

Pes Planovalgus
Tibialis Posterior Tendon Dysfunction
stadium II

Therapeutic choices

Medializing Calcaneal Osteotomy

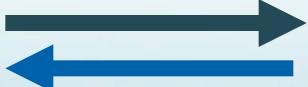
Versus

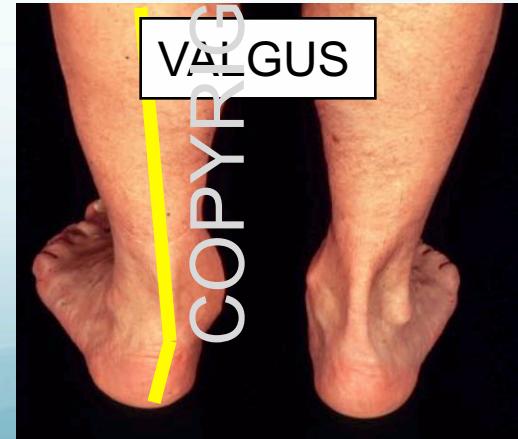
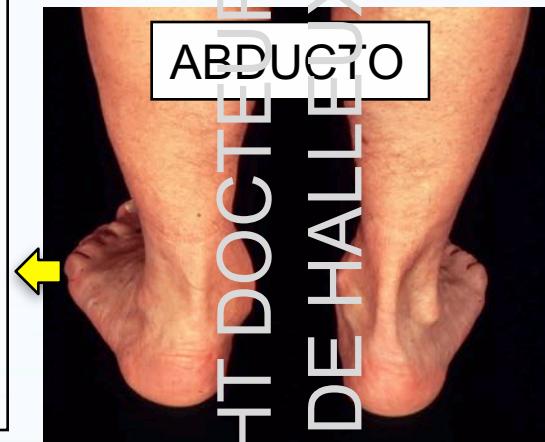
Lengthening Calcaneal Osteotomy

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TIBIALIS POSTERIOR INSUFFICIENCY

Calcaneum	valgus
Subtalar joint	tilted medially
Talus	medialy and down
T-N and N-C	subluxation
Midtarsal joints	Abduct + supination

valgus hindfoot  Achilles T = Evertor



STAGES tibialis posterior dysfunction

➤ Stage 1

- A : inflammation, no deformation
- B : partial PTT tear, no deformation
- C : partial PTT tear, little hindfoot valgus

➤ Stage 2 = SUPPLE

- A : valgus hindfoot; ($<50\%$ uncovering TN)
- B : forefoot supination flexible ($>50\%$ uncovering TN)
- C : A or B with forefoot supination fixed)
- D : Forefoot abduction
- E : medial column (TN, NC, CMT) instability

➤ Stage 3 = RIGID

- A : Hindfoot valgus
- B : Forefoot abduction

➤ Stage 4

- A : reducible ankle valgus
- B : rigid ankle valgus (more common presentation)

**PLANUS
VALGUS
ABDUCTUS
SUPINATION
MEDIAL COLUMN**

**complex problem that has
multiple treatment options ***

MENU A LA CARTE

BONE PROCEDURES

MEDIALIZATION CALCANEAL OSTEOTOMY (KOUTSOGIANNIS, MYERSON)

MALERBA CALCANEAL OSTEOTOMY

SILVER CALCANEAL OSTEOTOMY

LATERAL LENGTHENING OSTEOTOMY

LATERAL LENGTHENING CALCANEO-CUBOIDAL ARTHRODESIS

SUBTALAR ARTHRODESIS

SUBTALAR ARTHROERESIS

TALO-NAVICULAR ARTHRODESIS

MEDIAL COLUMN RESTORATION

COTTON CUNEIFORM 1 OSTEOTOMY

PLANTAR FLEXION MT1 OSTEOTOMY

ARTHRODESIS NAVICULO-CUNEIFORM 123

ARTHRODESIS TARSO-MT1

SOFT TISSUE PROCEDURES

TIBIALIS POSTERIOR RECONSTRUCTION

SUTURE

TRANSFER(TFDL OR FDC; COB TECHNIQUE)

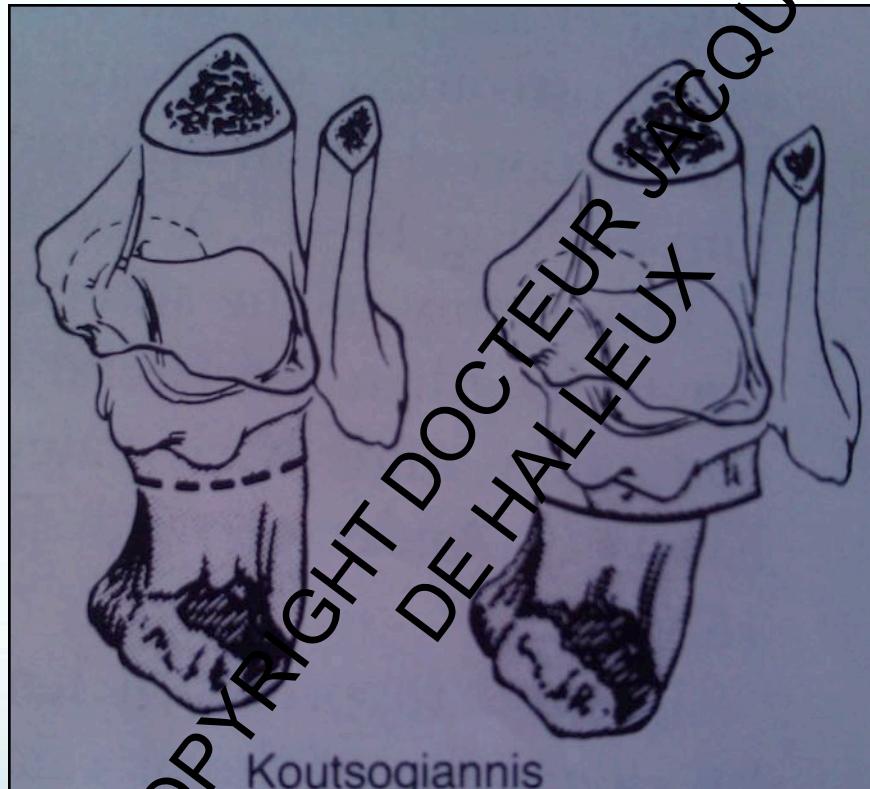
SPRING LIGAMENT RECONSTRUCTION

ACHILLES TENDON LENGTHENING

COPYRIGHT DOCTEUR JACQUES PAILLEUX

MEDIALIZING CALCANEAL OSTEOTOMY MCO

(*valgus correction*)



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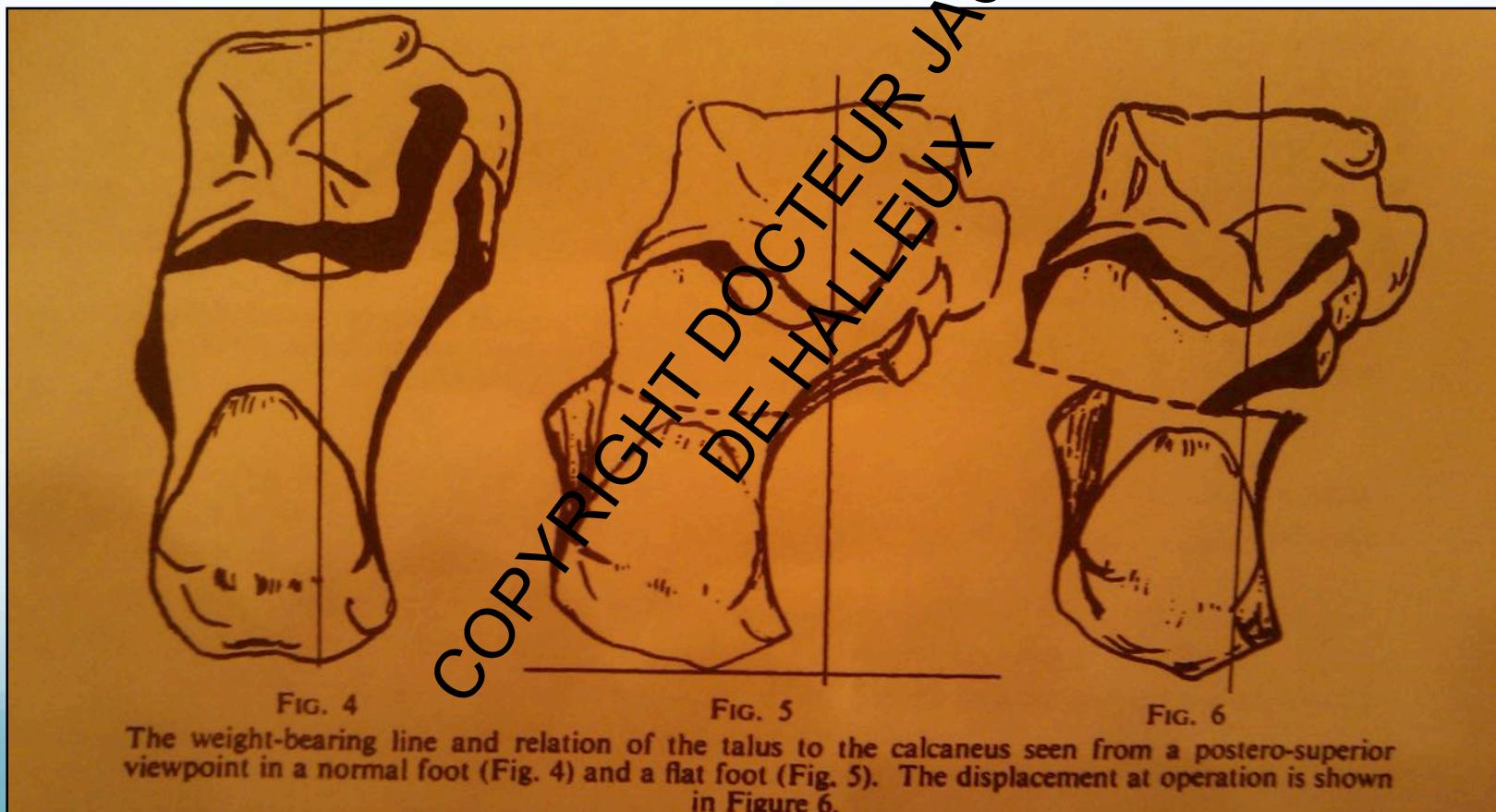
Koutsogiannis

Koutsogiannis. JBJS. Febr 1971

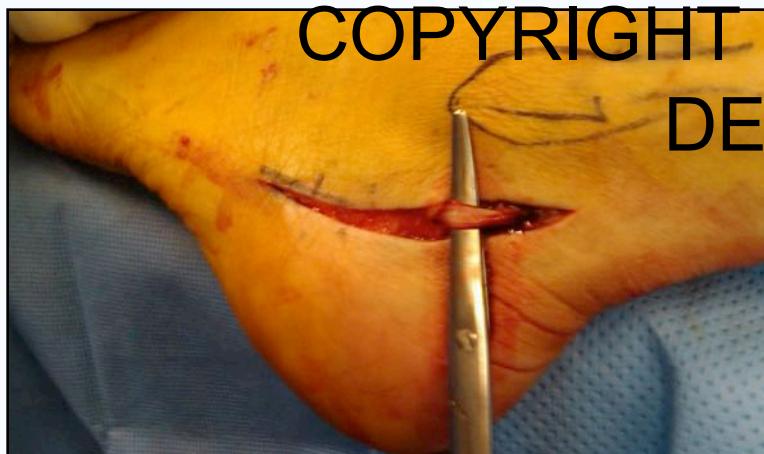
MEDIALIZING CALCANEAL OSTEOTOMY MCO

(valgus correction)

Line of weight-bearing transmitted through the talus
medial to the calcaneus

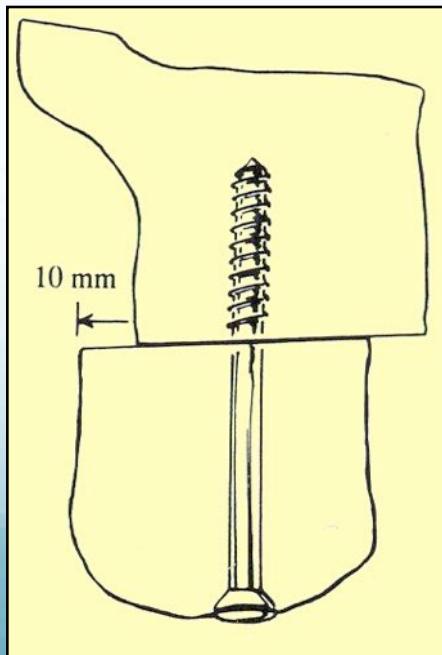


SURGICAL TECHNIQUE MCO

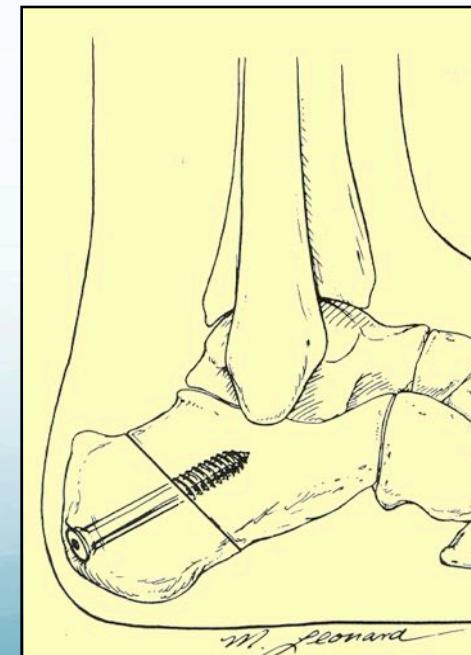


Lateral incision (parallel and
behind peroneal tendon) sural n !

