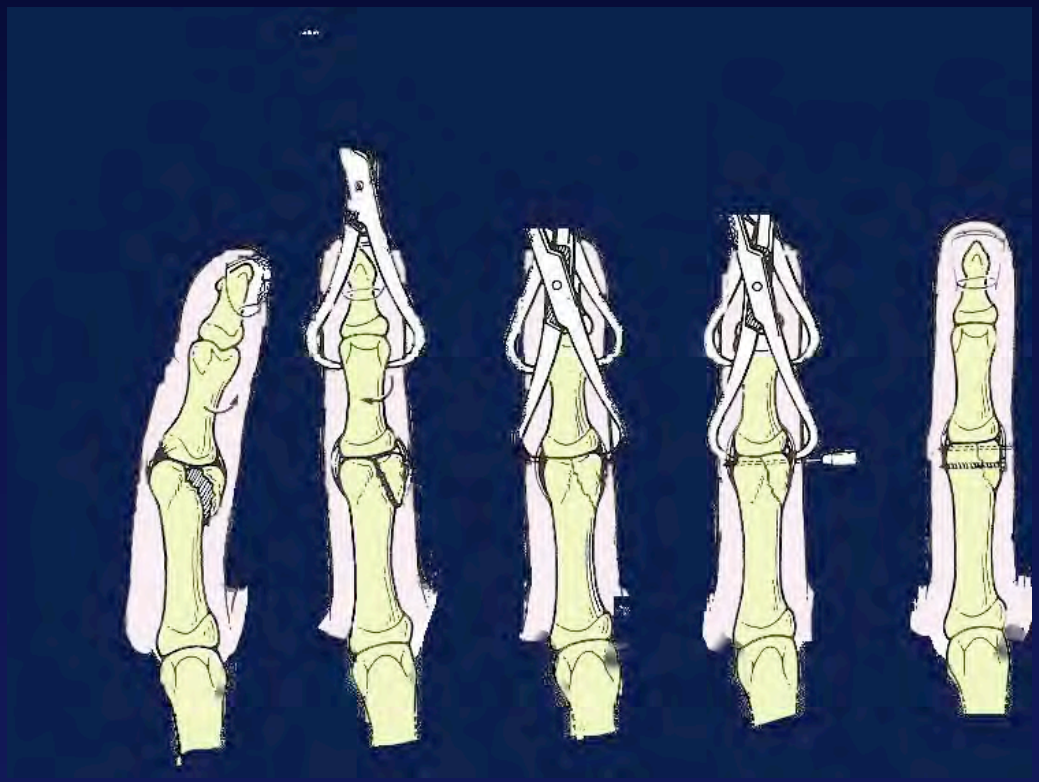
Open surgery



- K wires
- Screws
- Plates

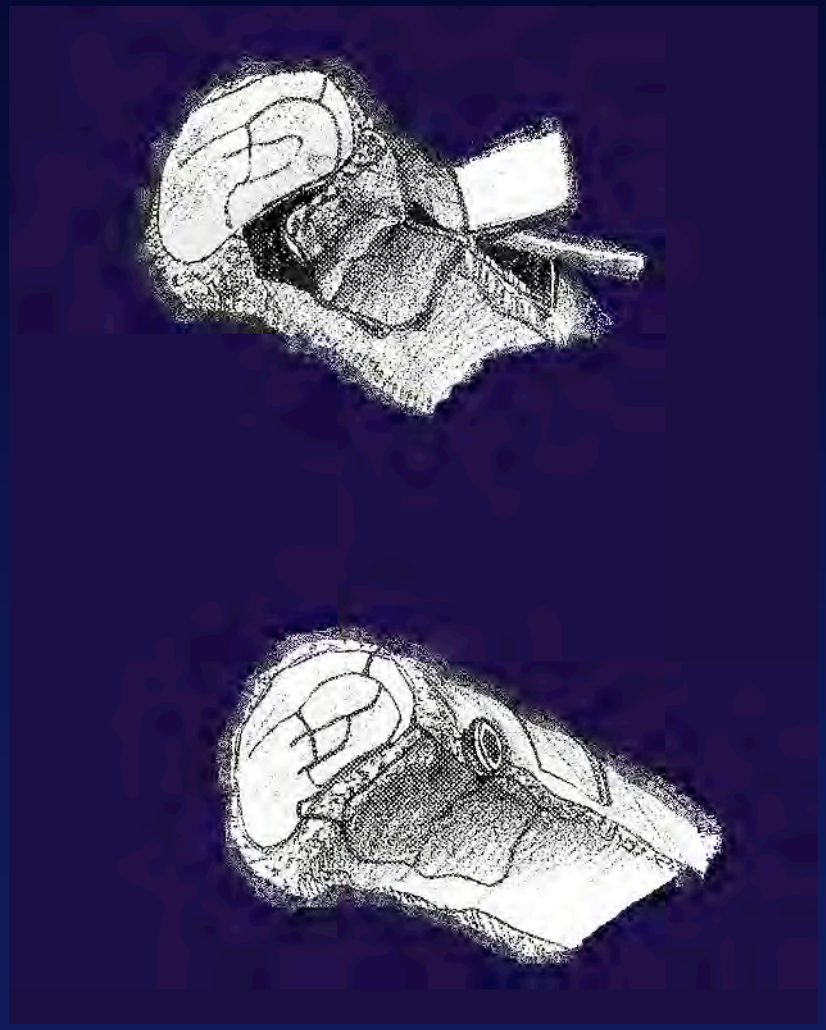
Essential guidelines
for
Internal fixation :

