



# **Hindfoot Deformity and**

# **The Concept of Asymmetric Ankle Arthritis**

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# Disclosure

Synthes – Consultant

Ascension - Consultant

I have no potential conflicts  
with this presentation.

# Overview

Valgus



Varus



# Etiology of Deltoid Dysfunction

- **Posterior Tibial Tendon Dysfunction**

- **Stage IV**

- **Triple with valgus malunion**

(Song SJ, Lee S, O'Malley et. al. Deltoid ligament strain after correction of acquired flatfoot deformity by triple arthrodesis.

Foot Ankle Int. 21(7):573-577, 2000)

- **Increased strain with triple**

- **Recommended**

- **Neutral position of triple**

- **Medial slide if needed**

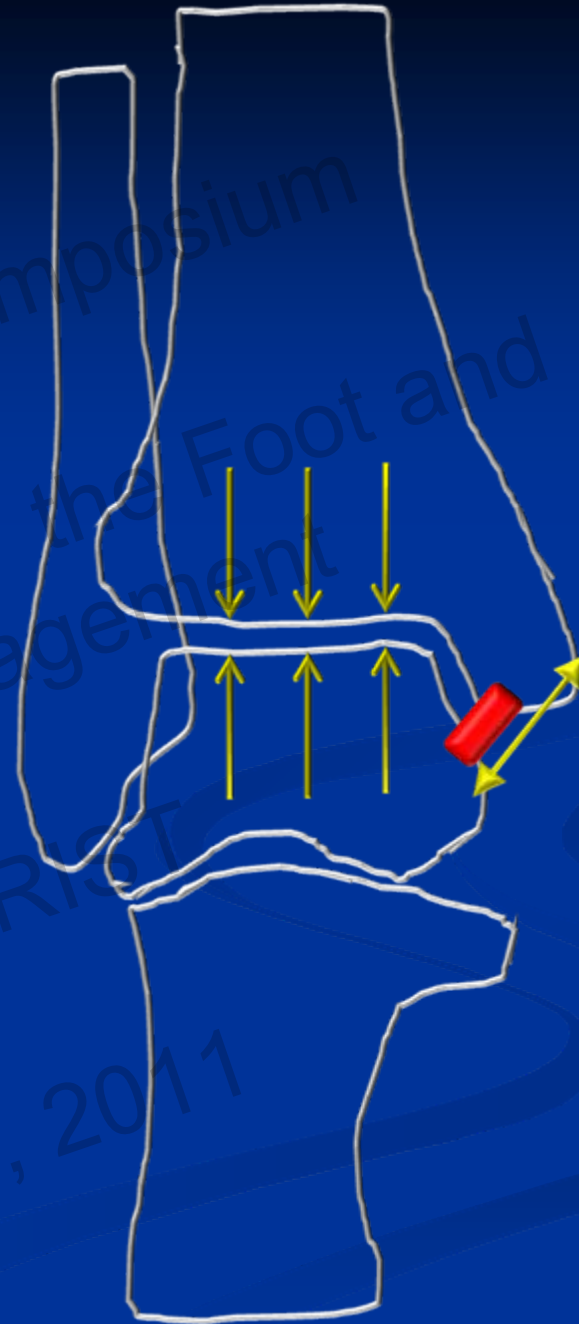


# Valgus Deformity

- **Assymmetric load**
  - **Abnormal forces**
    - **Lateral**
      - Increased pressure on articular cartilage
      - Accelerated wear
    - **Medial**
      - Increased tension on Deltoid ligament
        - Attenuated/Incompetent medial restraint
      - Decreased pressure on subchondral bone
        - Osteopenic bone