Osteotomy // skin incision



MEDIAL
TRANSLATION
POSTERIOR
PART
CALCANEUM
*(1/3 to 1/2 of the
width of the
calcaneus)*



1- TREATMENT of ACQUIRED FLATFOOT

= Association of different procedures that impact hindfoot alignment
(MCO, LCL, TMT fusion, reconstruction PTT + spring ligament ...)

→ Main Predictor of hindfoot valgus alignment correction = MCO
(others: much lesser effect)

2- LINEAR RELATIONSHIP between:

- amount of MCO displacement
- correction hindfoot alignment

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Articles

The Contribution of Medializing Calcaneal Osteotomy on Hindfoot Alignment in the Reconstruction of the Stage II Adult Acquired Flatfoot Deformity

Jeremy Y. Chan, BS¹, Benjamin R. Williams, BS¹, Pallavi Nair, BS¹, Elizabeth Young, BS¹, Carolyn Sofka, MD¹, Jonathan T. Deland, MD¹, and Scott J. Ellis, MD¹

AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY.

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DOI: 10.1177/1071100712460225
<http://fai.sagepub.com>

3- HINDFOOT MOMENT ARM

- Help surgeon to titrate amount of correction
- **0 - 5 mm varus = greatest clinical improvement ***

* M Conti et al, F&A International, 2015. 36(8):919-927

Articles

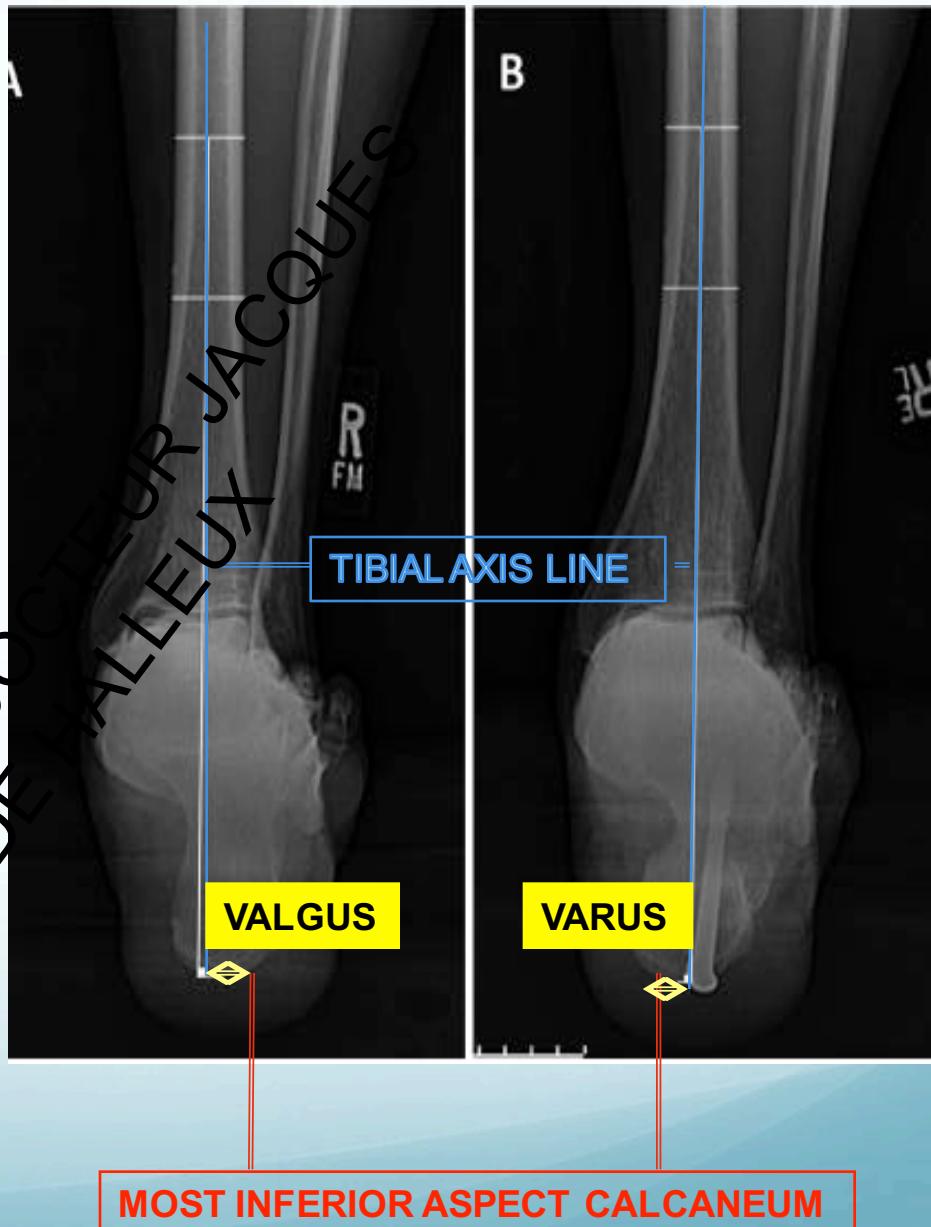
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PREOP

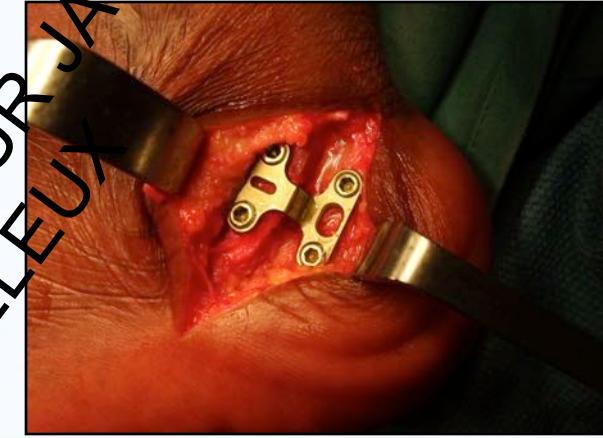
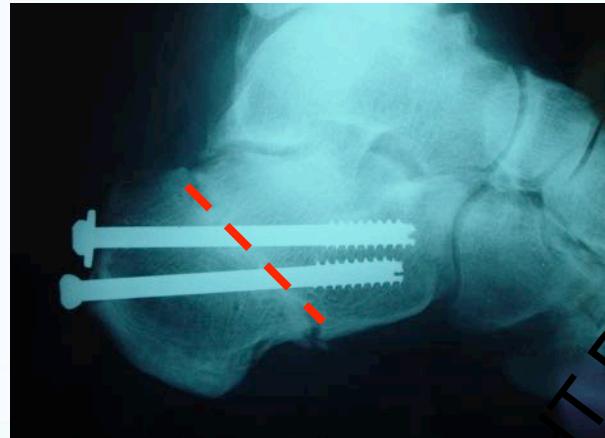
POSTOP



Comparison of Three Different Fixation Methods of Calcaneal Osteotomies

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DOI: 10.1177/1071100712473742
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Ali Abbasian, FRCS(Tr&Orth)¹, Razi Zaidi, MRCS², Abhijit Guha,
FRCS(Tr&Orth)², Andrew Goldberg, FRCS(Tr&Orth)², Nicholas Cullen,
FRCS(Tr&Orth)², and Dishan Singh FRCS(Tr&Orth)²



MCO FIXATION = 1 headless screw

- 2 headless screws
- Headed screw
- lateral plate

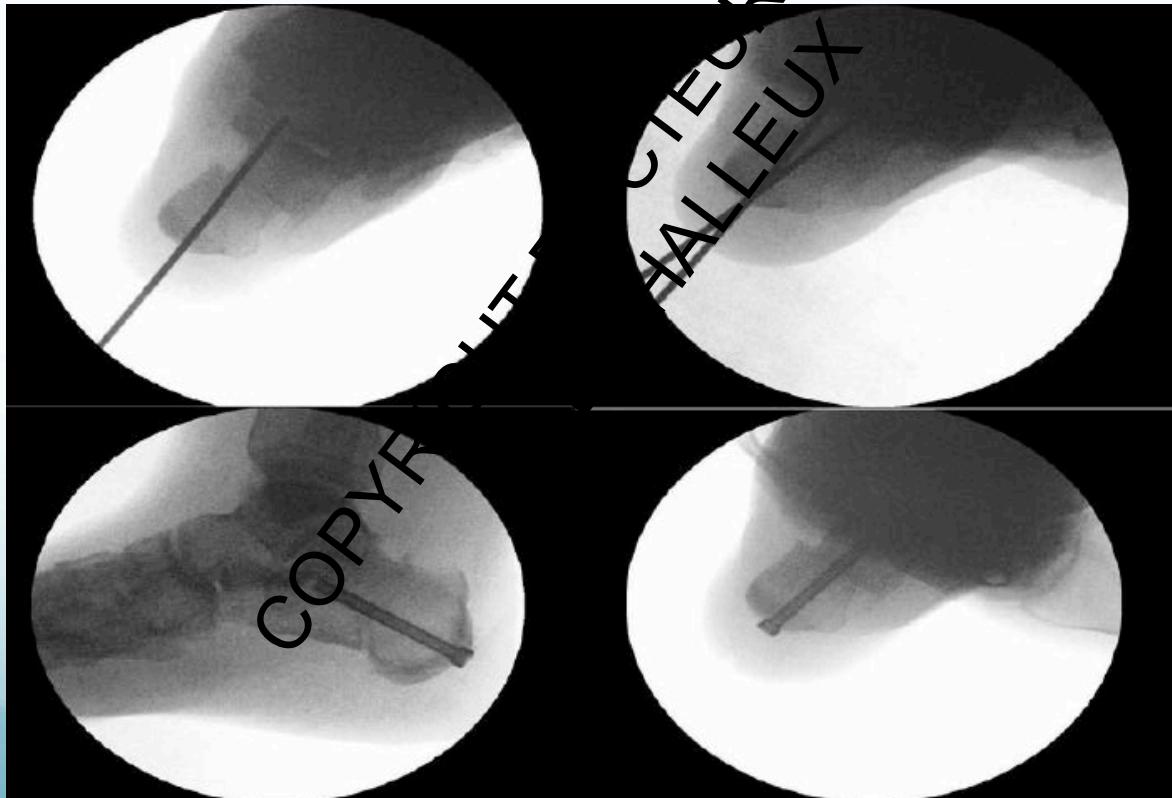
- : no better result
: 30 -50% removal
: more non-union

Medial Displacement Calcaneal Osteotomy Using Minimally Invasive Technique

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2015, Vol. 36(3) 248–252
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DOI: 10.1177/1071100714557154
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Ehab Kheir, FRCS Tr&Orth¹, Vishal Borse, MRCS¹, Jon Sharpe, FRCR²,
David Lavalette, FRCS Tr&Orth¹, and Mark Farndon, FRCS Tr&Orth¹

- Good results
- No non-union
- N = 30



MCO



Correction of :

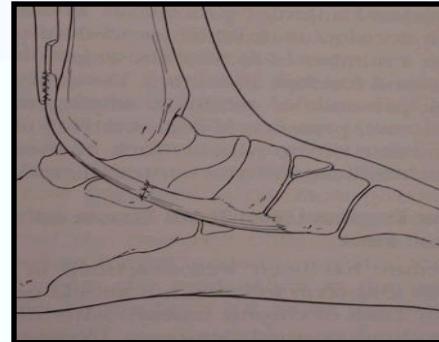
- Valgus
- Eversion force of the Achilles tendon
- Medial arch + Forefoot abduction
 - = only if no severe flatfoot

MCO alone

not enough!

RECONSTRUCTION PTT

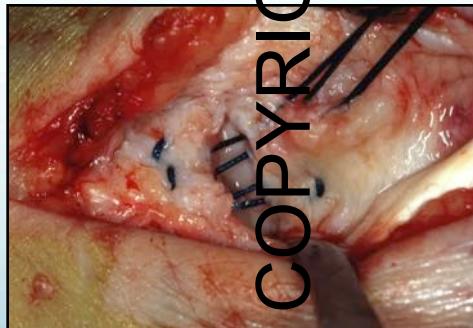
Suture / Z lenghtening



Transfert
FDL-FHL
Tib ant (Cobb)