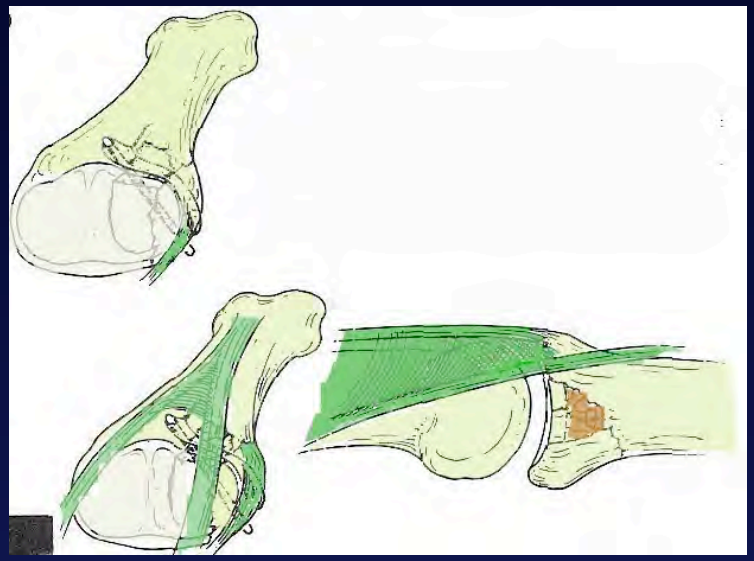


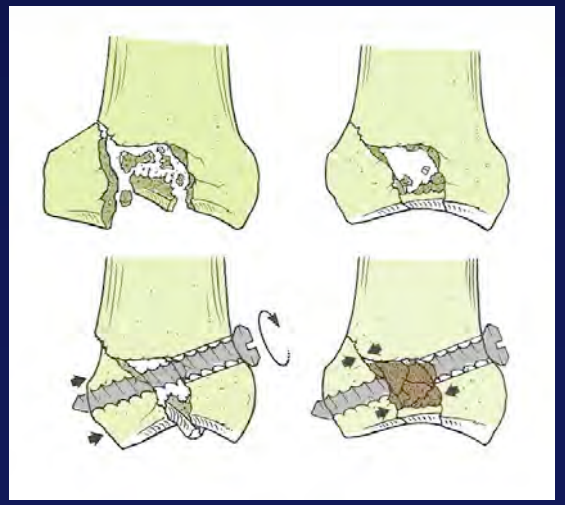


Closed K-Wire fixation

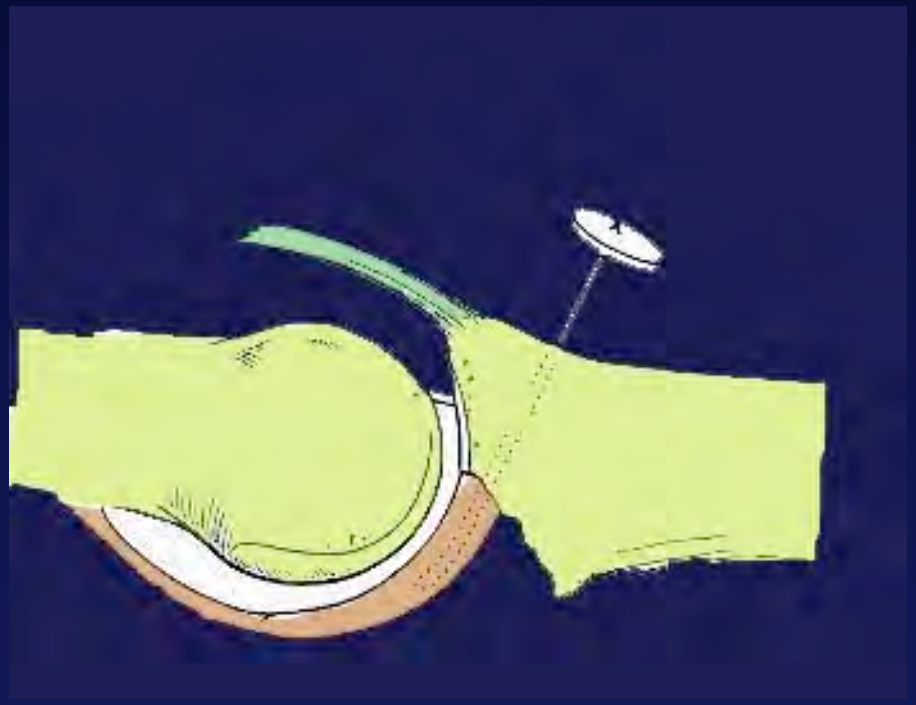
Bone grafts







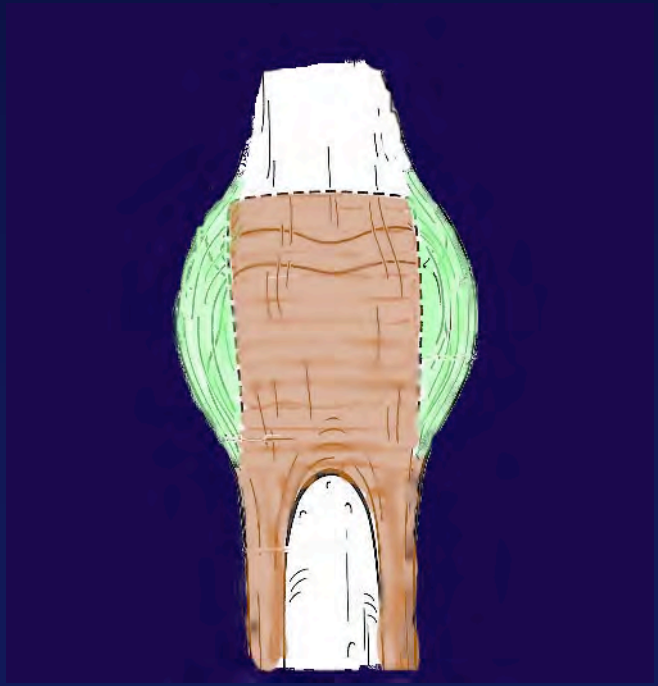
Volar plate arthroplasty

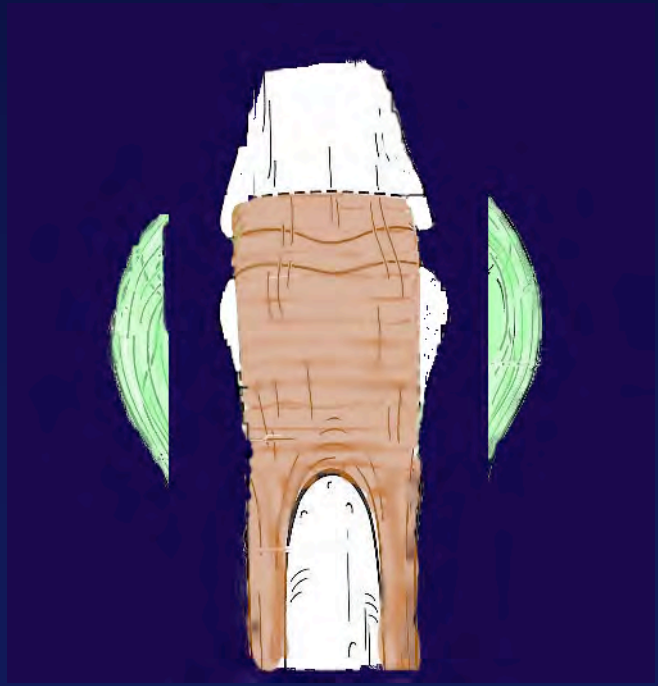


Eaton 1980

Volar plate arthroplasty

- Release of the palmar plate
- Excision of the lateral ligaments



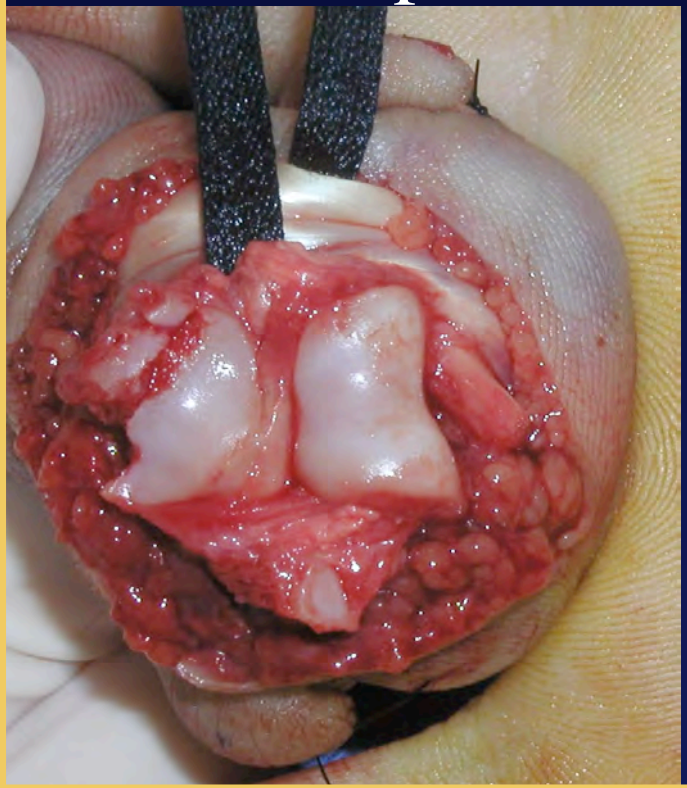


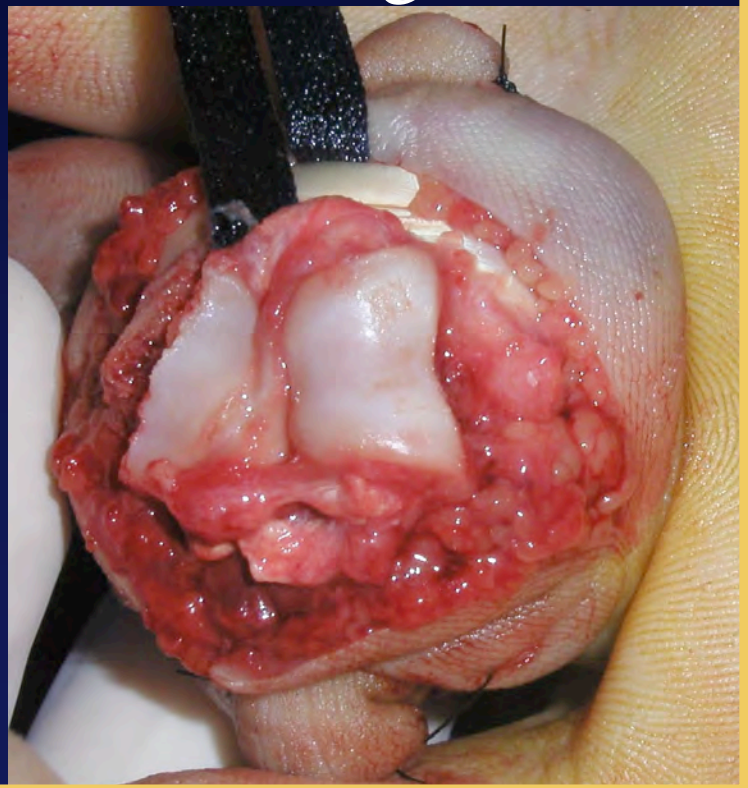
Volar plate arthroplasty

- Release of the palmar plate
- Excision of the lateral ligaments

Volar plate arthroplasty

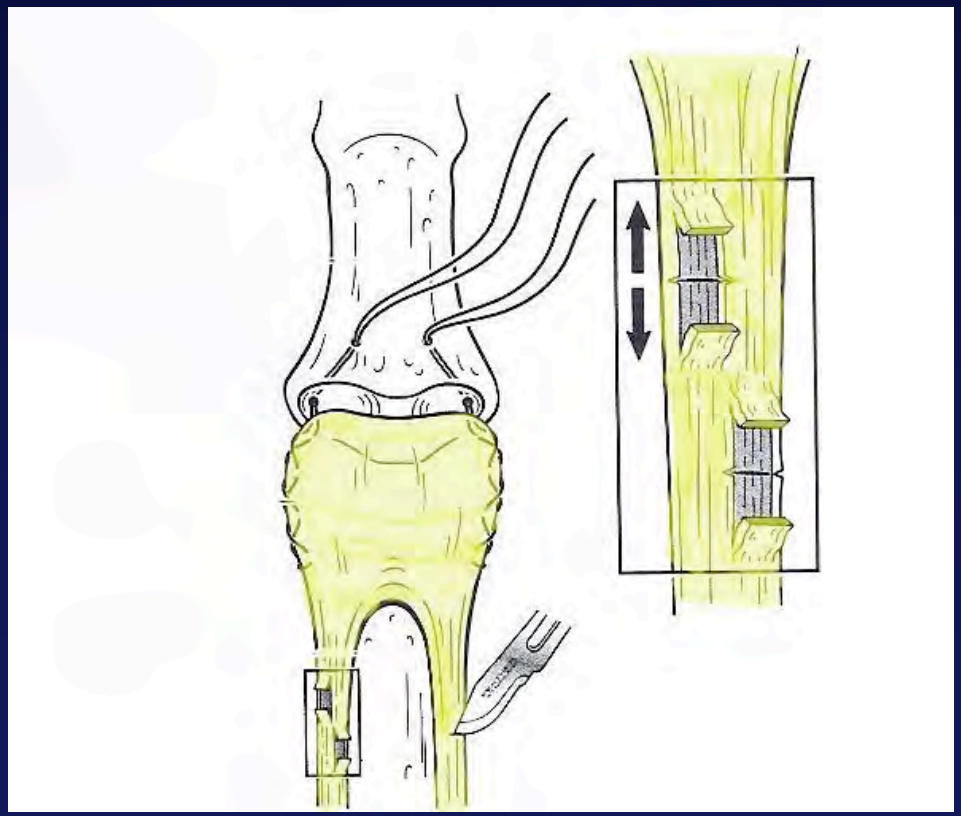
Preparation of a symetric trough





Volar plate arthroplasty

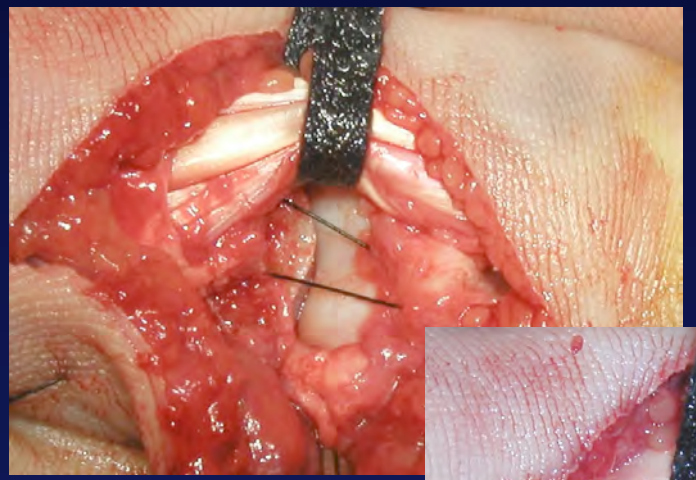
- Lengthening of the Check Reins



Blazar 2001

Volar plate arthroplasty

- Palmar plate advancement and fixation



Anchor

or

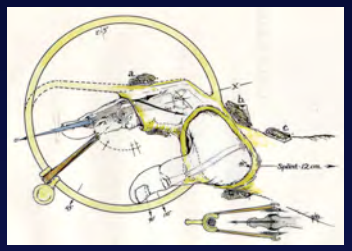
Pull out

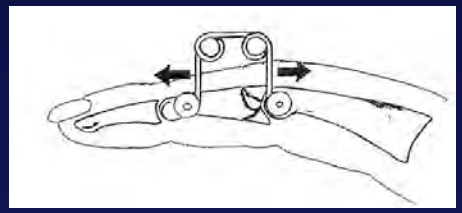
Volar plate arthroplasty

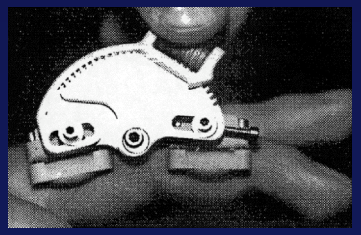
- Reduction is checked fluoroscopically
- Complementary stabilisation
  - Extension-Block splinting
  - Extension-Block pinning
  - Temporary K wire fixation
  - Dynamic external fixator