# Joint Forces

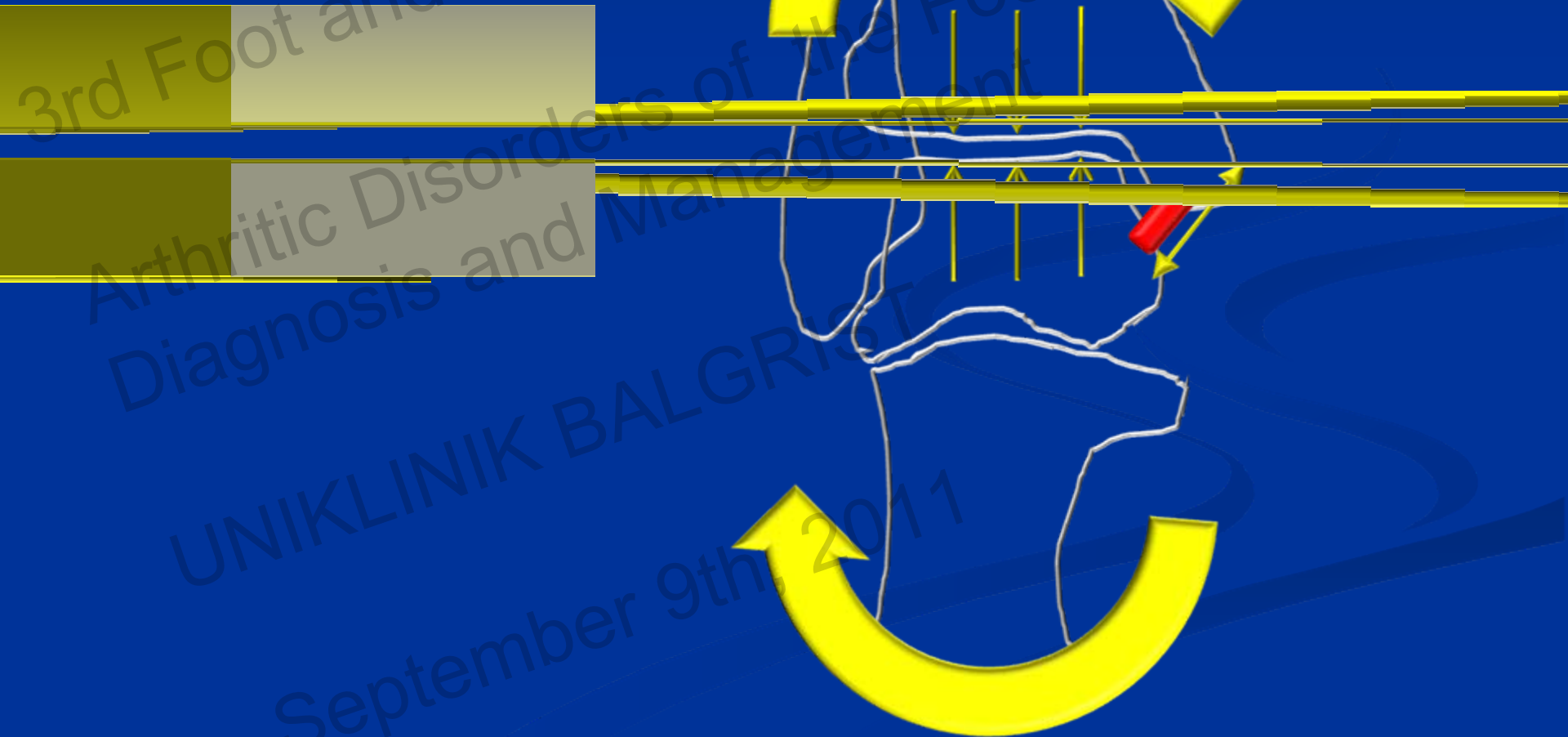
## Minimal Deformity