RECONSTRUCTION SPRING LIGAMENT



LCL, Cotton, MT1

OSTEOTOMY - ARTHRODESIS

N-C, T-MT

RESULTS

MCO + FDL transfert

Myerson M S *

n:32 st II PTT dysfunction

mean age : 58 y

FU : 20 months (14 to 48)

results : AOFAS score 48 to 84

94% pain relief, improvement arch of the foot

Wacker J T **

n : 44 st II PTT dysfunction

mean age 61 y

FU : 51 months (38 to 62)

results : AOFAS score 48 to 88,5

95% pain relief

80% improvement arch of the foot

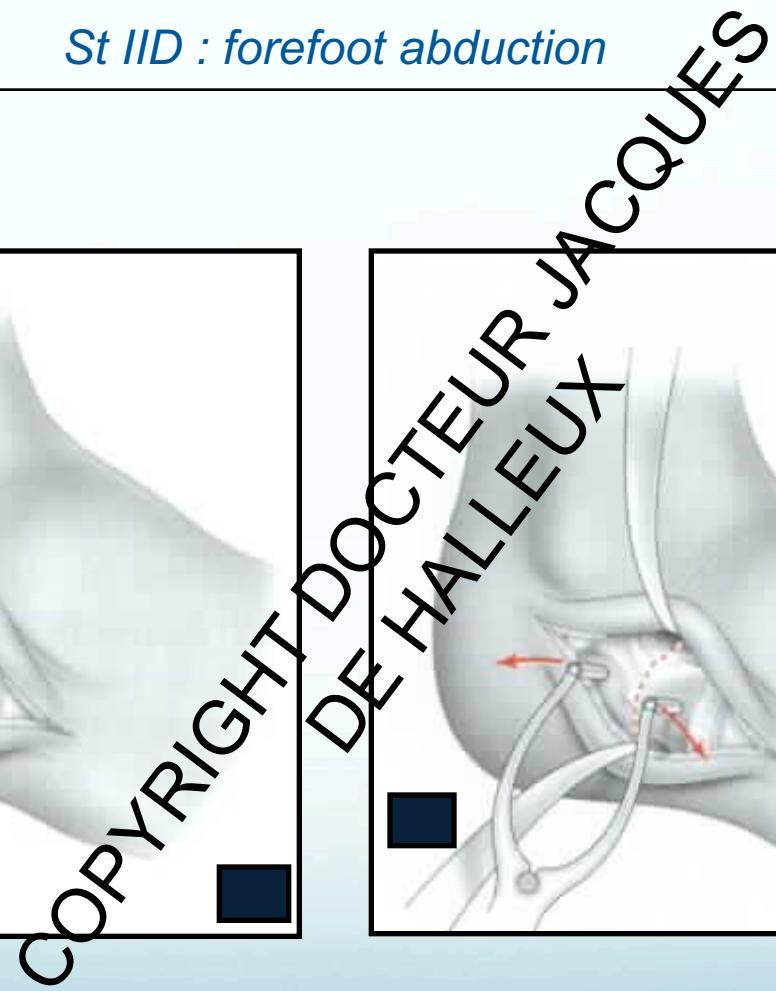
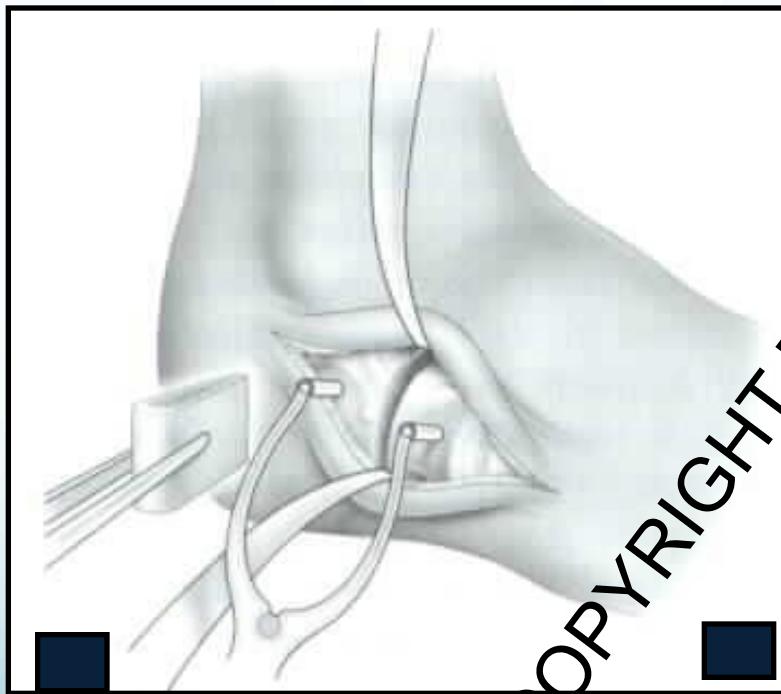
* Myerson MS, Orthopedics. 19:383-8, 1996

** Wacker JT, JBJS. 84-B : 54-8, 2002

CALCANEAL OSTEOTOMY:

Lateral column lengthening

St IID : forefoot abduction



EVANS PROCEDURE:

Lateral column lengthening

JURJUX

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Correction of:

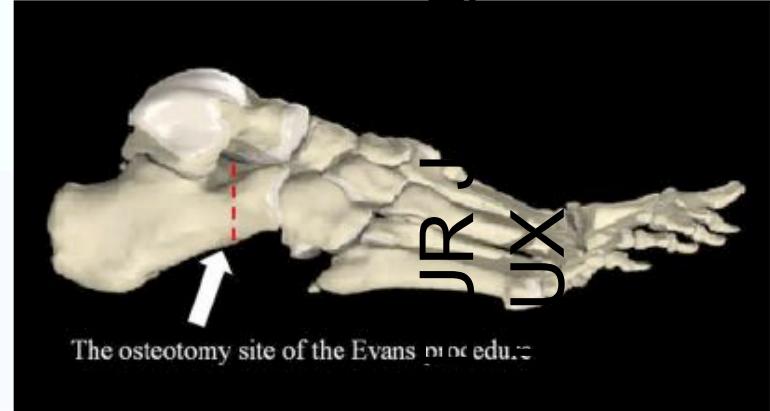
- **Medial arch height ***

not because FPI tightness ***

- **Forefoot abduction***

improve coverage Talar head by Navicular

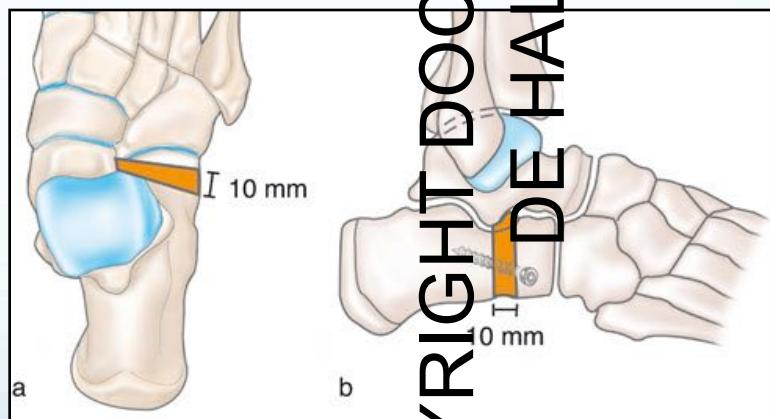
- **Hindfoot valgus***



Side effect:

- **Lateral forefoot plantar pressure ↑****

→ simultaneous procedure medially



* Evans D, Calcaneo-valgus deformity. JBJSBr. 1975;57-B(3):270-278

** Benthien et al, Foot Ankle International. 2007;28(1):70-77

*** Horton, Myerson et al, Foot Ankle International. 1998;19:370-373

LATERAL COLUMN LENGTHENING OSTEOTOMY LCL



calcaneo-cuboidal osteoarthritis

Evans :	65% at 13 years follow-up
Mosier-Laclair :	14% at 5 years follow-up *

Alternative = calcaneocuboïd distraction arthrodesis

- less motion hindfoot,
*(loss subtalar motion of 18 to 30% and loss TN of 40%**)*
- increasing arthritis hind and midfoot

• Mosier-Laclair, Foot Ankle Clin 16(1):95-119, 2001 Mar
** Deland Jet al, Foot Ankle 16(11), 1995

Table I. The Calcaneocuboid Joint Peak Pressures Under 7 Conditions With Vertical Loads of 350 N (kg/cm^2 , $\bar{x} \pm s$, n= 6)

Conditions	Peak Pressure Across the CC Joint	
Intact foot	9.21 ± 1.6	
Flatfoot	24.90 ± 2.45	CC joint pressure ↑
Corrected with 4 mm LCL	21.68 ± 2.21	
Corrected with 6 mm LCL	15.94 ± 2.59	
Corrected with 8 mm LCL	11.04 ± 1.15	CC joint Pressure ↘
Corrected with 10 mm LCL	15.20 ± 2.35	
Corrected with 12 mm LCL	21.35 ± 2.03	CC joint Pressure ↑

CC, calcaneocuboid; LCL, lateral column lengthening.

→ **LCL with 8mm trapezoidal grafts**

**Biomechanical Analysis of the
Calcaneocuboid Joint Pressure
After Sequential Lengthening
of the Lateral Column**

Jiang Xia, PhD¹, Peng Zhang, MD², Yun-Feng Yang, PhD², Jia-Qian Zhou, MD²,
Qian-Ming Li, MD², and Guang-Rong Yu, MD²



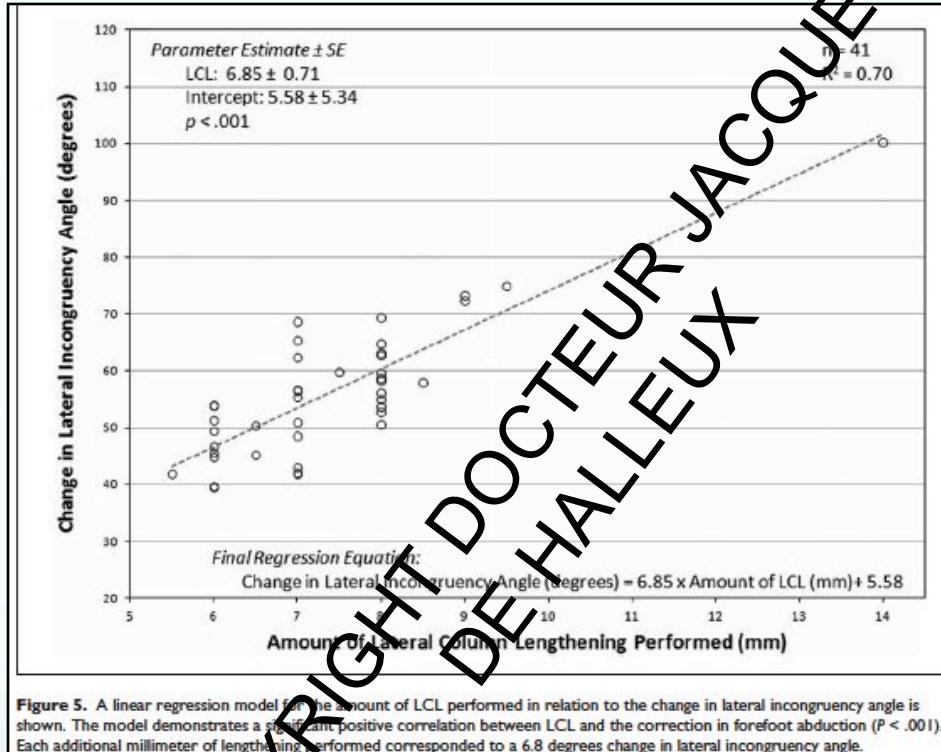
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Cadaveric study

Linear relationship : - Graft size (Lengthening LCL) - Correction forefoot abduction

(measured by the RX lateral incongruity angle)

→ **helpfull for surgeon to titrate the proper amount of correction**



Article

Contribution of Lateral Column Lengthening to Correction of Forefoot Abduction in Stage IIb Adult Acquired Flatfoot Deformity Reconstruction



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1–12
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DOI: [10.1177/1071100715596607](https://doi.org/10.1177/1071100715596607)
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Jeremy Y. Chan, MD¹, Stephen T. Greenfield, MD¹, Dylan S. Soukup, BS¹,
Huong T. Do, MA², Jonathan T. Deland, MD¹, and Scott J. Ellis, MD¹

Kind of graft shape?

Majority of publications = trapezoidal graft

Rectangular graft

- Better bony realignment = Better flatfoot deformity correction
(more graft volume medially)
(Intraarticular TN pressure: trapezoidal = rectangular)

Article

AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY.

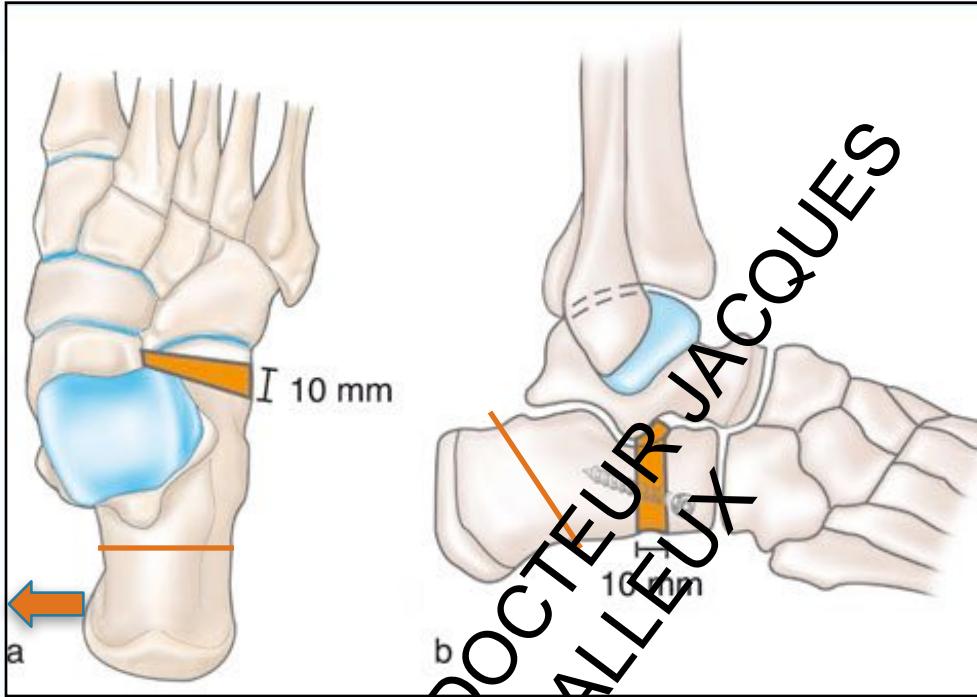
Effect of Graft Shape in Lateral Column Lengthening on Tarsal Bone Position and Subtalar and Talonavicular Contact Pressure in a Cadaveric Flatfoot Model

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DOI: 10.1177/1071100714549044
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Sean T. Campbell, MD¹, Keri A. Reese, MD^{1,2}, Steven D. Ross, MD²,
Michelle H. McGarry, MS¹, Thu-Ba Leba, MD¹, and Thay Q. Lee, PhD^{1,2}

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DOUBLE OSTEOTOMY : MCO + LCL



If double osteotomy performed : Prior MCO or Prior LCL?

- Performing MCO prior to the LCL osteotomy
 - *Risk of overcorrection (or additional hindfoot inversion)*
- Performing LCL osteotomy prior to MCO
 - *Reduce risk of overcorrection*

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Article

 AMERICAN ORTHOPAEDIC
FOOT & ANKLE SOCIETY.