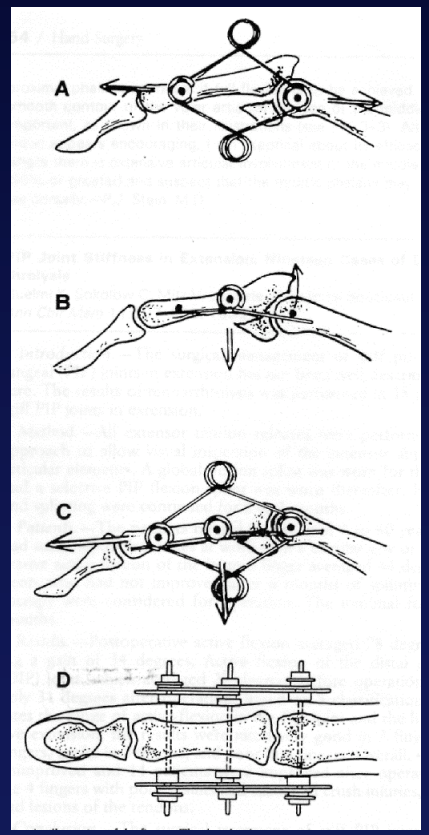
Dynamic external fixators

- Agee 1978
- Schenck 1986
- Inanami 1993
- Susuki 1994
- Allison 1996
- Compass hinge (Krakauer 1996,Bain 1998, Feldscher 2002)
- Duteille 2003
- Syed 2003









Dynamic external fixator

- Goals of the treatment
  - No surgical approach (adhesion -vascularization)
  - Concentric joint reduction
  - Ligamentotaxis
  - Early mobilization
  - Remodelling

- No reduction of impaction

« Pins & Rubbers »
Technical procedure

Susuki 1994

- Simple
- Light
- Cheap
- Easily available components

- Allows postop X Ray control

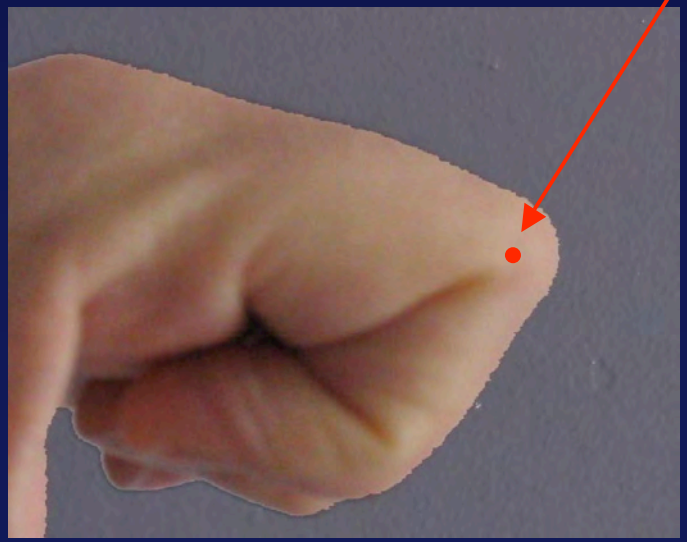
« Pins & Rubbers »
Technical procedure

Susuki 1994

2 parallel K-wires

Axial traction pin : 1,2 mm Center of motion

Hook pin : 1,0 mm



« Pins & Rubbers »
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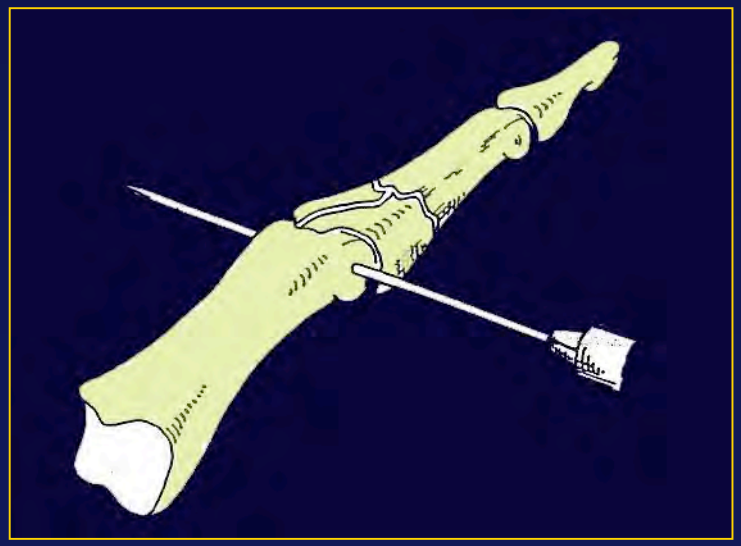

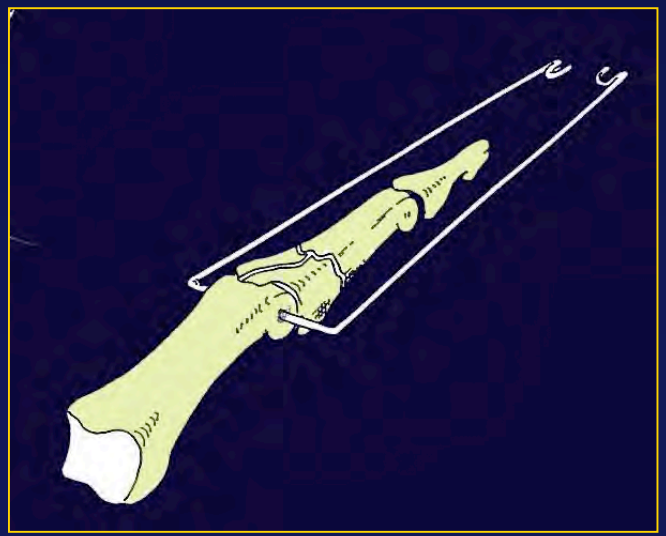

« Pins & Rubbers »
Technical procedure

Susuki 1994

2 parallel K-wires

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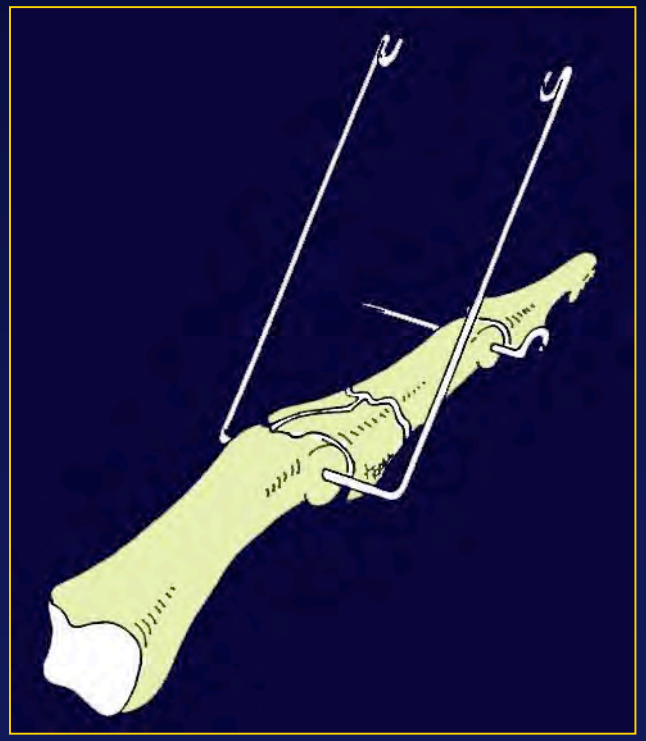