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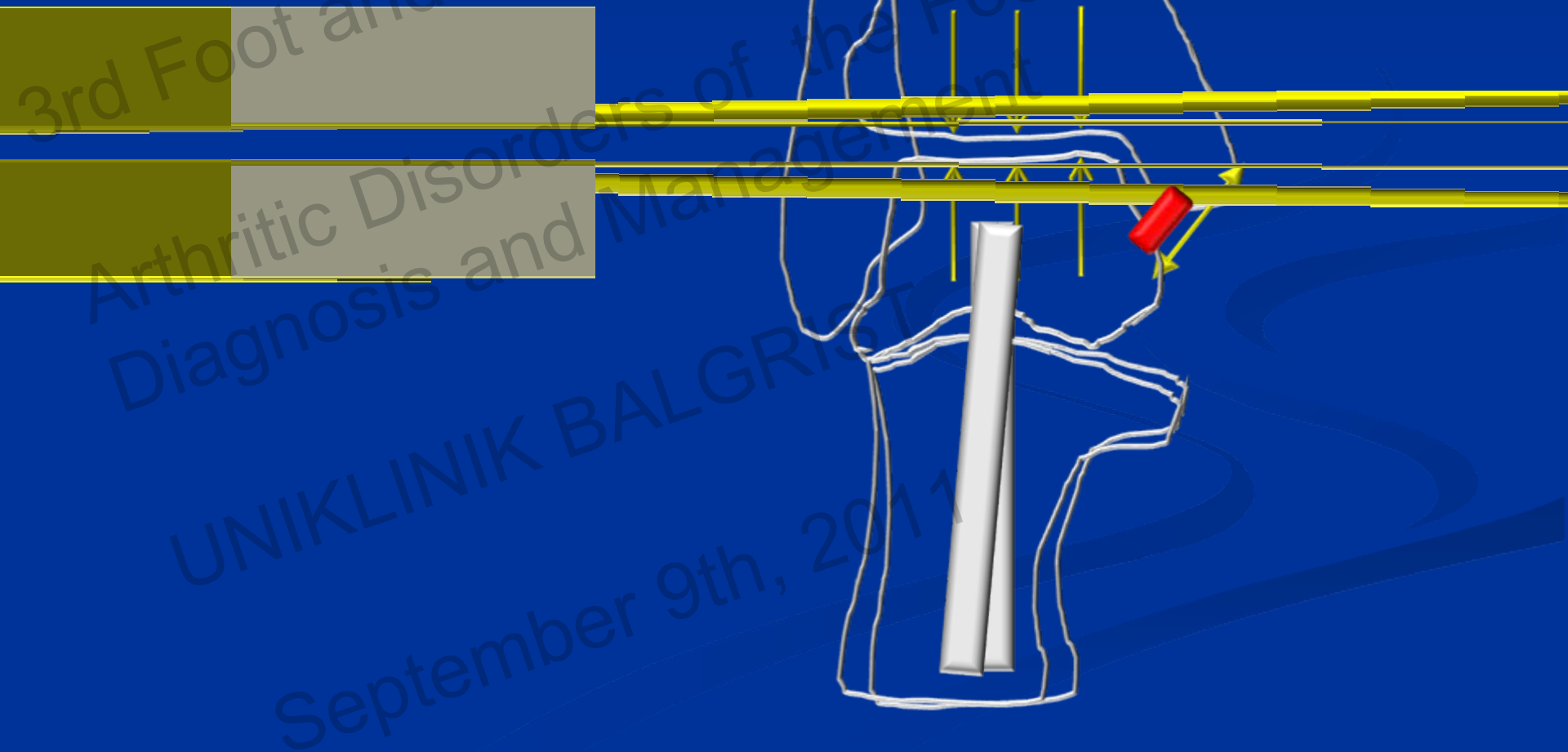
# Joint Forces