Lateral Column Lengthening Corrects Hindfoot Valgus in a Cadaveric Flatfoot Model

Josh R. Baxter, PhD¹, Constantine A. Demetracopoulos, MD²,
Marcelo Pires Prado, MD^{2,3}, Theerawoot Tharmviboonsri, MD^{2,4},
and Jonathan T. Deland, MD²

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LCL without MCO

Foot and Ankle Surgery 19 (2013) 56–61

Contents lists available at SciVerse ScienceDirect

Foot and Ankle Surgery

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

Elsevier

Lengthening osteotomy of the calcaneus and flexor digitorum longus tendon transfer in flexible flatfoot deformity improves talo-1st metatarsal-Index, clinical outcome and pedographic parameter

Martinus Richter MD, PhD*, Stefan Zech MD

Department for Foot and Ankle Surgery Rummelsberg and Nuremberg, Germany

- LCL osteotomy
(autologous tricortical bone block, V plate)
- Reinsertion Post. tib.
- FDL transfer to navicular
- Reconstruction Spring ligament
- Gastroc-slide/lengthening



N=112 feet

FU 2 years n101 feet

58,2y

Talo-MT1 normalized

Post Tib insufficiency improved

VAS FA improved

Pedography normalized

9% wound healing delay

Association

- LCL
- reconstruction Tib Post + Spr

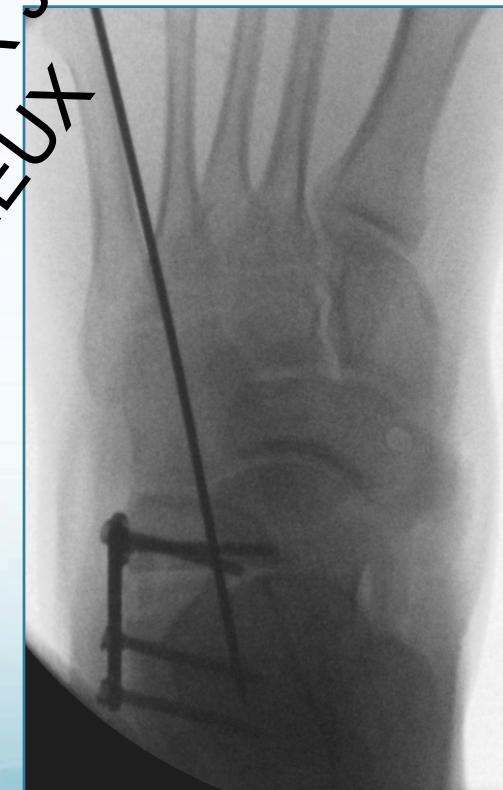
Lig

- - Ach T lengthening

safe and predictable technique

Flatfoot correction

(Abducto-Plano-Valgus)



CONCLUSION

- Posterior Tibialis Tendon Dysfunction St II
 - =
Complex problem
multiple therapeutic options
- MCO or LCL = not to be used alone
Need for Additional procedures
depending on the deformations

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Thanks



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1970. PIED. ANTONIO

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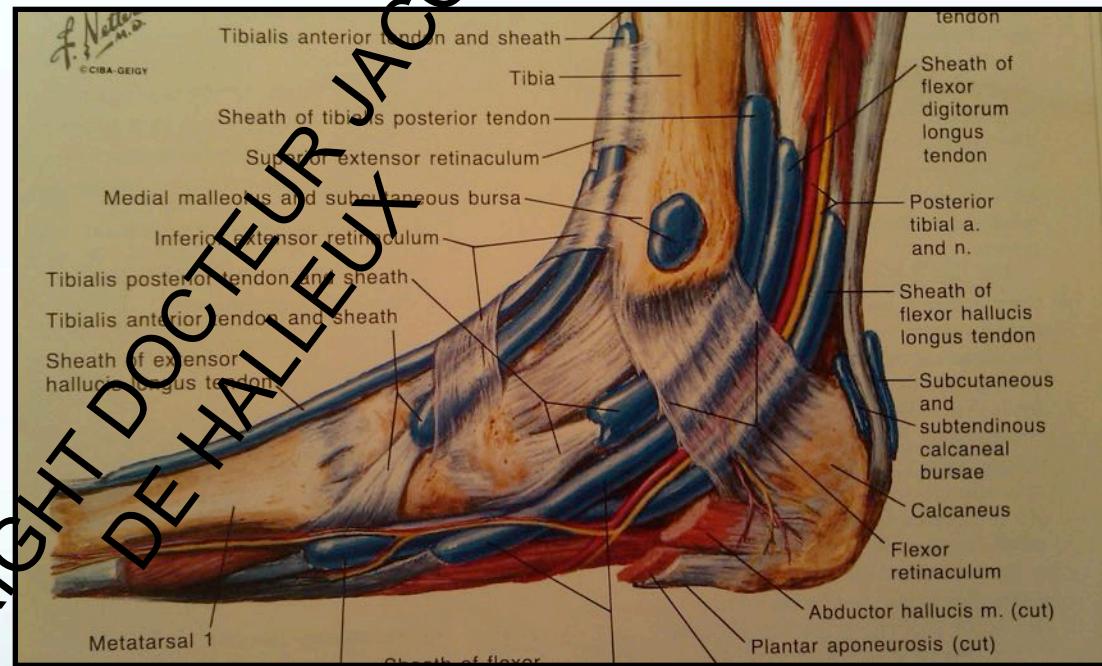
DE LA STATUE D'HERCULE dit FARNÈSE Musée de NAPLES



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TIBIALIS POSTERIOR TENDON

- Inversion of the heel
- Adduction forefoot
- Plantar flexion of the Ankle



*Inversion of the heel
Adduction forefoot
Plantar flexion of the Ankle*



Tibialis posterior tendon



PLANO



VALGO



DIAGNOSIS

tibialis posterior dysfunction

- flattening longitudinal arch

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DIAGNOSIS

tibialis posterior dysfunction

- valgus of the hindfoot

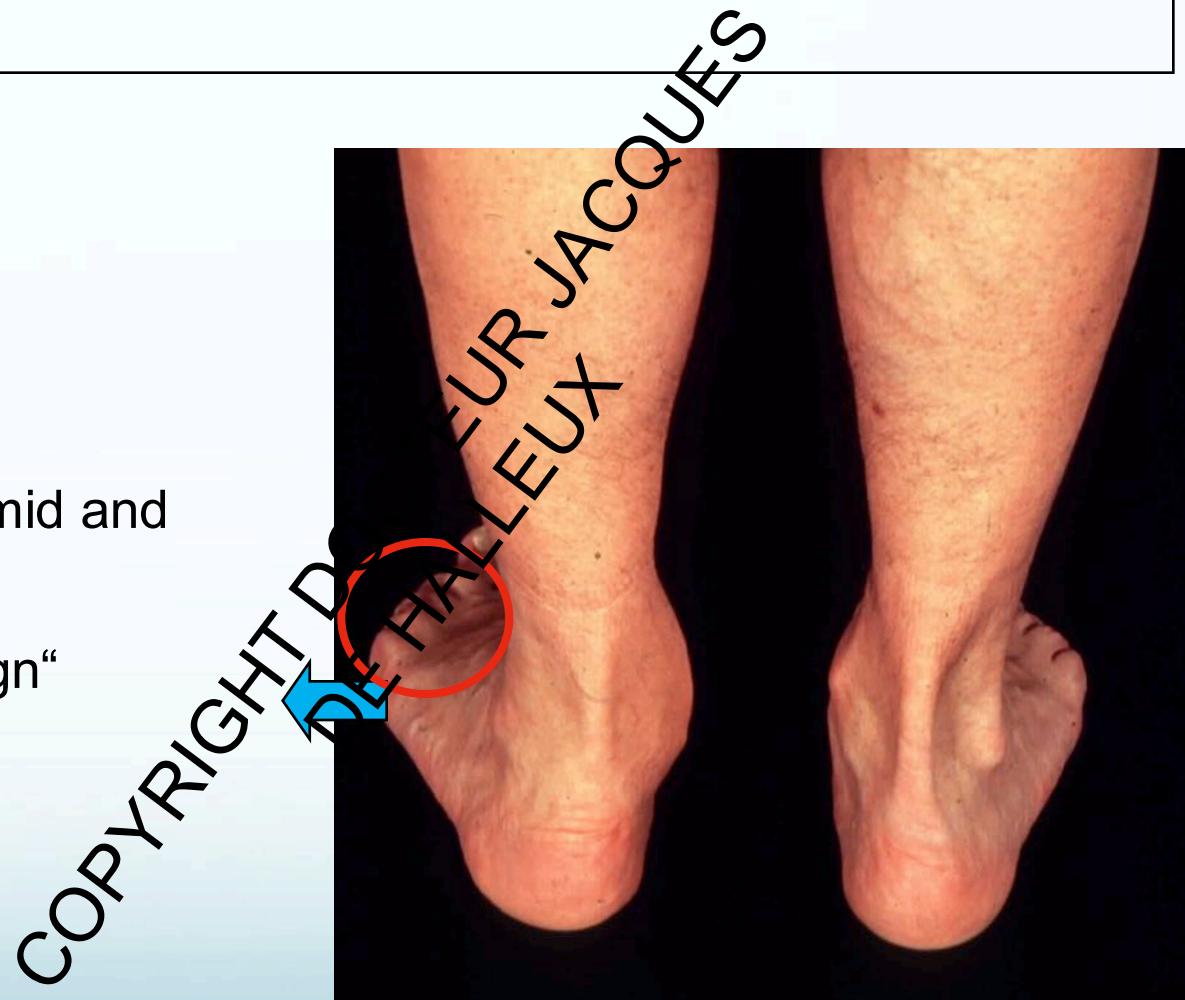
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DIAGNOSIS