« Pins & Rubbers »
Technical procedure

Susuki 1994

Application

of

the rubber bands

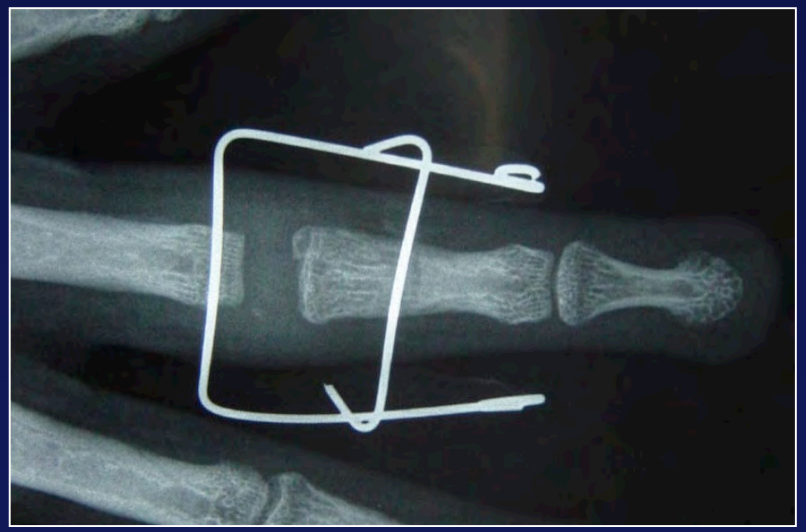
« Pins & Rubbers »
Technical procedure

Susuki 1994

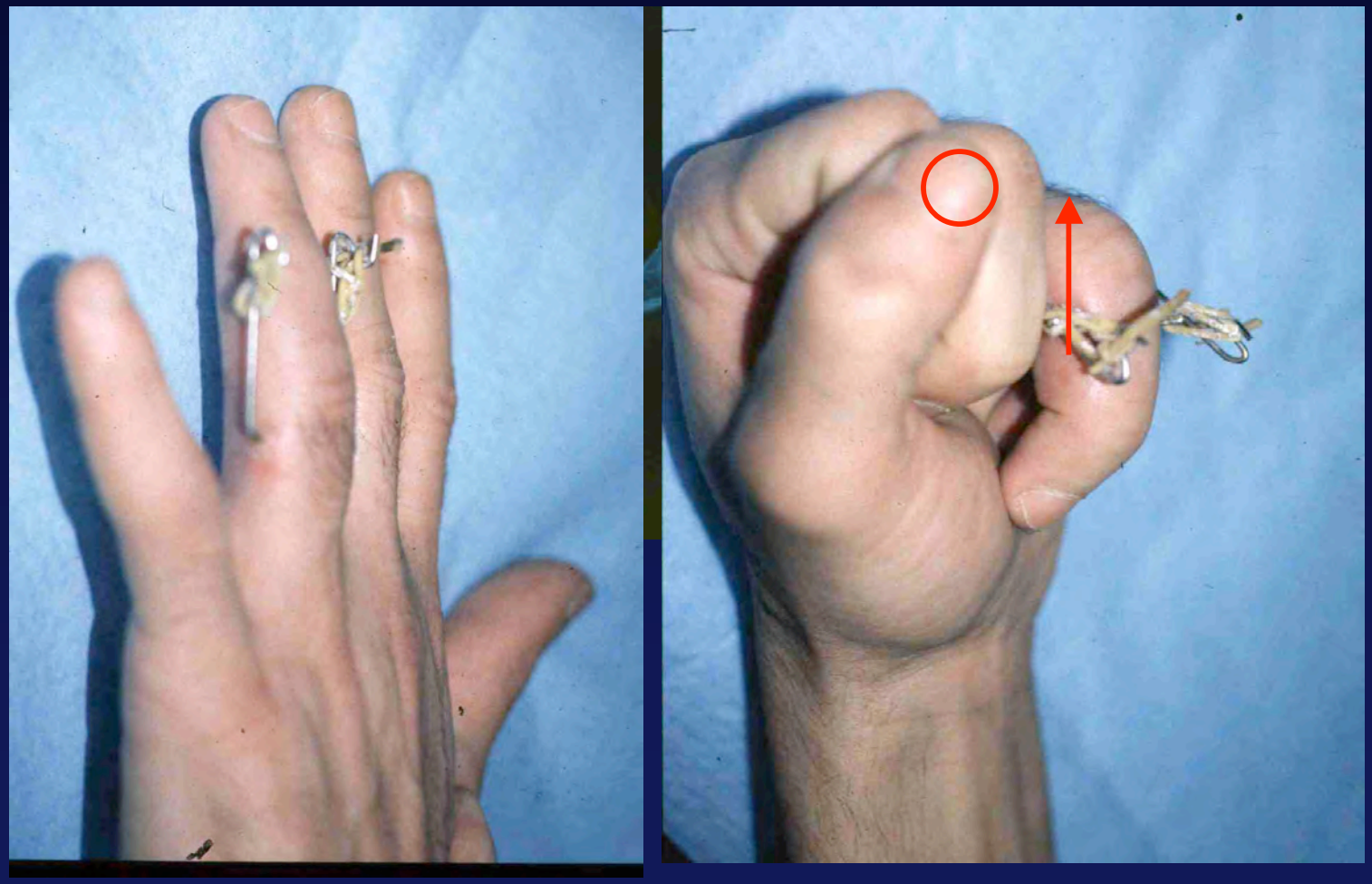
Application of rubber bands

Distraction and reduction

checked radiographically



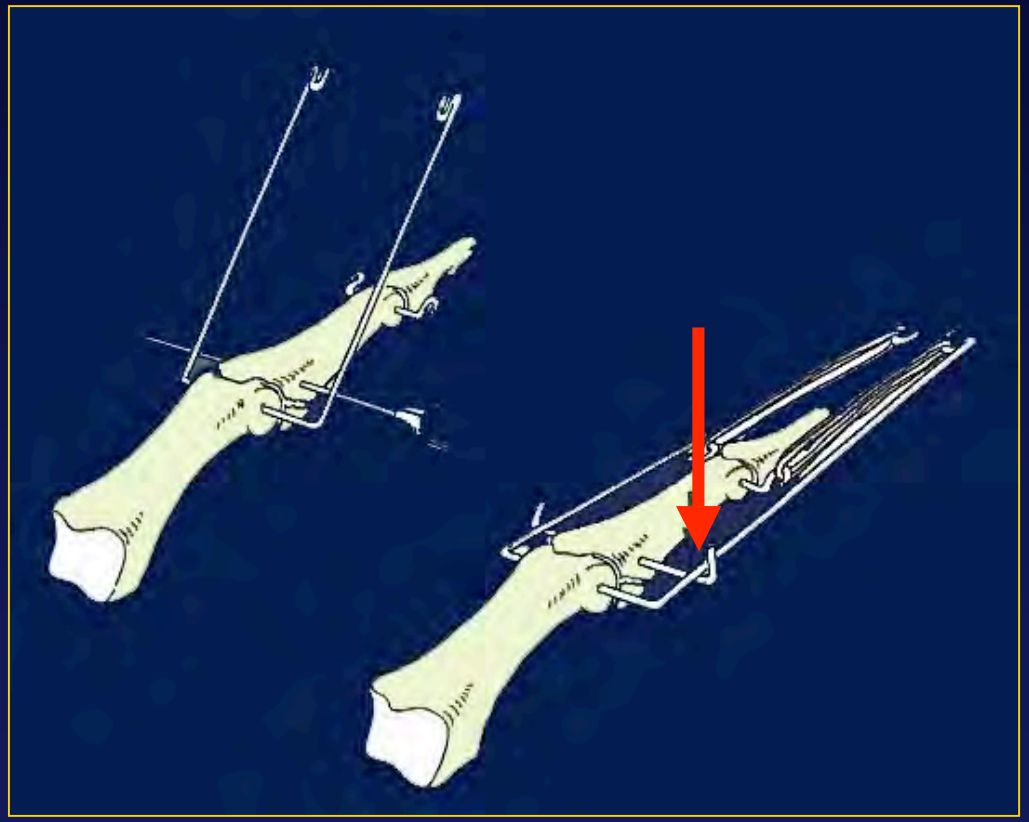
« Pins & Rubbers »
Technical procedure



Prevention of dorsal subluxation

Reduction pin

Base of the middle phalanx



Immediate mobilization

Daily pin care

indoor ? *Duteille 2003*

Removal between 3 and 8 weeks

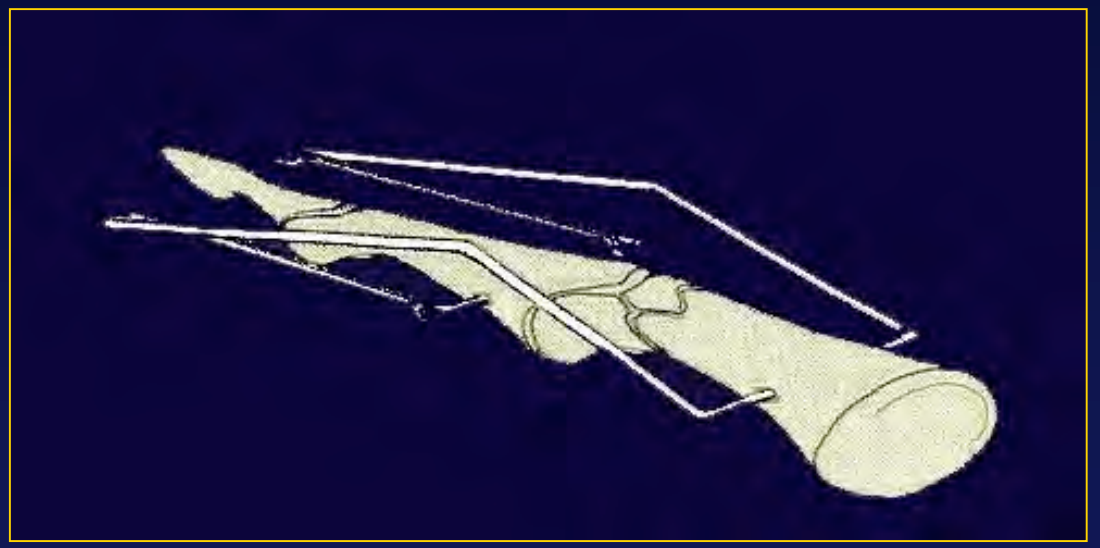
Results

PIP ROM :
> 80° mobility on average

- *Chahidi* *2003*
- *Inanami* *1993*
- *Susuki* *1994*
- *Morgan* *1995*
- *De Soras* *1997*
- *De Smet* *1998*
- *Duteille* *2003*

For P1 fractures ?