## Severe Deformity



# Joint Forces

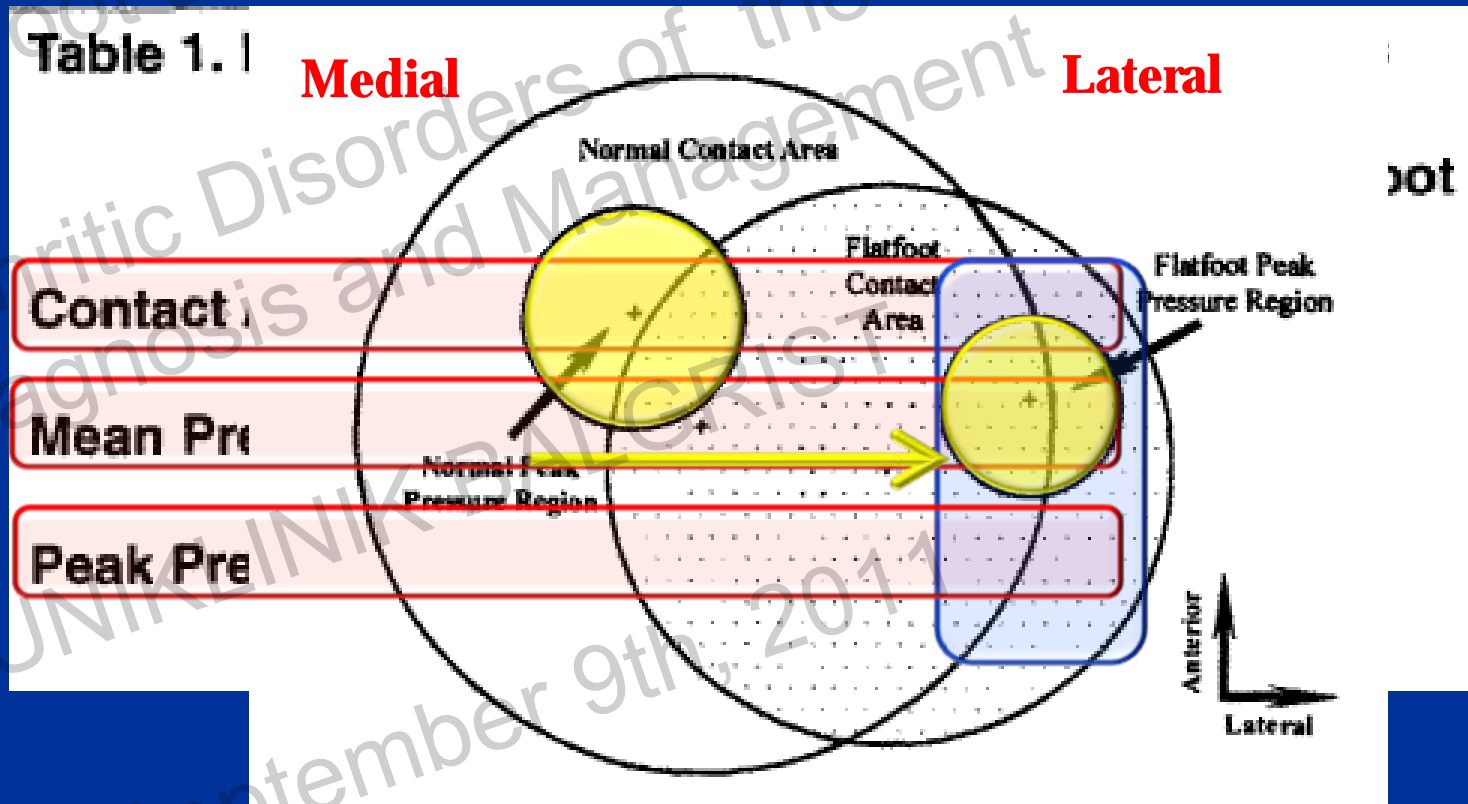
## Triple arthrodesis





# Tibiotalar Joint Contact Pressure

- **Cadaveric Study with simulated flatfoot**  
(Friedman et. al. FAI 2001)



# Bad flatfoot = Stage IV?

- **Significant pes planus**
  - **Deltoid may not see stress if hindfoot mobile**



# Bad flatfoot $\neq$ Stage IV

- **Severe hindfoot deformity without significant ankle valgus**



# Why Stage IV?

- **Transfer of stress from Calcaneus to Talus**
  - **Persistent ligamentous connection**
  - **Hindfoot DJD**
  - **Iatrogenic (Triple)**



# Treatment Strat - Nonop

- **Cadaveric Model – Medial slide calc ost vs. UCBL** (Havenhill TG, Toolan BC, and Draganich LF. FAI 2005)

**Table 1:** Mean (SEM) values of contact characteristics for the intact foot, flatfoot, and flatfoot corrected by orthosis and osteotomy

Variable	Intact	Flatfoot	Flatfoot + orthosis	Flatfoot + calcaneal osteotomy
Contact Area (mm <sup>2</sup> )	281 (11.2)	252 (25.0)	261 (14.6)	252 (17.7)
Mean Pressure (MPa)	8.39 (0.16)	8.54 (0.19)	8.23 (0.13)	8.38 (0.14)
Peak Pressure (MPa)	10.46 (0.28)	10.85 (0.34)	10.23 (0.28)	10.68 (0.37)
Displacement of Global Contact Area (mm)*				
x	0	-2.1 (0.6)	-1.0 (0.5)	-1.6 (0.7)
y	0	0 (0.2)	0.3 (0.2)	-0.2 (0.2)
Displacement of Peak Pressure (mm)*				
x	0	-5.5 (1.6)	-1.2 (2.1)	-3.6 (1.9)
y	0	-0.8 (1.5)	-0.7 (1.2)	-1.4 (0.9)