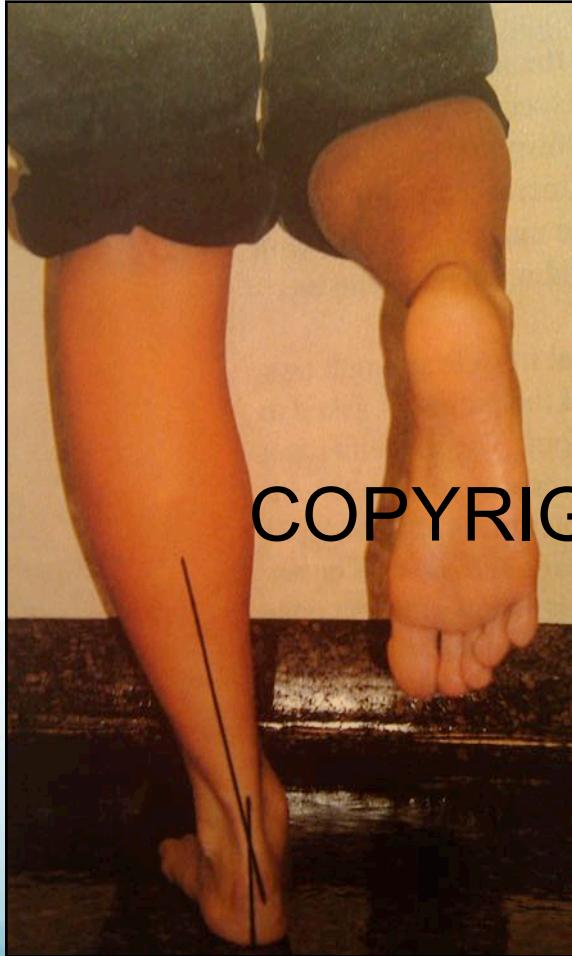
tibialis posterior dysfunction

- abduction of the mid and forefoot
- „too-many-toes sign“



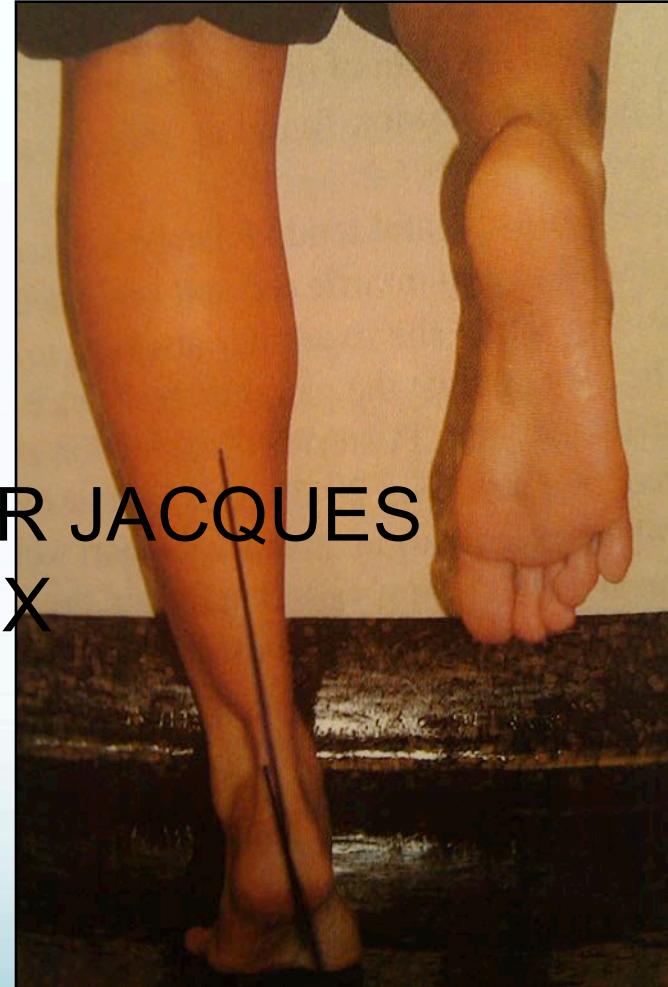
DIAGNOSIS

tibialis posterior dysfunction



**single-heel
rise test**
*Normal Tib
Post*

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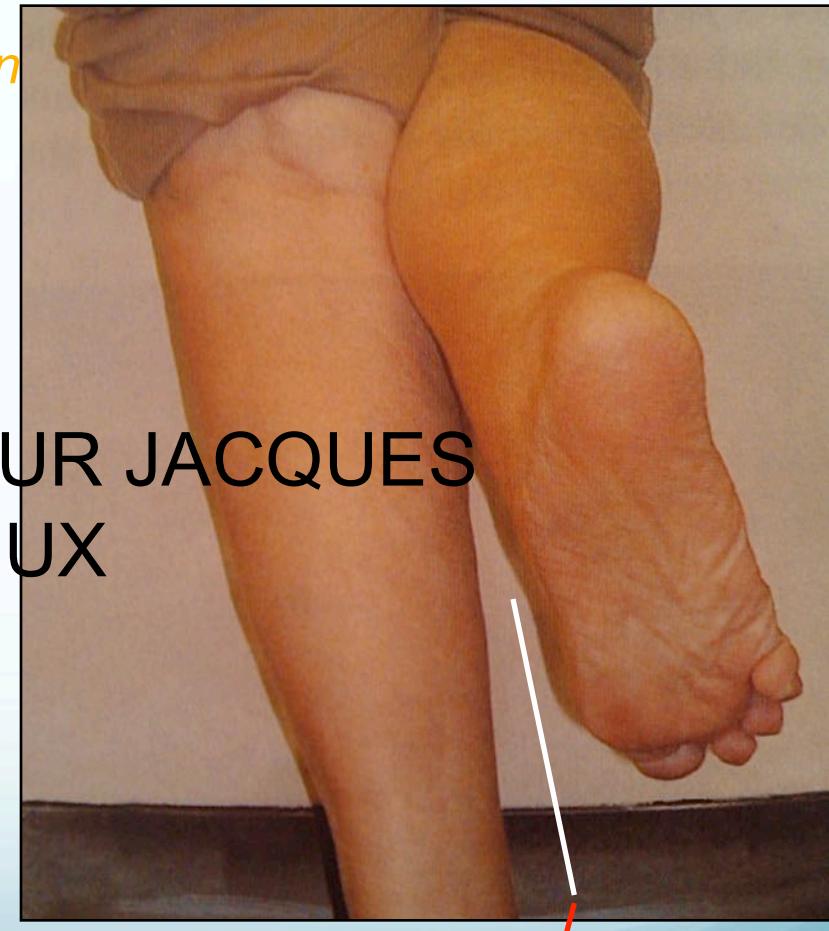
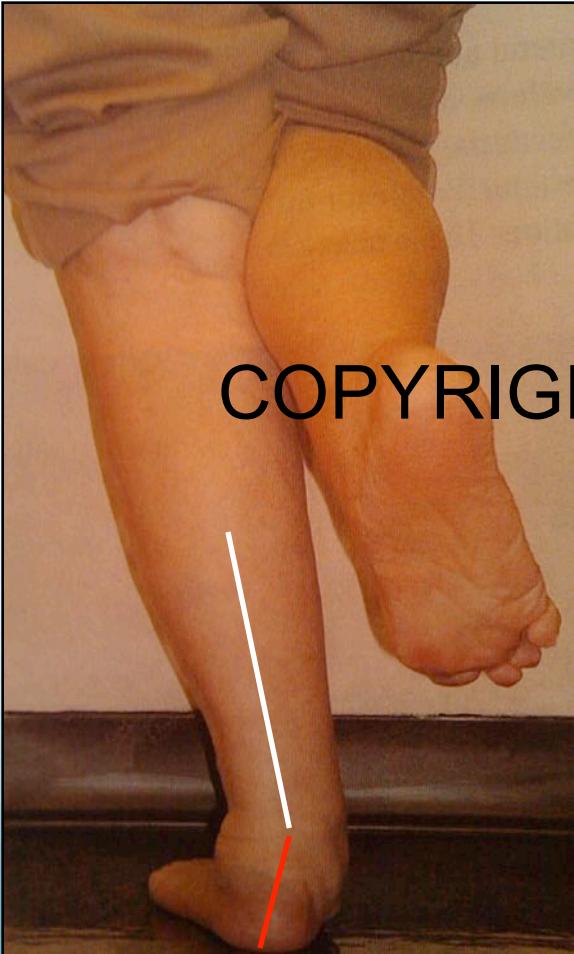


tibialis posterior dysfunction

„single-heel-rise test“

Tib Post Dysfun

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STAGES tibialis posterior dysfunction

- retromalleolar pain
- hindfoot valgus
- arch flattening
- forefoot supination
- forefoot abduction
- deformity
- **Ankle pain**

	stage 1	stage 2	stage 3	stage 4
+	++	++	++	++
(+/-)	++	++	++	++
(+/-)	++	++	++	++
(+/-)	(+)	++	++	++
+/-	++	++	++	++
	supple	supple	rigid	rigid
	-	-	-	++

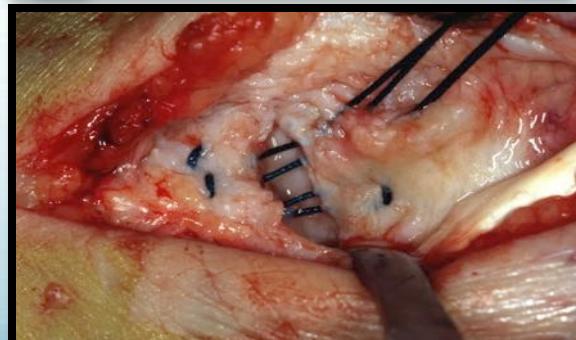
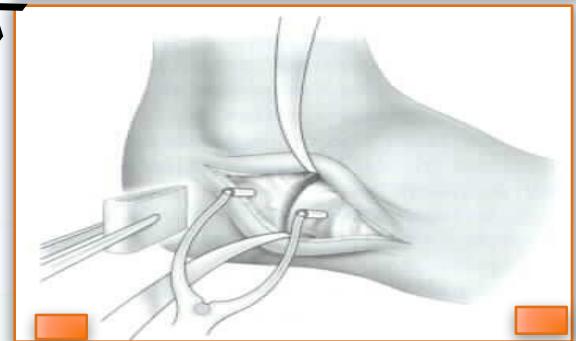
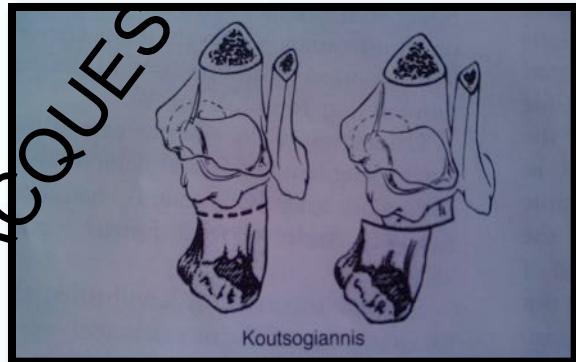
Posterior Tibial Tendon Dysfunction St II

TREATMENT

*complex problem that has
multiple treatment
options **

- Valgus hindfoot?
- Forefoot abduction?
- Forefoot supination?
- Medial column instability?
- Spring ligament ?
- Tibialis posterior?
- Achilles tendon ?

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* Hill K, Foot Ankle Clin.8(1):91-104, 2003 Mar

Posterior Tibial Tendon Dysfunction

Stage 1

- retromalleolar pain
- X Ray Normal
- Stages A : inflammation, no deformation
 - B : partial PTT tear, no deformation
 - C : partial PTT tear, little hindfoot valgus

→ Tenosynovitis or partial
rupture



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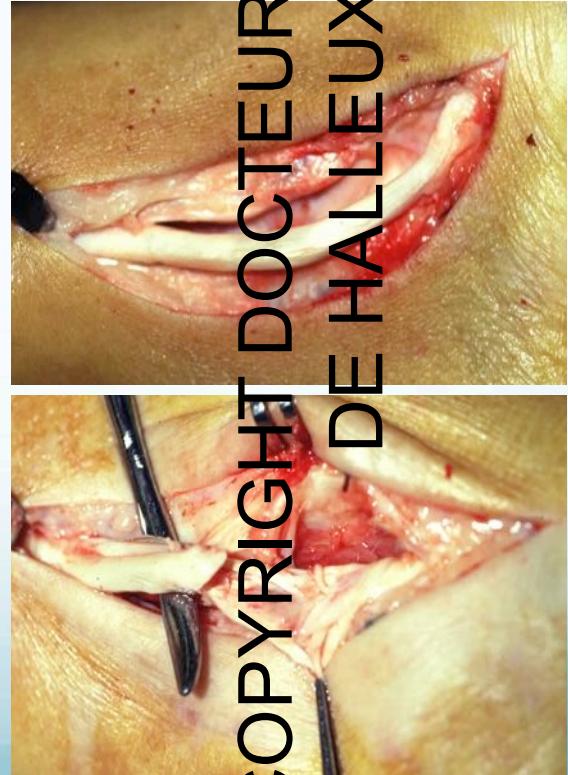
Posterior Tibial Tendon Dysfunction

Stage 2

Supple pes plano valgus

- A : *valgus hindfoot ;* ($<50\%$ uncovering TN)
- B : *forefoot supination flexible* ($>50\%$ uncovering TN)
- C : A or B with *forefoot supination fixed*)
- D : *Forefoot abduction*
- E : *medial column (TN, NC, CMT) instability*

→ Elongation, tendinosis
→ (partial) rupture



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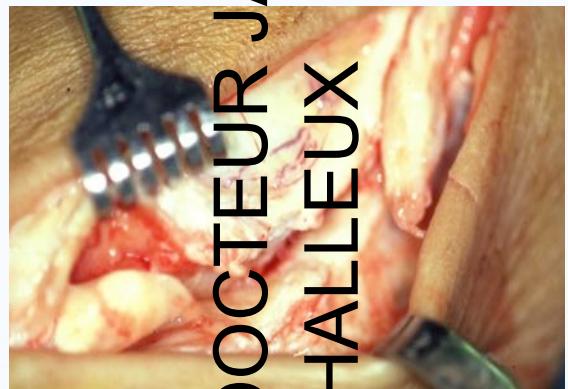
Posterior Tibial Tendon Dysfunction

Stage 3

- Rigid pes plano valgus
- A :Hindfoot valgus
- B :Forefoot abduction

→ More advanced course of tendon rupture

Haddad St, Myerson MS and al, Foot and Ankle Int, 2011, jan

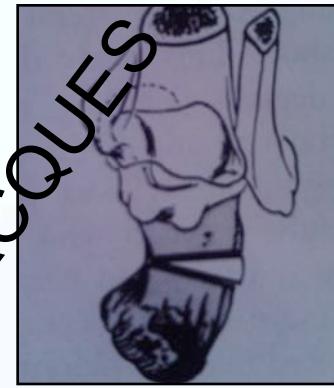


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1893 : medial closing
wedge (**Gleich**)

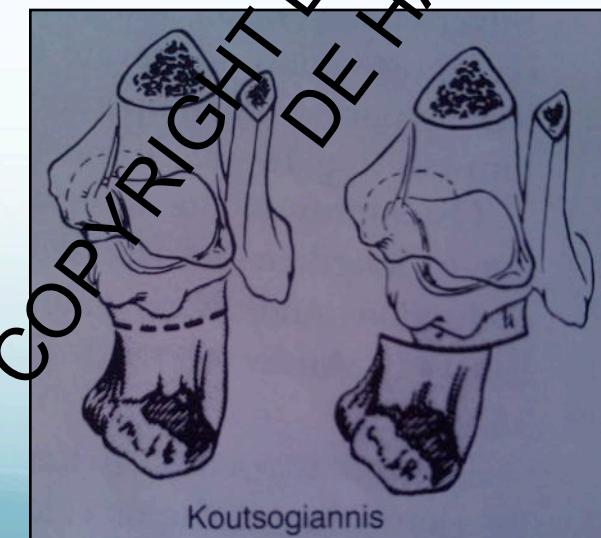


1967: lateral opening
wedge (**Silver**)



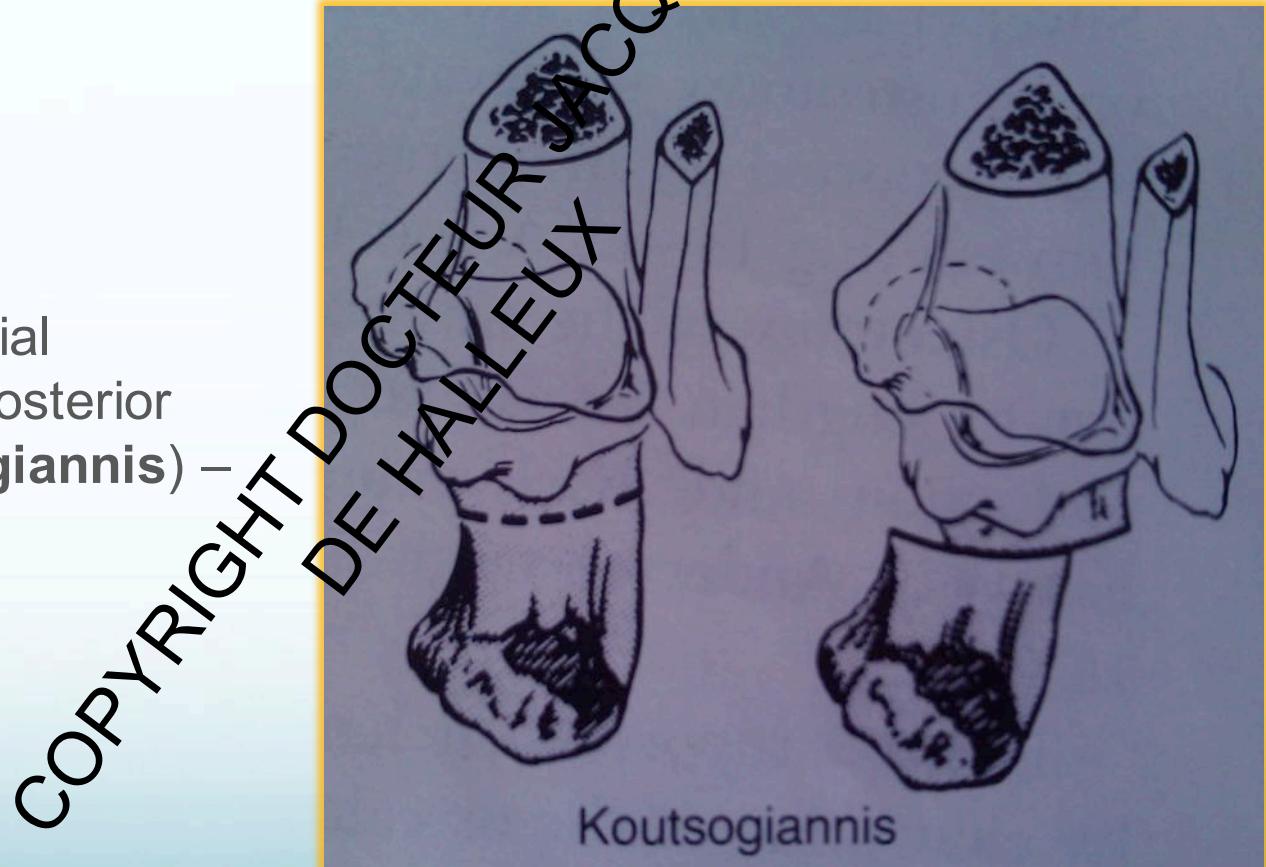
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MEDIALIZING CALCANEAL OSTEOTOMY
MCO (Koutsogiannis) JBJS. Febr 1971
(*valgus correction*)