- *De Soras 1997*
- *Duteille 2003*

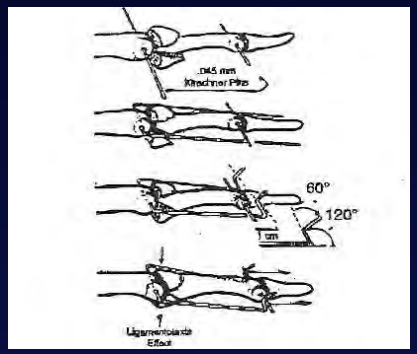


Inversed Push-pin device

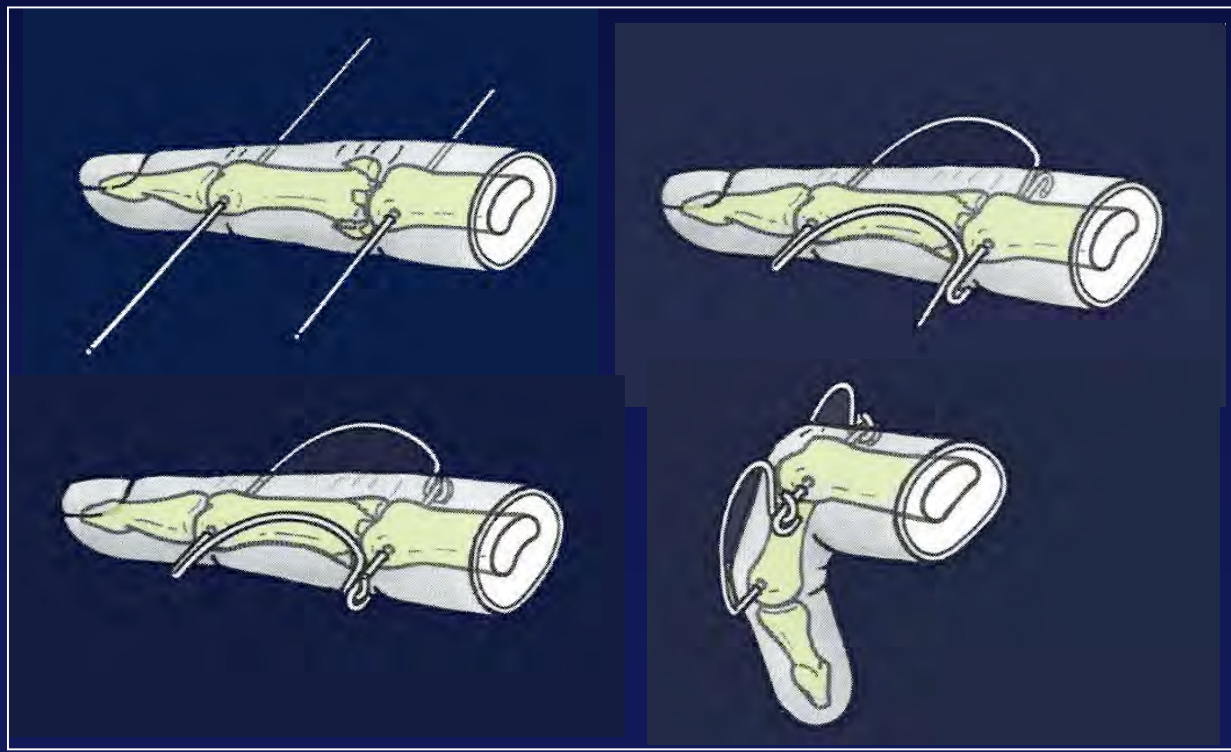
Syed 2003

8 pilon fractures

No infection



Gaul 1998



No rubber-band

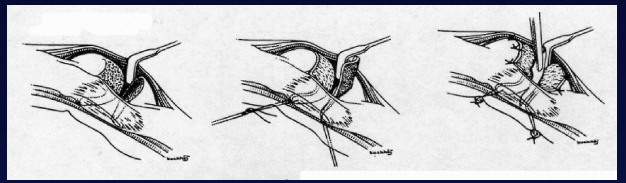
Less cumbersome

Unlikely to break

Radical procedures

- Joint fusion
- Arthroplasties
- Silicone arthroplasty

Cartilage defect



- Perichondrial resurfacing
- Non vascularized osteo-chondral grafts ?
  - hemiarthroplasties
  - Small fragments
  - Synovial preservation
  - Innervation

Rinaldi 1976, Gill 1915, DePalma 1962, Campbell 1963, Menon 1983

- Silicone prosthesis
- Vascularized articular transfer

Vascularized toe transfer

Vascularized toe transfer

Indications
for conservative treatment

Proximal phalanx

– Undisplaced Fractures ?

– Comminutive Fractures

Indications for conservative treatment

Middle phalanx

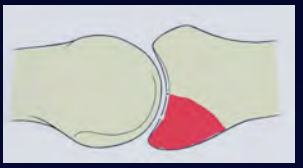
- Undisplaced fractures
- Impaction < 30% with concentric joint
- Complementary to surgery

Indications for surgery

- Open fractures
- Central slip injury
- Flexor tendon injury

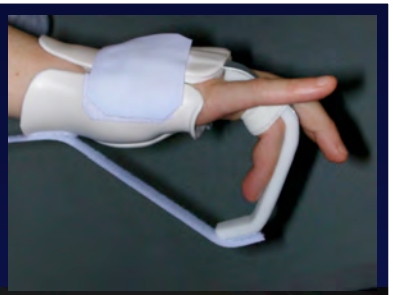
Joint instability

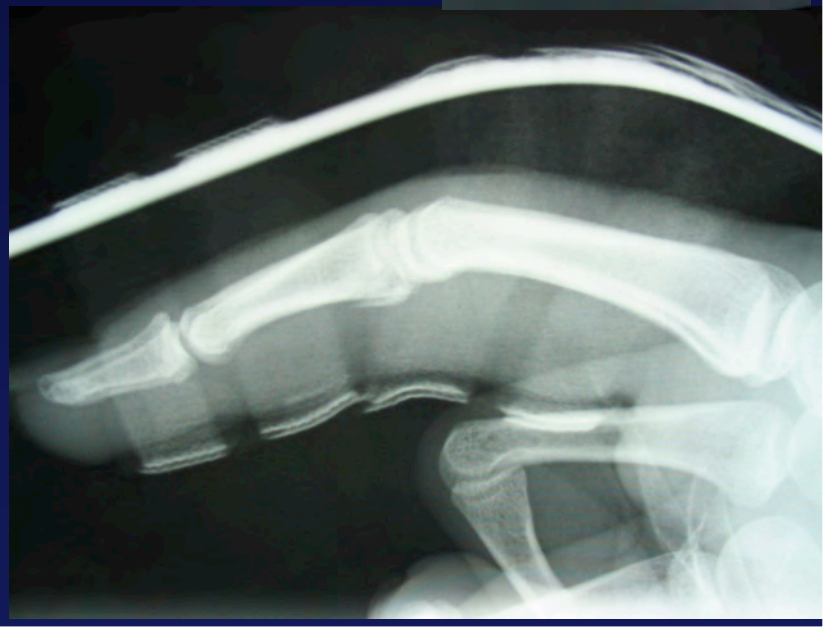
Palmar Base of the middle phalanx



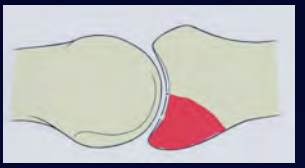
30% to 50 % (and unstable)

Attempt to conservative treatment



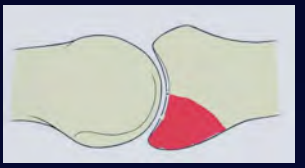


Palmar Base of the middle phalanx
30 à 50%



Conservative treatment

Palmar Base of the middle phalanx
30 à 50%

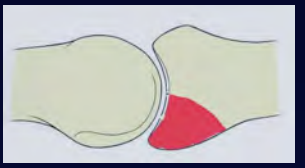


In case of conservative treatment failure

- Large fragment : internal fixation

- Comminutive fragments :
  - Dynamic external fixators
  - Volar plate arthroplasty

Palmar Base of the middle phalanx
30 à 50%

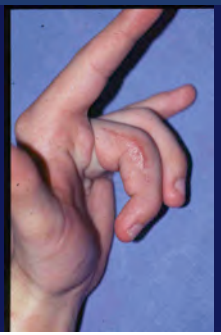


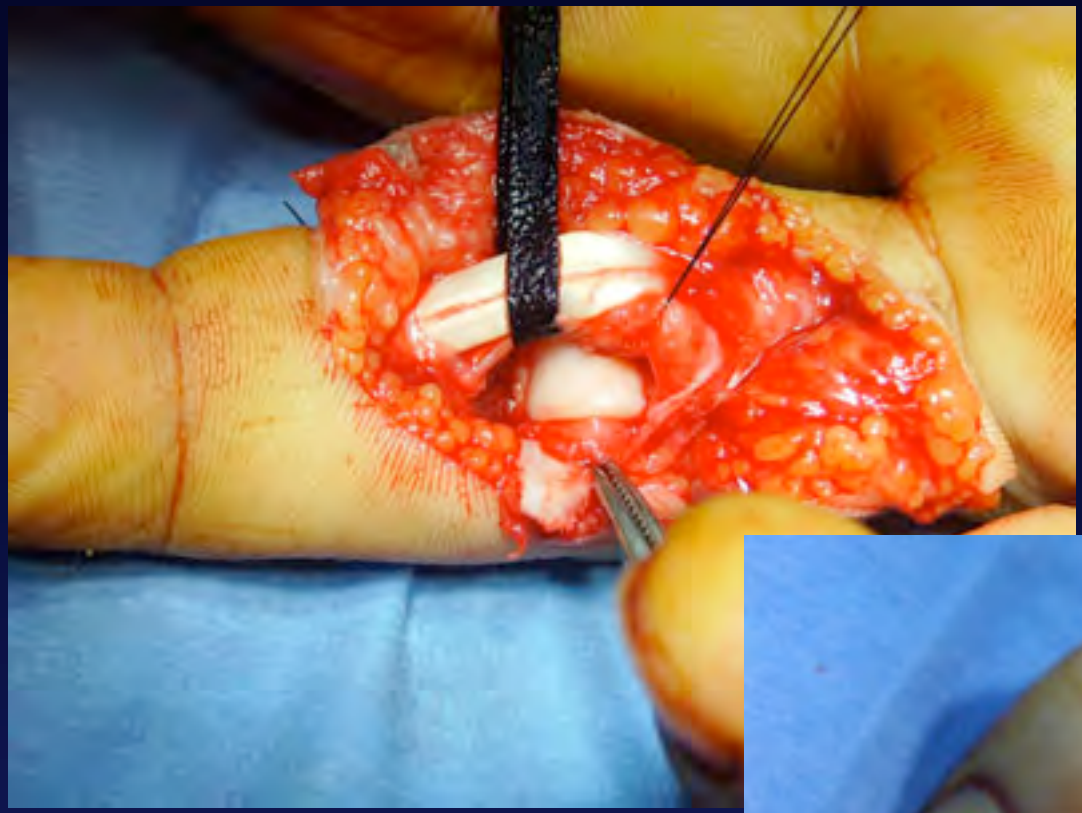
Internal fixation

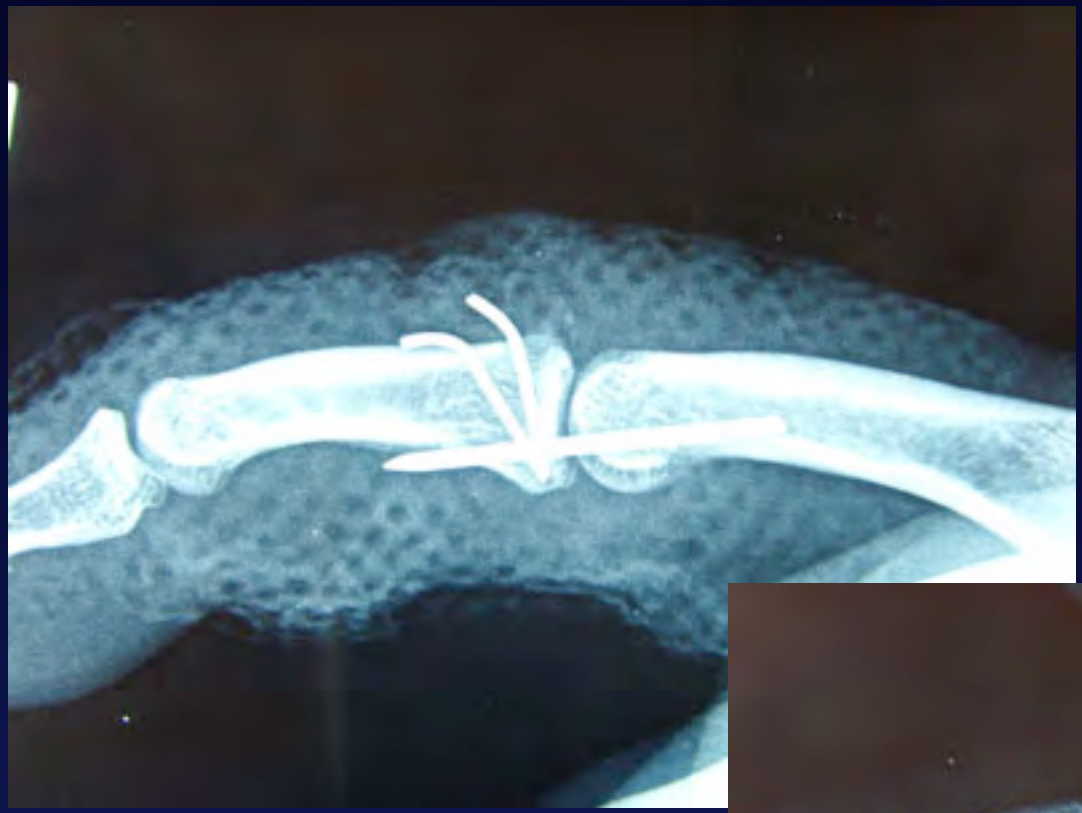
- Lateral approach with distraction
- or Anterior approach

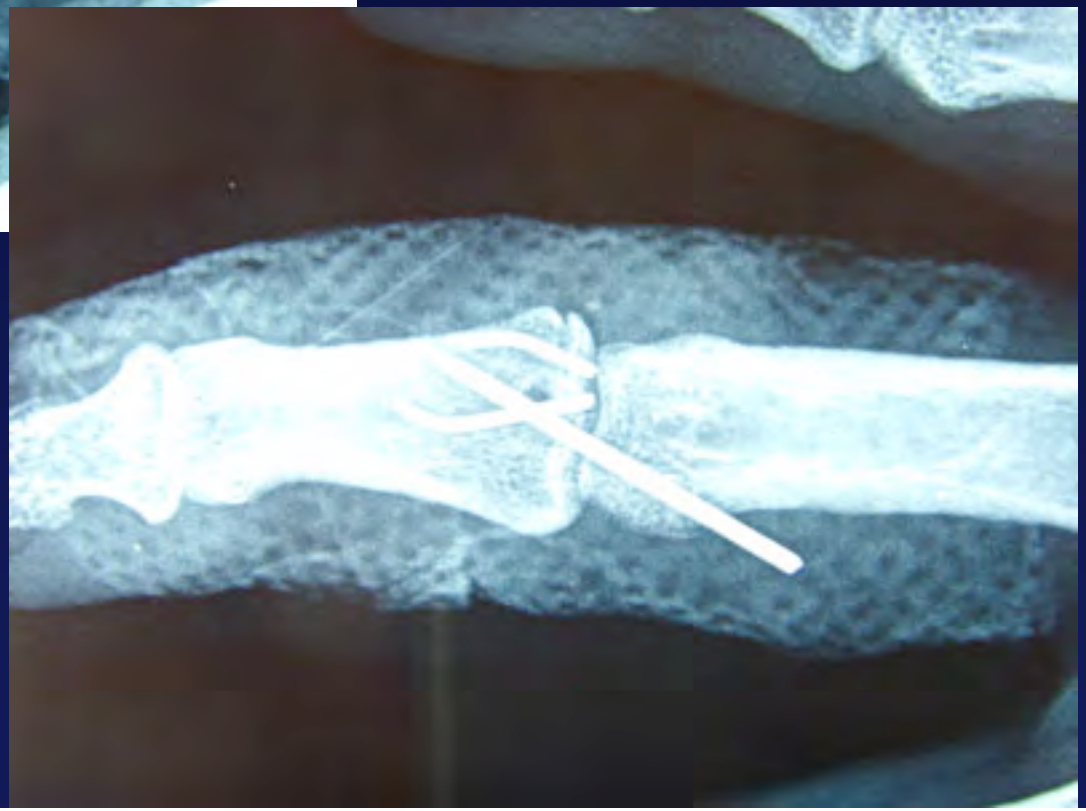
- Desimpaction +- graft
- Complementary Stabilisation

Difficult operation





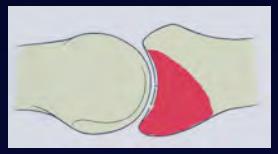




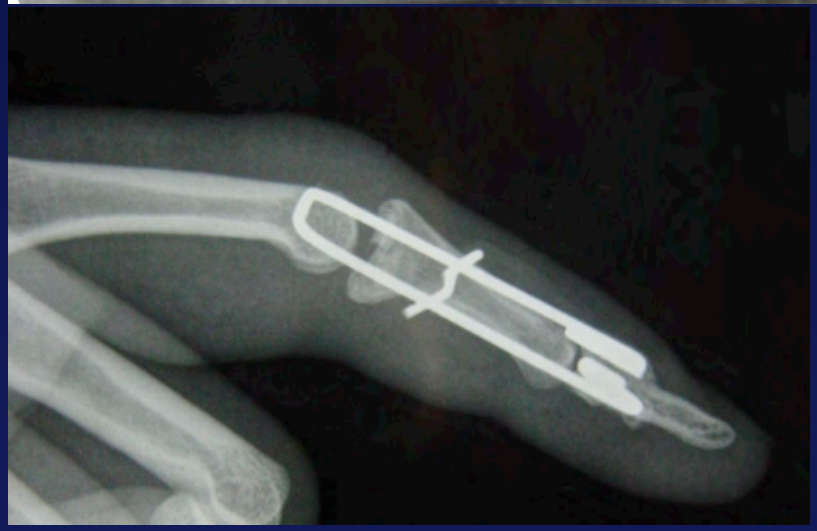
When internal fixation is not possible

30 to 50%

or > 50%



Dynamic external fixator



+ Restoration of Congruency

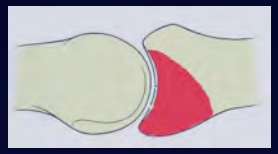
Volar buttress

No Impaction reduction

When internal fixation is not possible

30 to 50%

or > 50%

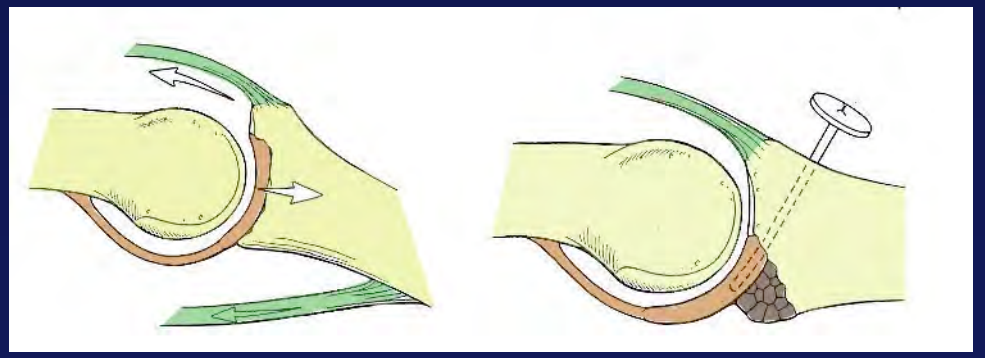


Volar arthroplasty +- bone graft

+ Restoration of

Congruency

Volar buttress



Shaft fixation + Volar arthroplasty

1. Dorsal approach

→ Shaft internal fixation

2. Anterior « ShotGun »

→ Volar arthroplasty

Shaft fixation + Volar arthroplasty

- Extension block splinting

- Immediate rehabilitation

When internal fixation is not possible

hemi-hamate autograft

13 cases

- Mean follow-up 16 months
- Average ROM : PIP 85 DIP 60

Williams 2003

Dorsal fractures *of* the base of the middle phalanx

Internal fixation when :

> 20% or displaced > 2 mm

P2 Fractures Pilon
no spared dorsal cortical

- Splintage
- Internal fixation
- Dynamic traction

Condylar fractures *of* the proximal phalanx

- Closed pinning
- Or Internal fixation

2 K-Wires or screws

Condylar fractures *of* the proximal phalanx

<u>Prefer</u>

< 2 mm screws

2 screws

Bicondylar fractures *of* the proximal phalanx

Always internal fixation

Basics for rehabilitation

- Early mobilization
- MP and DIP
- Adjacent fingers

Dynamic splint after 3 weeks

Long term results

Complete recovery is exceptional

- Residual swelling
- ROM limitation (PIP and DIP)
- Mal union
- Necrosis
- Non union
- Cold intolerance

Post-traumatic arthritis is rarely symptomatic

Long term results

Conclusion (IPP)

- Condylar fracture of the proximal phalanx :
  - Anatomical repair

- Palmar base fracture of the middle phalanx :
  - Articular surface management
  - Stabilization and early mobilization