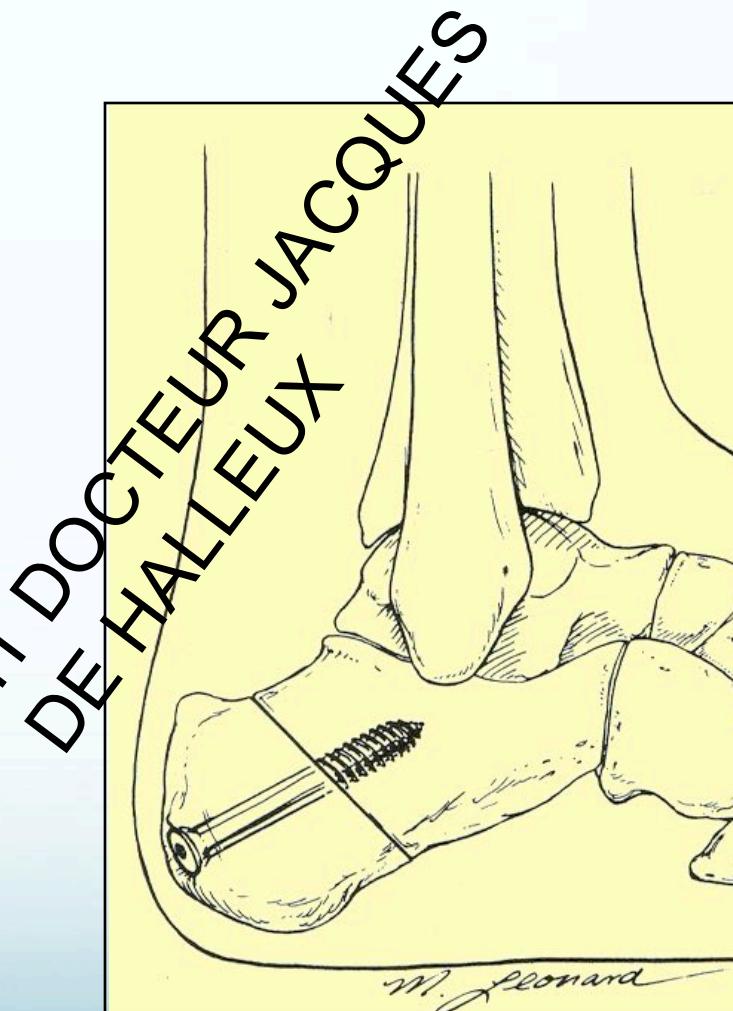
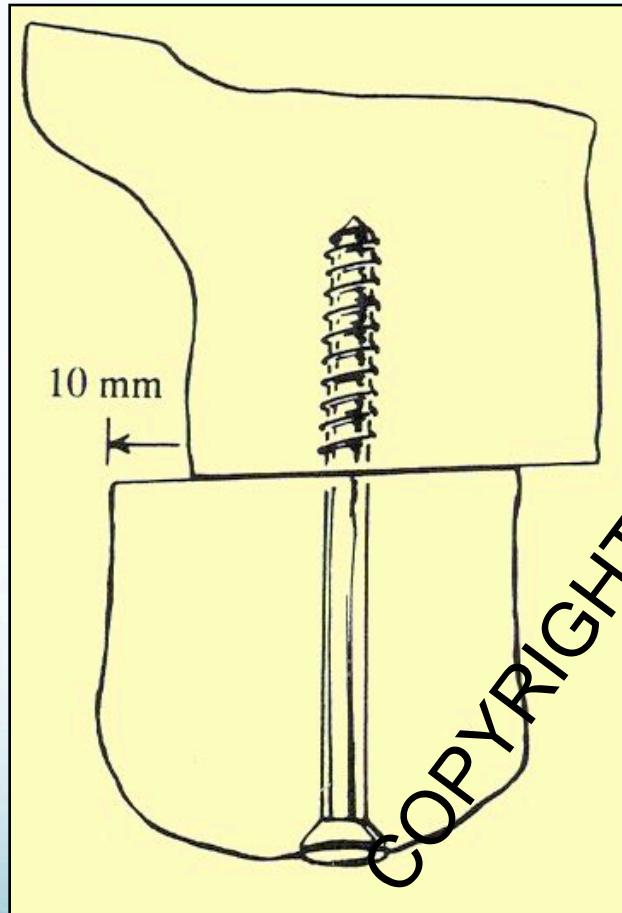
CALCANEAL OSTEOTOMY (*valgus correction*)

- 1971 : medial translation of the posterior fragment (**Koutsogiannis**) – *JBJS, febr 1971-*



MEDIAL TRANSLATION POSTERIOR PART CALCANEUM

(1/3 to $\frac{1}{2}$ of the width of the calcaneus; 1 cm)



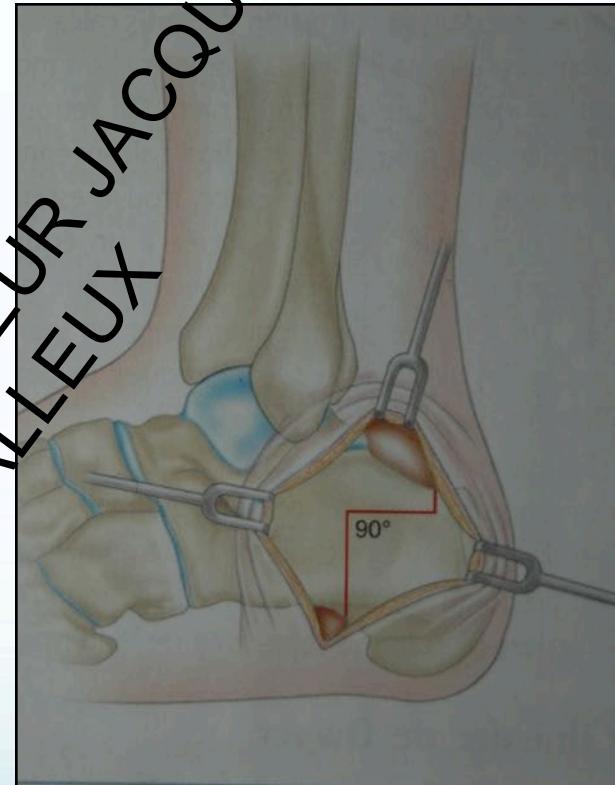
CALCANEAL OSTEOTOMY

(valgus correction)

LATERAL OPENING WEDGE OSTEOTOMY

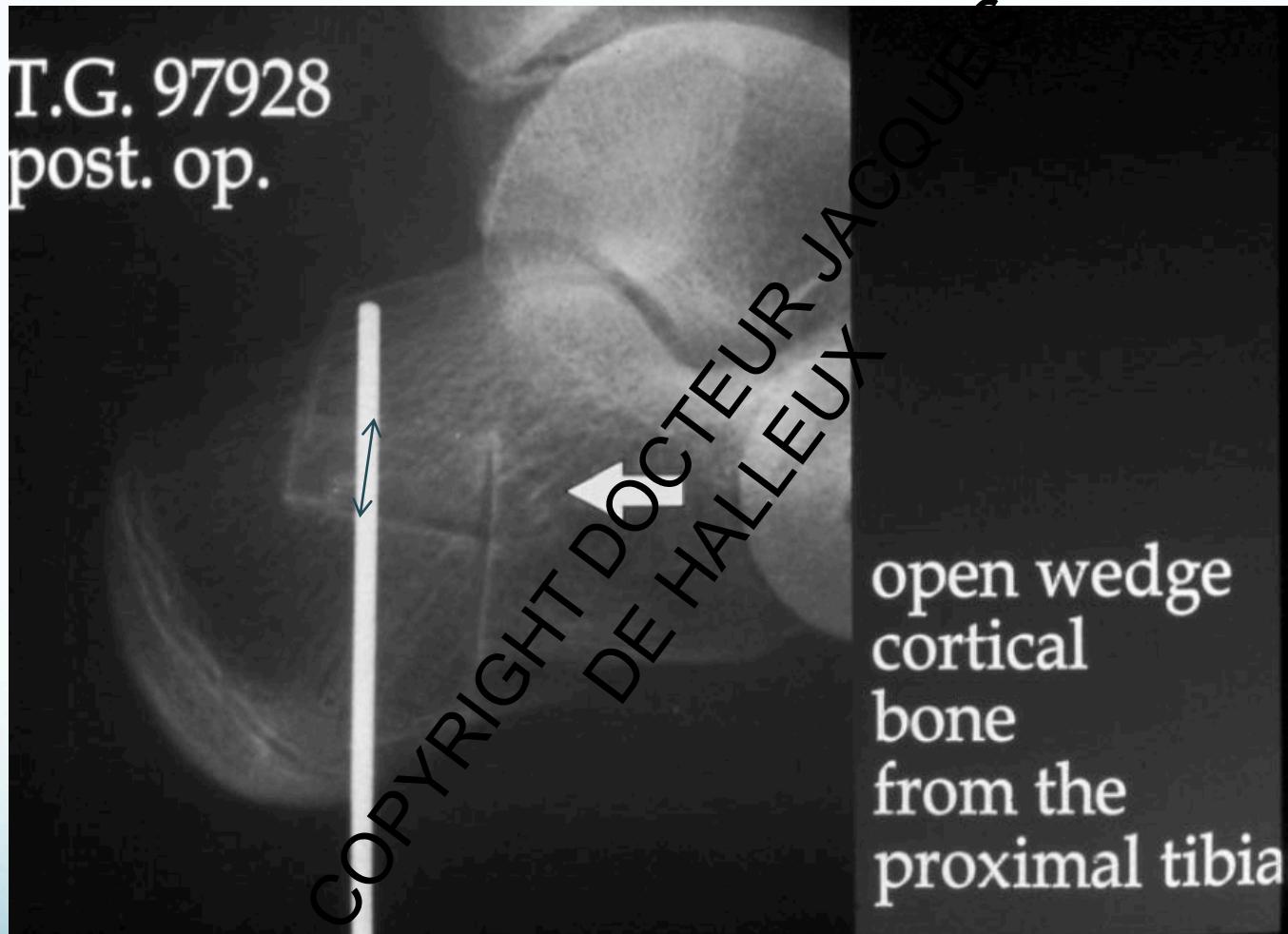
2005 : Z osteotomy
(Malerba)

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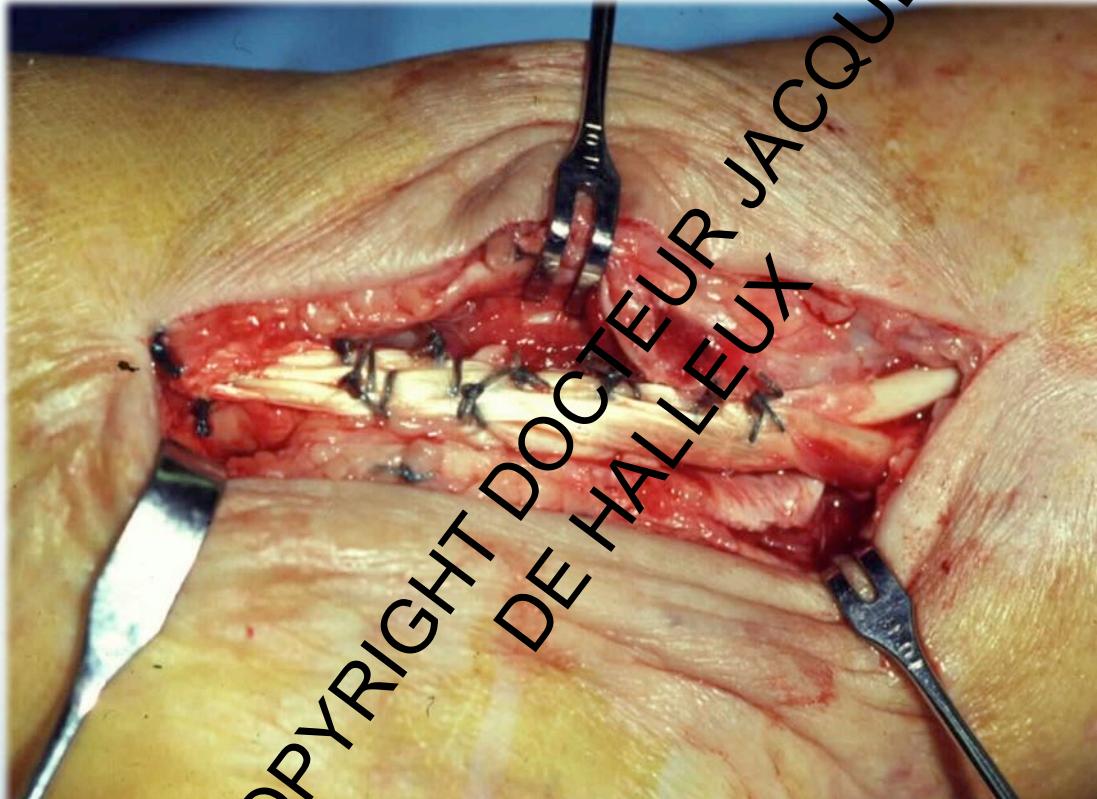
MALERBA OSTEOTOMY

Lateral opening wedge osteotomy



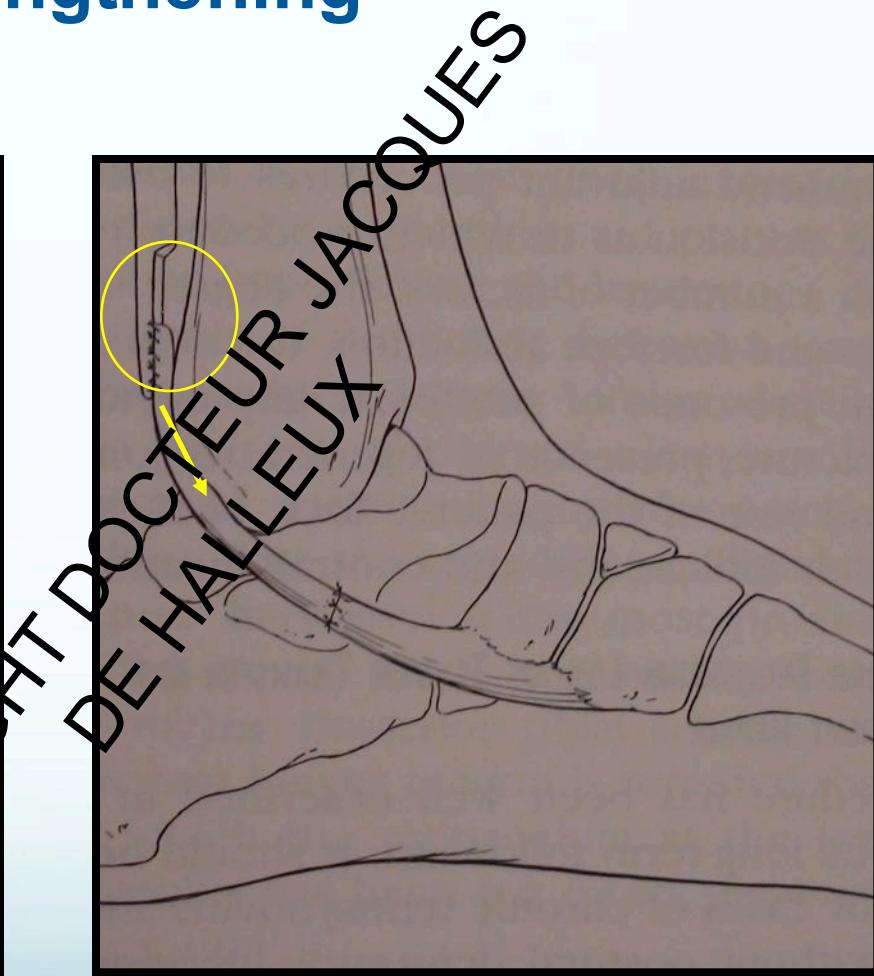
picture from: Th Leemrijse, B Valtin, Pathologie du Pied et de la cheville, 2009

TIBIALIS POSTERIOR RECONSTRUCTION : suture

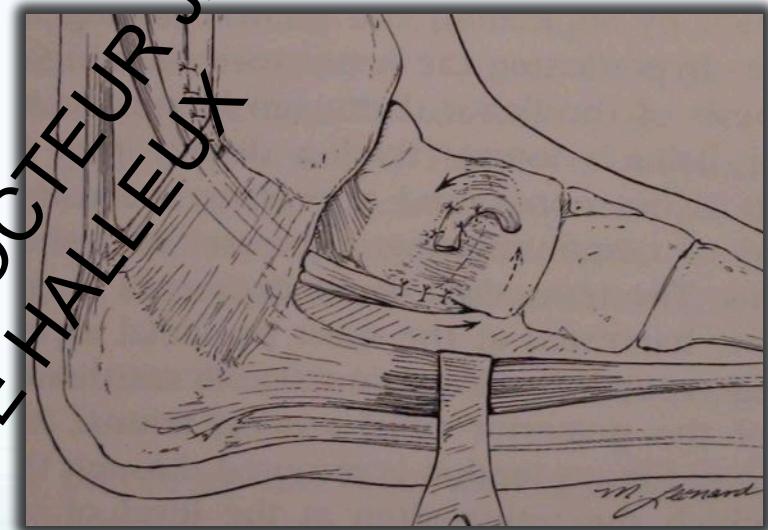
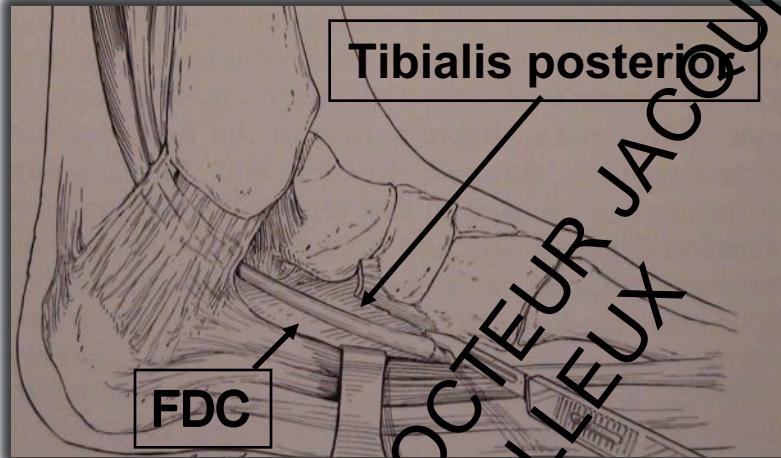


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TENDON RECONSTRUCTION: Z-lengthening



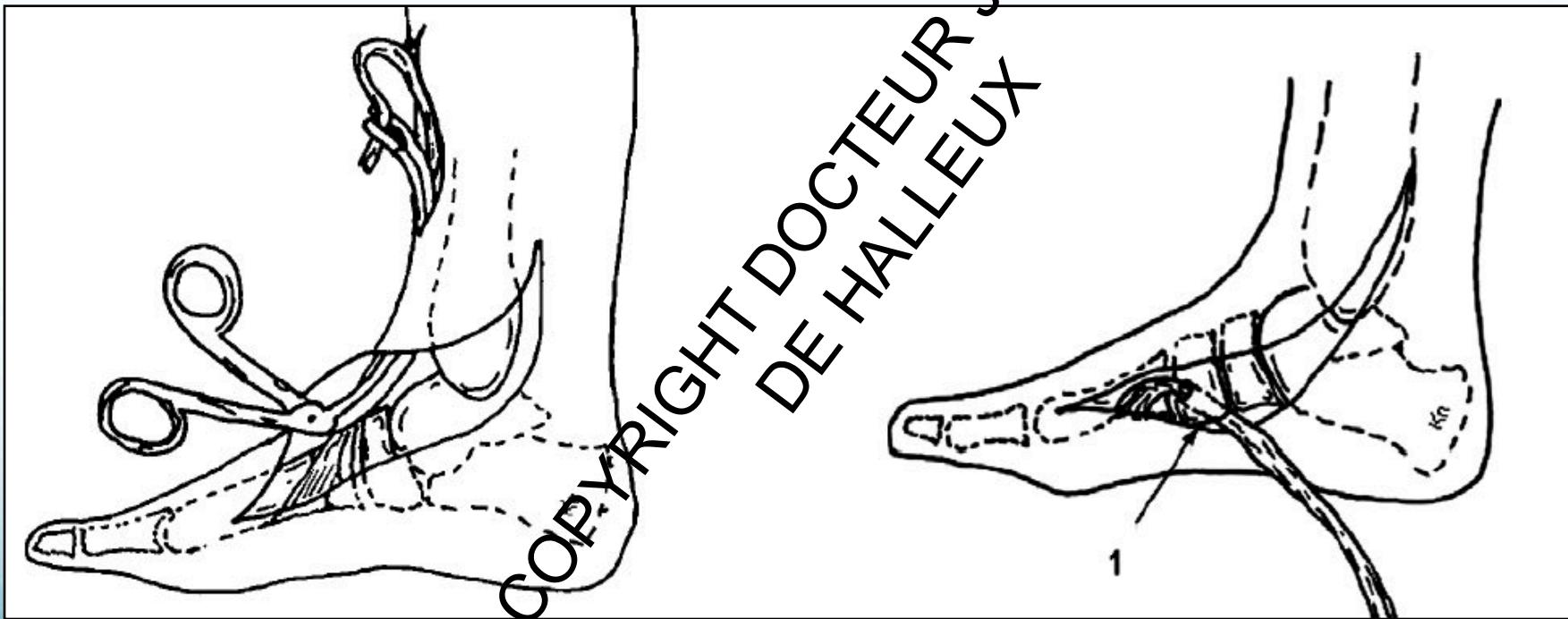
TENDON RECONSTRUCTION : FHL or FDC transfert



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TENDON RECONSTRUCTION WITH TIBIALIS ANTERIOR COBB TECHNIQUE

restore plantar flexion power of the 1st ray
(more distal insertion of the Tib Ant)
supple forefoot supination STUB



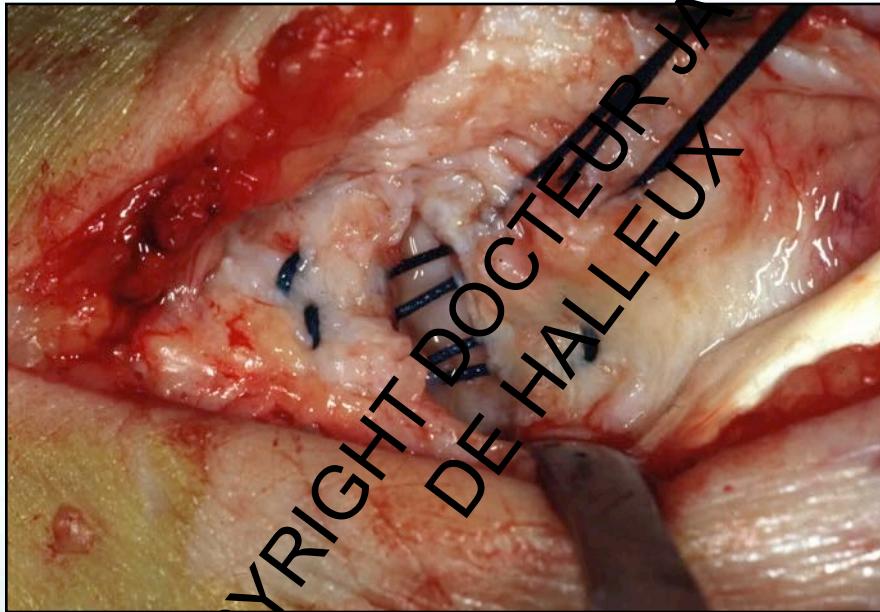
COBB TECHNIQUE

Knupp M, Hintermann B

- n = 22 PTT dysfunction st IIB
- FU : 24 months
- results : AOFAS score 53,2 to 88,5
excellent / good results: 95 %
no decreasing Force of TA
- Cobb technique = appropriate alternative to arthrodesis
in st II B PTT dysfunction (in addition with other technique)

LIGAMENT RECONSTRUCTION

spring ligament suture



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RESULTS

MCO + LCL + FDL transfert (*Mosier-Laclair***)

- Satisfaction rate high
- No medial arch rest
- Cc arthritis 14%

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** Mosier-Laclair, *Foot and Ankle Clinic*, Mar 2001: (6):95-119;

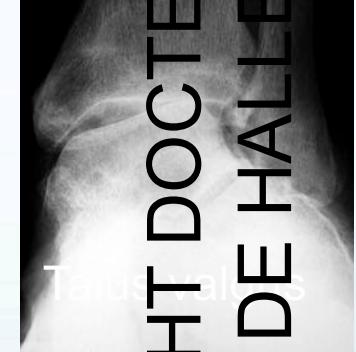
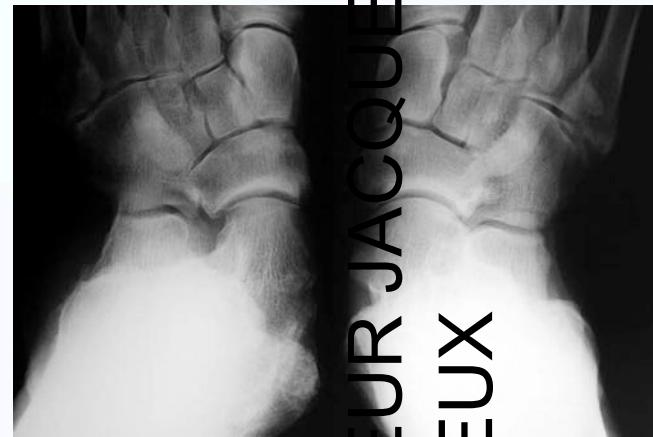
Posterior Tibial Tendon Dysfunction

Stage 4

- Rigid pes plano valgus
- Lateral ankle pain
- A : *reducible ankle valgus*
- B : *rigid ankle valgus (more common presentation)*