Conclusion

Palmar base fracture
of the
middle phalanx

1. Reconstruction of the anterior buttress
   Internal fixation
   Volar plate arthroplasty
   Dynamic traction

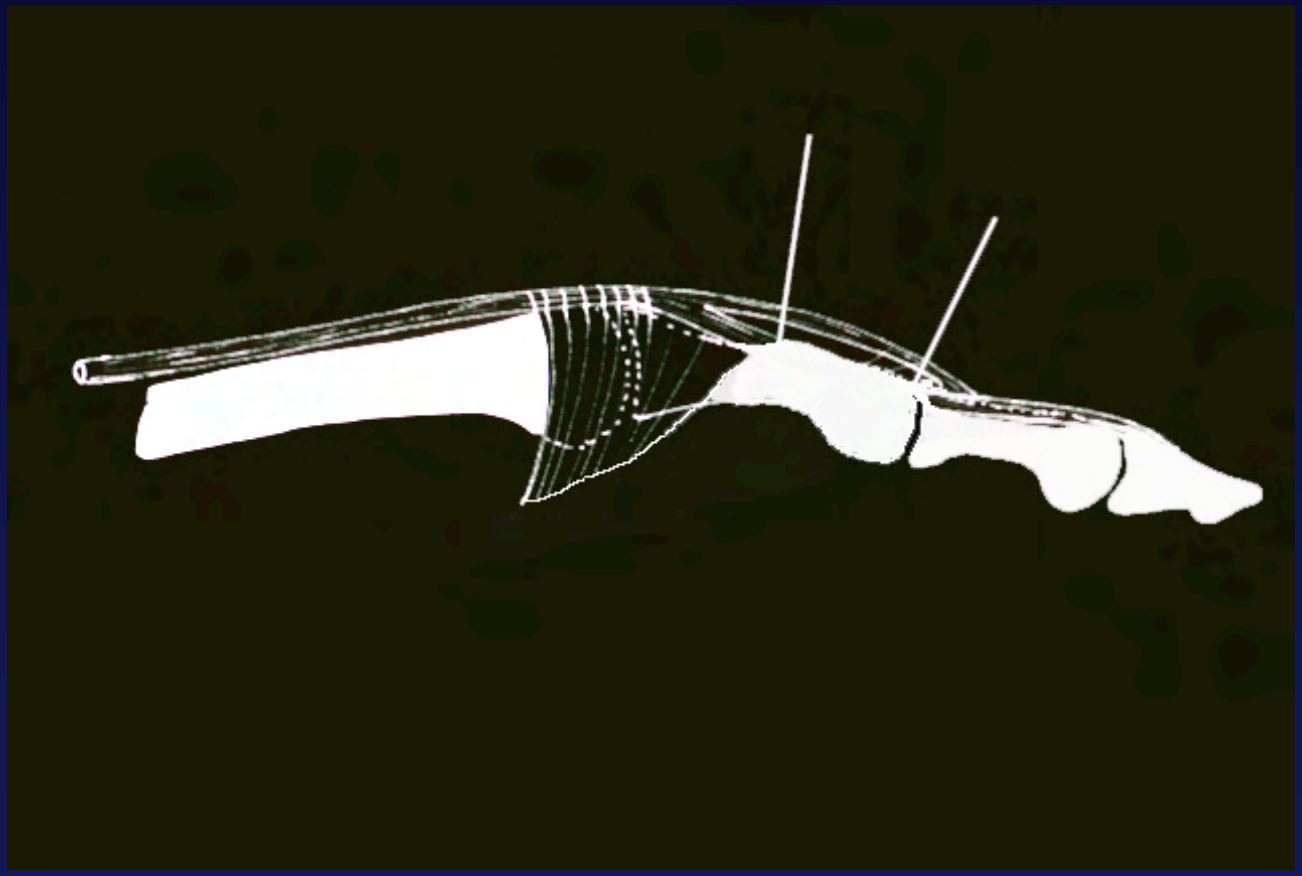
Stabilisation

2.Stabilisation
Trans articular pinning
Extension -block pinning
Extension-block splinting
Dynamic traction