→ rupture

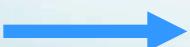
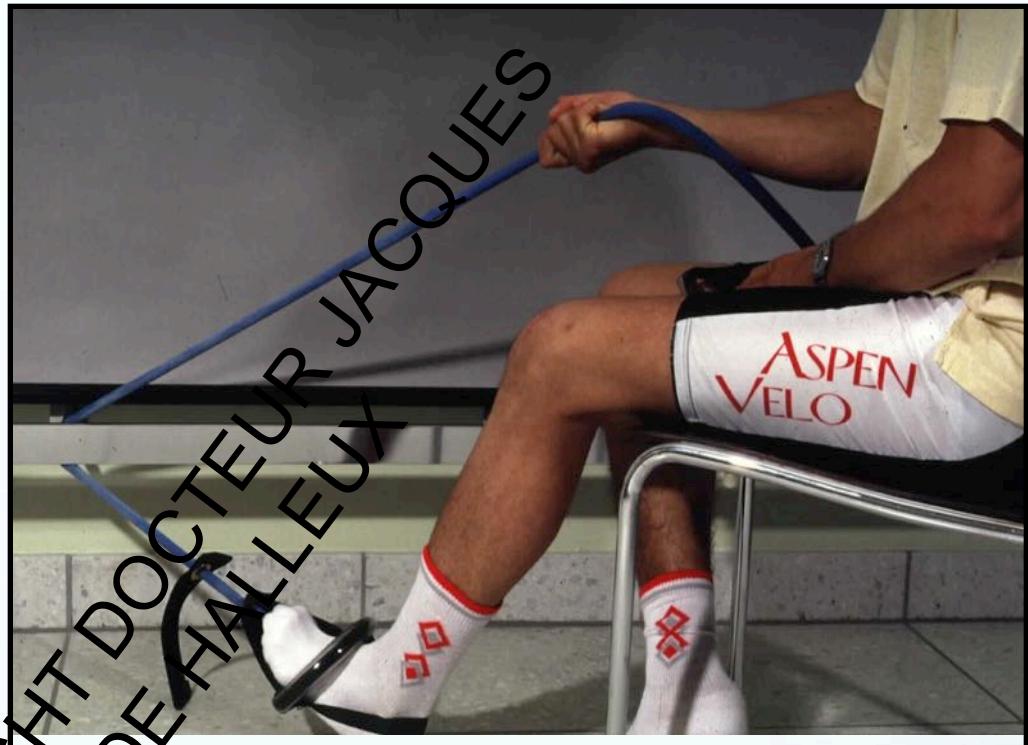
→ ankle arthrosis



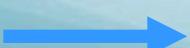
Posterior Tibial Tendon Dysfunction

TREATMENT

➤ Stage 1



conservative



Surgery?

- physiotherapy
- shoe corrections
- medial support

Ténosynovectomy?

LCL osteotomy

correct

- Majority of the

hindfoot valgus deformity

- While also correct

the midfoot deformity

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Posterior Tibial Tendon Dysfunction Stage II

Treatment

SURGICAL

- Calcaneal osteotomy
 - (>< valgus :MCO and others (Silver, Malherba...))
 - (>< abd midfoot :LCL lateral column lenghtening)
- Arthrodesis
 - (>< abd forefoot : lateral column lenghtening)
 - (>< supp forefoot : medial column)
- Tendon reconstruction
 - (suture, plasty, transpert FHL or FDC, Cobb)
- Ligament reconstruction
 - (spring ligament)
- Others
 - (Achilles tendon lenghtening, TN arthrodesis, subtalar arthrodesis, subtalar arthroeresis, medial cuneiform osteotomy, 1st MT osteotomy)

RESULTS

CC arthrodesis + PTT repair + Achilles tendon lengthening (Lauwerens, 2006)

- **N = 20; FU = 24 months**
- **85% complete relief of pain**
- **10% nonunion**
- **15% sural nerve damage**

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RIGID FOREFOOT SUPINATION? STADIUM II C

- Arthrodesis naviculo-cuneiform^{123 *}
- Arthrodesis 1st tarso-metatarsal
- Cotton osteotomy (plantar flexion opening wedge cun 1)**
- Plantar flexion osteotomy MT1

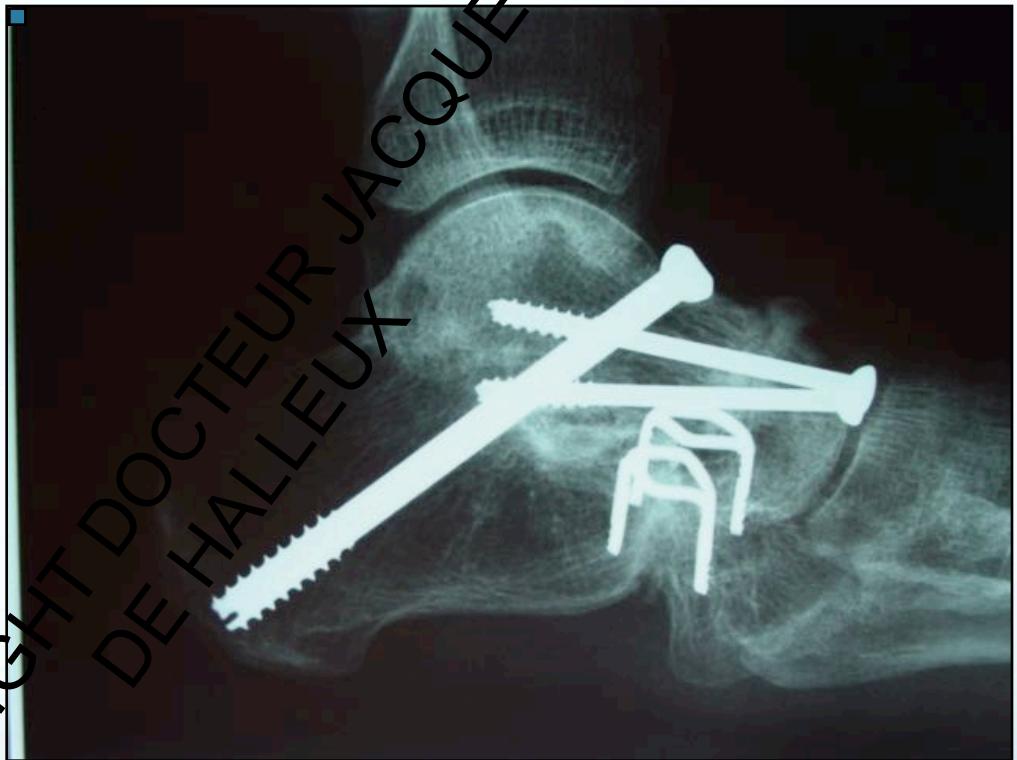
• Alastair Younger, *Foot Ankle Int.* 32 (1) : 101-3, 2011

** Hirose CB, *Foot Ankle Int.* 25 : 568-74, 2004

Stephen J Pinney, *Foot Ankle Int.*, 27 (1) : 66-75, 2006 jan

Posterior Tibial Tendon Dysfunction

Treatment



➤ Stage 3

- A : + Medial transl calc ost
- B : + lenght lat column

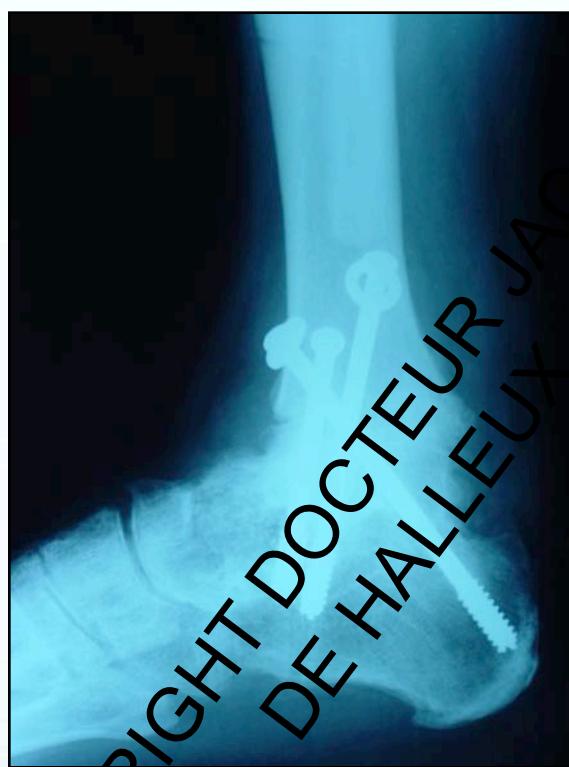


surgical

- triple arthrodeses

Posterior Tibial Tendon Dysfunction Treatment

- Stage 4



→ Surgical*

COPYRIGHT DOCTEUR DE HALLEUX : ankle soft tissue repair + Triple Arthrodesis
CB : Panarthrodesis / TTC arthrodesis

*Bluman EM, Myerson MS, Foot Ankle Clinic, 12(2): 341-62, 2007

Posterior Tibial Tendon Dysfunction TREATMENT

CONCLUSION

		I	II	III / IIII	III / IV	IV					
		conservative	MTCO	PTT repair	spring ligam	Medial column	Lateral column	Triple arthrodesis	Soft tissue ankle	Pantalar	
I	pain	A PTT inflam; no deform	synovectomy								
		B parti PTT tear; no deform									
		C parti PTT tear: little valgus									
II	supple PPV	A calc valgus									
		B supple forefoot supp									
		C rigid forefoot supp									
		D forefoot abd									
		E mdI column instabilty									
III	rigid PPV	A calc valgus									
		B forefoot abd									
IV	ankle valgus	A supple									
		B rigid									

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Posterior Tibial Tendon Dysfunction

CONCLUSION

- Good physical examination
- Good treatment indication
- Good results

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Linear relationship : - LCL graft size - Correction forefoot abduction

(measured by the RX lateral incongruity angle)

→ helpfull for surgeon to titrate the proper amount of correction

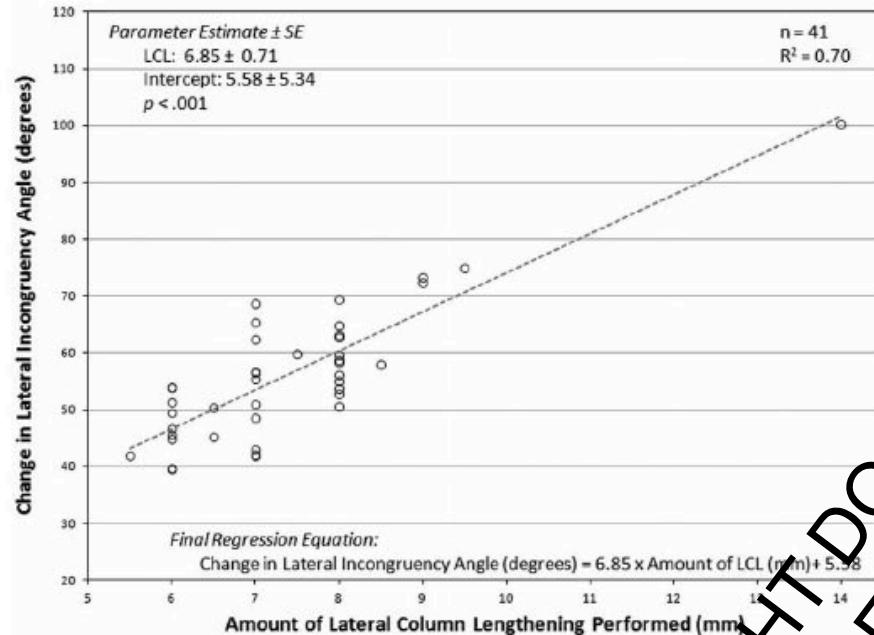


Figure 5. A linear regression model for the amount of LCL performed in relation to the change in lateral incongruity angles shown. The model demonstrates a significant positive correlation between LCL and the correction in forefoot abduction ($P < .001$). Each additional millimeter of lengthening performed corresponded to a 6.8 degrees change in lateral incongruity angle.



Figure 1. Preoperative (A) and postoperative (B) anteroposterior radiographs of the foot in a stage IIb flatfoot patient demonstrating the lateral incongruity angle (λ). The lateral incongruity angle was defined as the angle between a line connecting the lateral aspect of the talar and navicular articular surfaces (TN) and a line connecting the lateral aspect of the talar neck and talar articular surface (TT). The angle was defined as a positive value when the TN line was positioned lateral to the TT line, indicating a position of relative forefoot abduction. Change in the lateral incongruity angle was the only parameter found to be significantly correlated with the amount of lateral column lengthening performed.

Article

Contribution of Lateral Column Lengthening to Correction of Forefoot Abduction in Stage IIb Adult Acquired Flatfoot Deformity Reconstruction

Jeremy Y. Chan, MD¹, Stephen T. Greenfield, MD¹, Dylan S. Soukup, BS¹,
Huong T. Do, MA², Jonathan T. Deland, MD¹, and Scott J. Ellis, MD¹

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What kind of graft shape?

Rectangular graft (no trapezoidal)

- better bony realignment = better flatfoot deformity correction
(more graft volume medially)
- Intraarticular TN pressure \downarrow : trapezoidal = rectangular

Article

Effect of Graft Shape in Lateral Column Lengthening on Tarsal Bone Position and Subtalar and Talonavicular Contact Pressure in a Cadaveric Flatfoot Model

Sean T. Campbell, MD¹, Keri A. Reese, MD^{1,2}, Steven D. Ross, MD², Michelle H. McGarry, MS¹, Thu-Ba Leba, MD¹, and Thay Q. Lee, PhD^{1,2}

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CONCLUSIONS

- Tibialis Posterior Dysfunction St II

=

Complex problem
multiple therapeutic options

- MCO or LCL = not to be used alone

Additional procedures mandatory
depending on the deformations

- Displacement :

- MCO = *Hindfoot moment arm* > 0,5 mm varus
- LCL = 0,8 cm

- Double Osteotomy: LCL prior to the MCO

avoid overcorrection

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