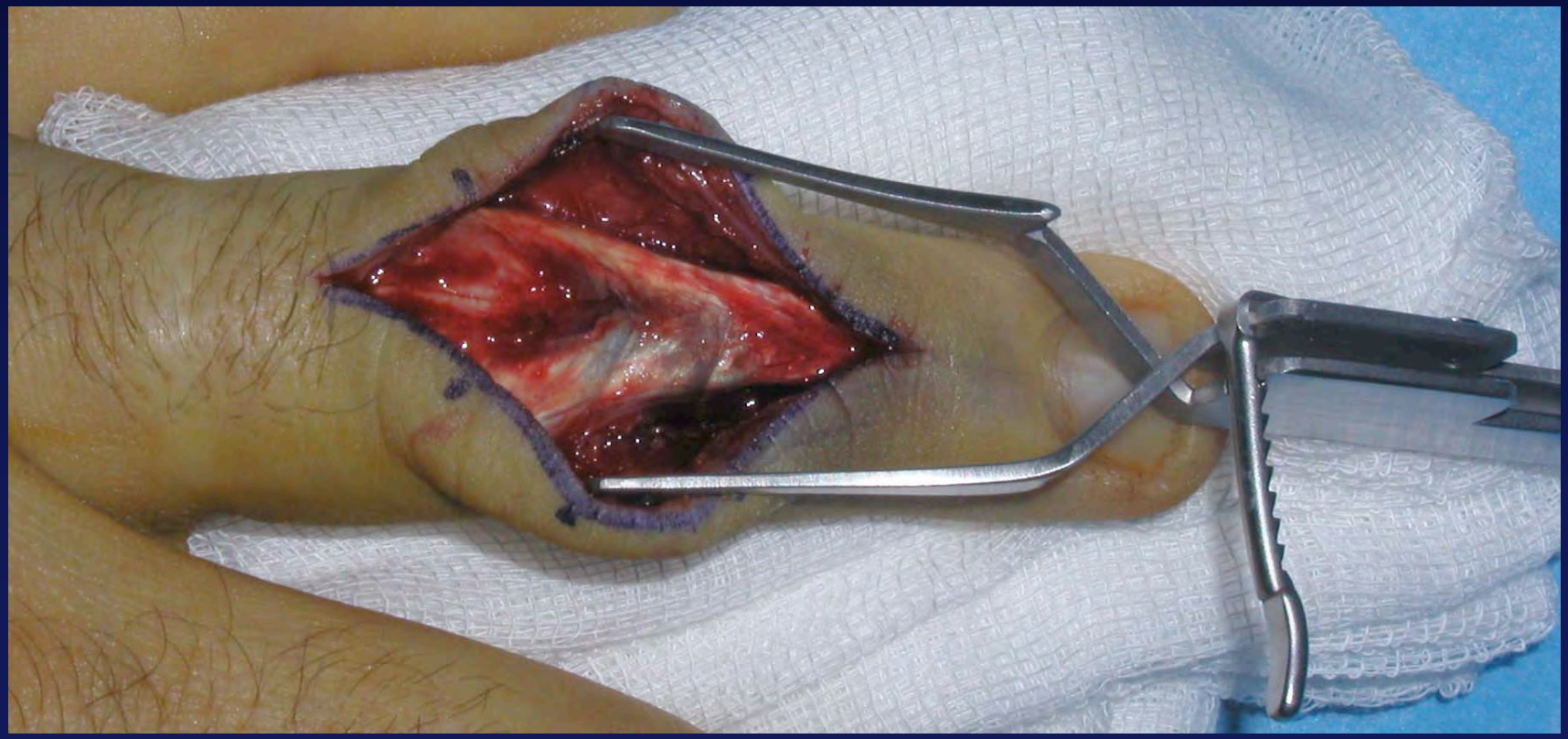
Mobilisation

Middle Phalanx Shaft fracture

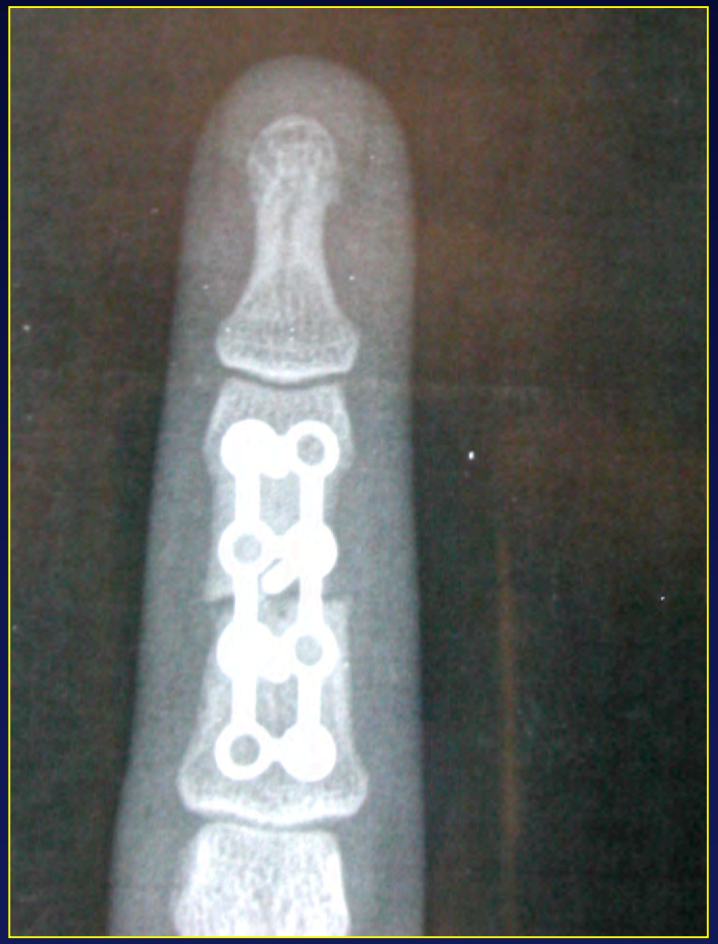
Middle Phalanx Shaft fracture



Middle Phalanx Shaft fracture



Middle Phalanx Shaft fracture



Stable bone fixation
Early rehabilitation

Middle Phalanx Shaft fracture

Middle Phalanx Shaft fracture

Middle Phalanx Shaft fracture

Amputations trans P2

DIP fracture- Distal P2

Orthopaedic stabilization

DIP fracture

Surgical fixation

DIP fracture- dorsal instability

DIP fracture - Mallet fracture

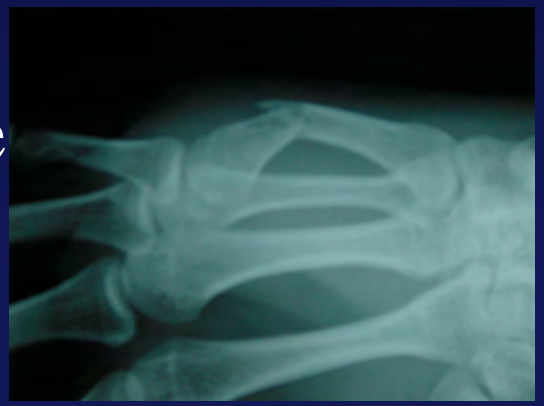
DIP fracture - Lateral impaction

Metacarpal fractures

- III & IV : stable

- II & V
  Mutliple unstable

  non displaced conservative
  displaced bone fixation



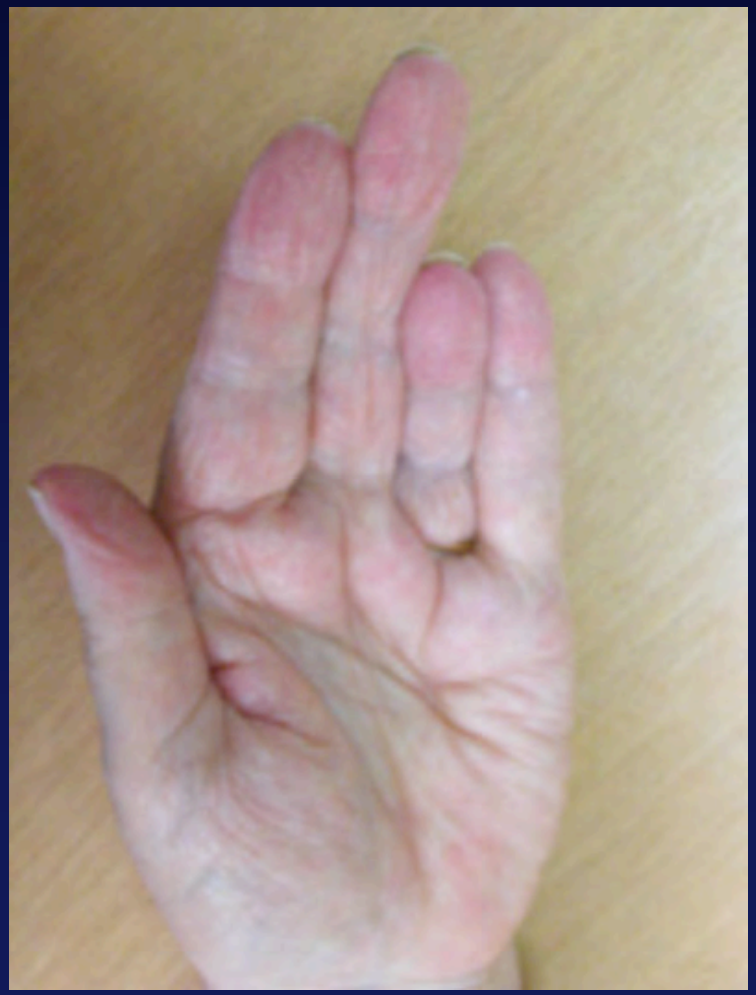
Metacarpal shaft fractures

Metacarpal shaft fractures

Metacarpal shaft fractures

Metacarpal shaft fractures

Metacarpal shaft fractures



Base of the fifth metacarpal

- Fracture-dislocation in almost every case
  - Intermetacarpal stabilization
  - Articular reconstruction

Base of the fifth metacarpal

Neck of the fifth metacarpal

- Conservative treatment
- Surgical treatment in select
  - Angulation > 60°
  - Open fractures
  - Rotational displacement

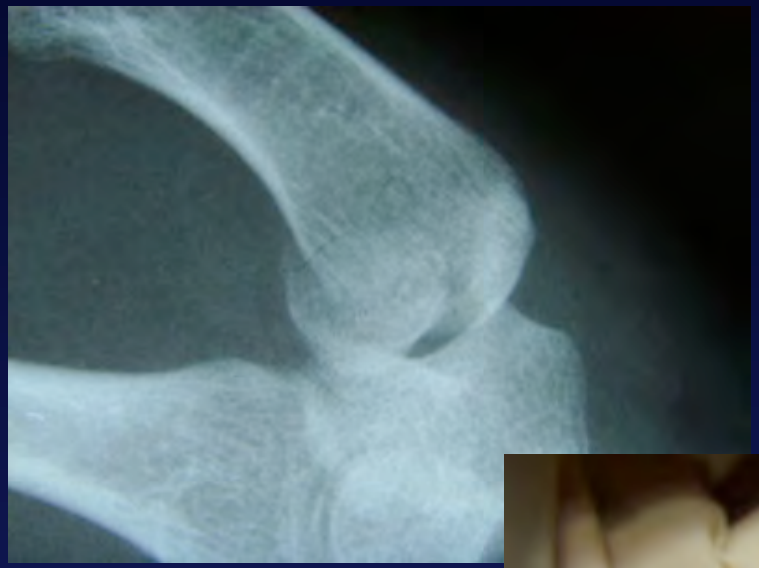
Neck of the fifth metacarpal

Neck of the fifth metacarpal

First metacarpal fractures

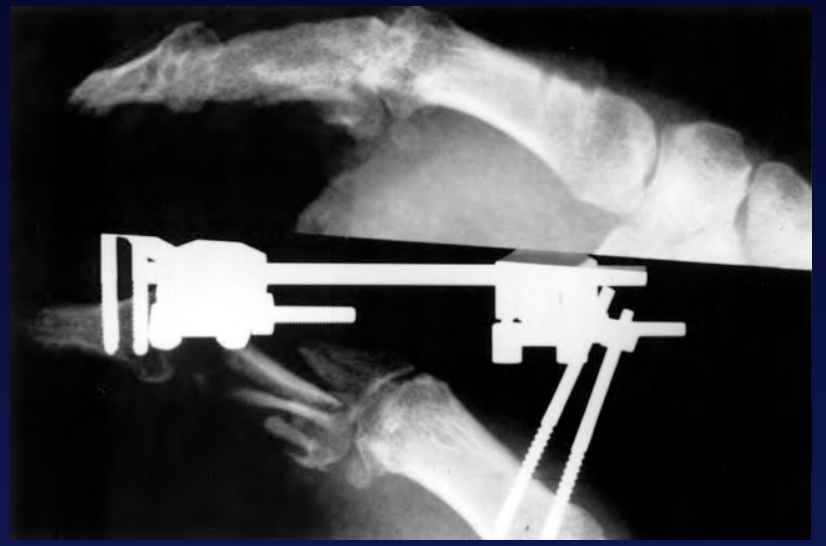
- Extra-articular
- Articular
  - Bennet fracture
  - Comminutive fracture

First metacarpal fractures



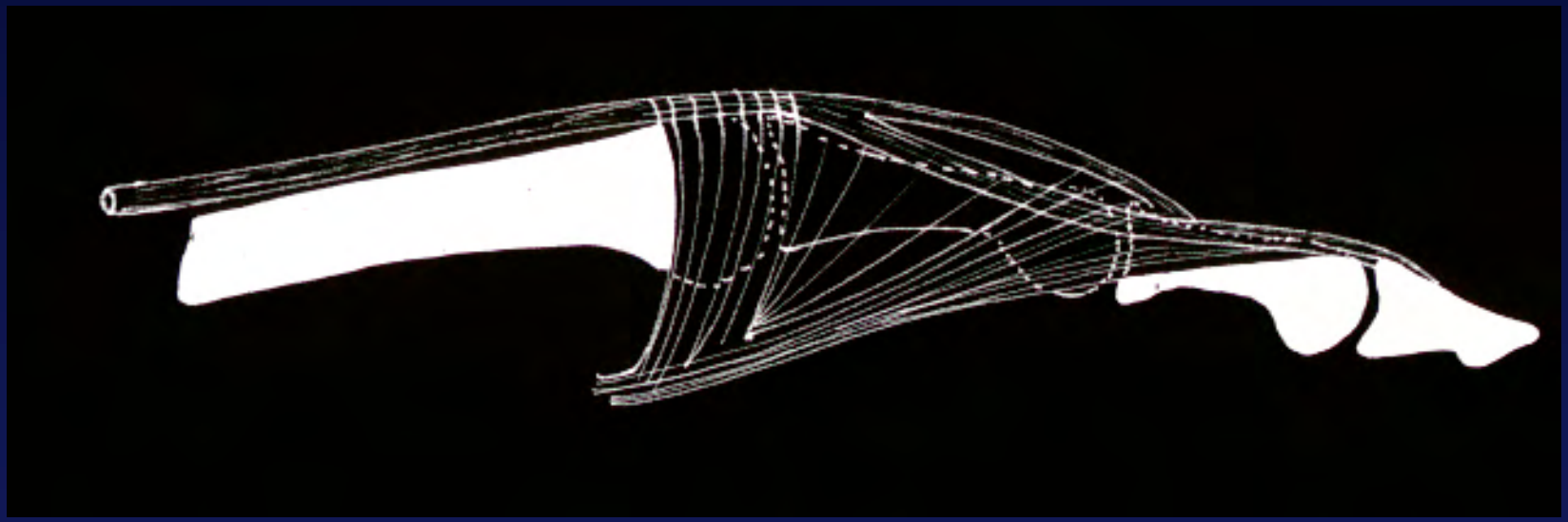
Advantages of external fixation

No surgical approach
Less bone
devascularization
Easy hardware removal
Good stability (Fitoussi 96)



External fixation

Where to put the pins?

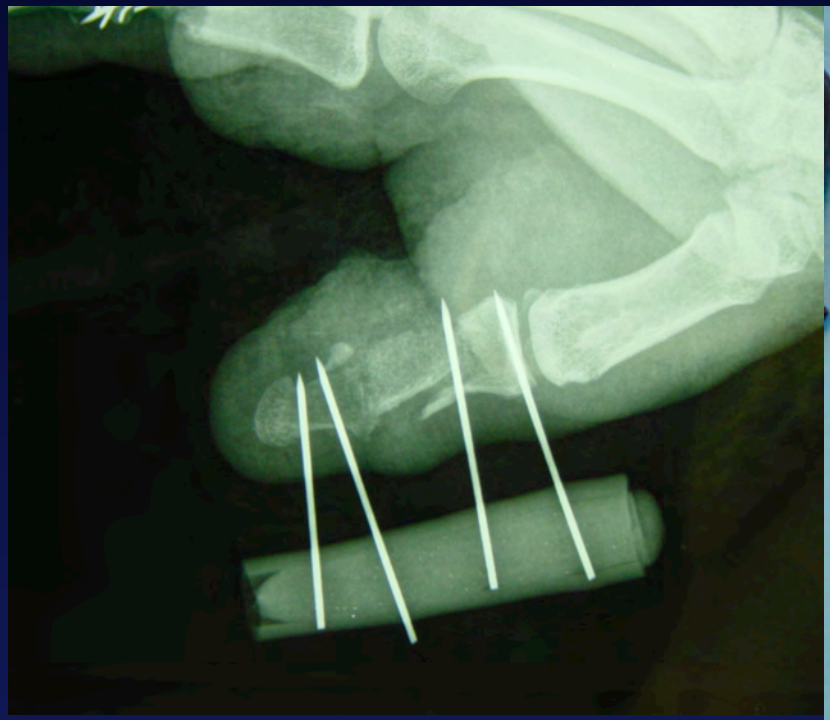


FE : indications

- I, II & V easier than III & IV
- Compound fractures
- Bone loss
- Transitory stabilization

Freeland 1987
Shearer 1992
Shehadi 1991
Fricker 1996
Hochberg 1994
Drenth 1998

Pertes de substances osseuses



- Greffe osseuse non vascularisée
- En 1 (ou 2) temps

Pathological fractures

Open fractures

Thank you