# Treatment Strat - Nonop

- **Cadaveric Model – Medial slide calc ost vs. UCBL** (Havenhill TG, Toolan BC, and Draganich LF. FAI 2005)

	<b>Peak Pressure</b>	<b>Displacement of Peak Pressure X</b>
Intact vs. FF	$p = .027$	$p = .01$
Intact vs. FF+O	$p = .037$	NS
Intact vs. CO	NS	NS
FF vs. FF+O	$p = .007$	$p = .035$
FF vs. CO	NS	$p = .044$
FF+O vs. CO	$p = .036$	NS

# Treatment Strat - Nonop

- Focus is to shift peak pressure towards neutral
  - UCBL
    - Flexible
- Minimize strain across the deltoid ligament
  - AFO/Arizona
    - Control hindfoot
      - Shift peak pressure
    - Stabilize Ankle
      - Decrease strain upon deltoid

# Treatment Strat - Operative

## ■ Goals

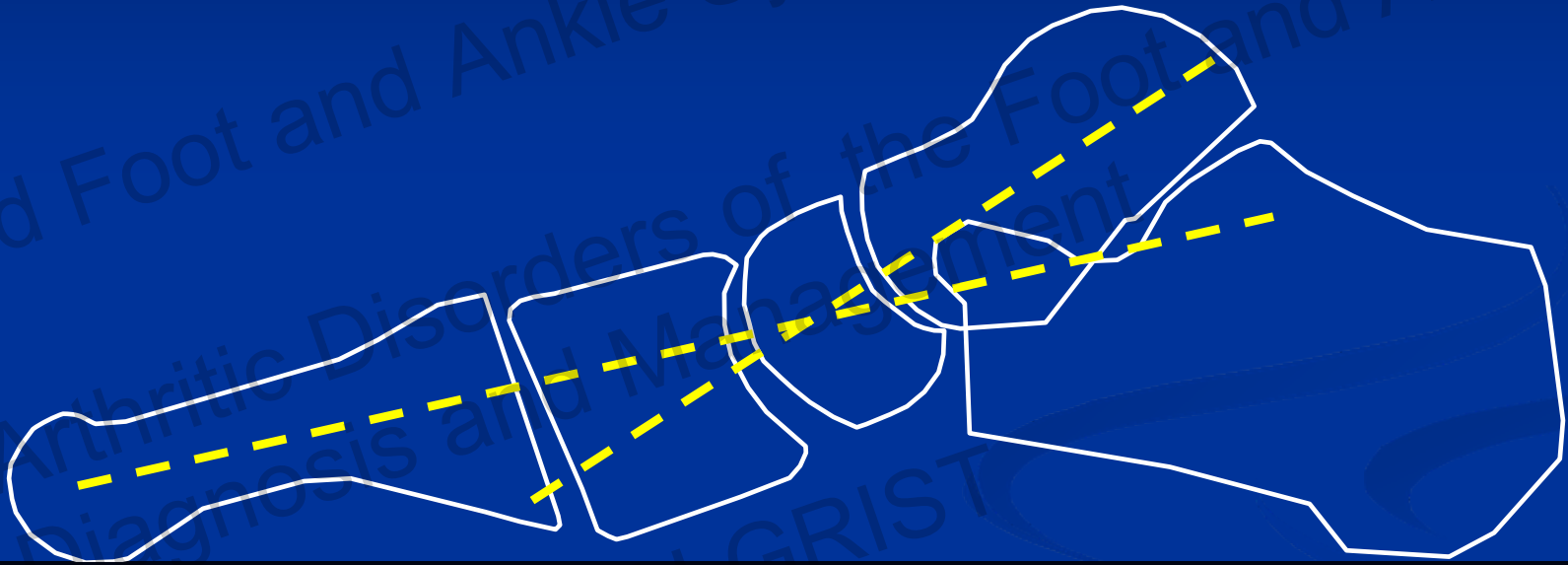
- Decrease peak pressure
- Shift location of peak pressure to neutral
- Minimize strain on Deltoid

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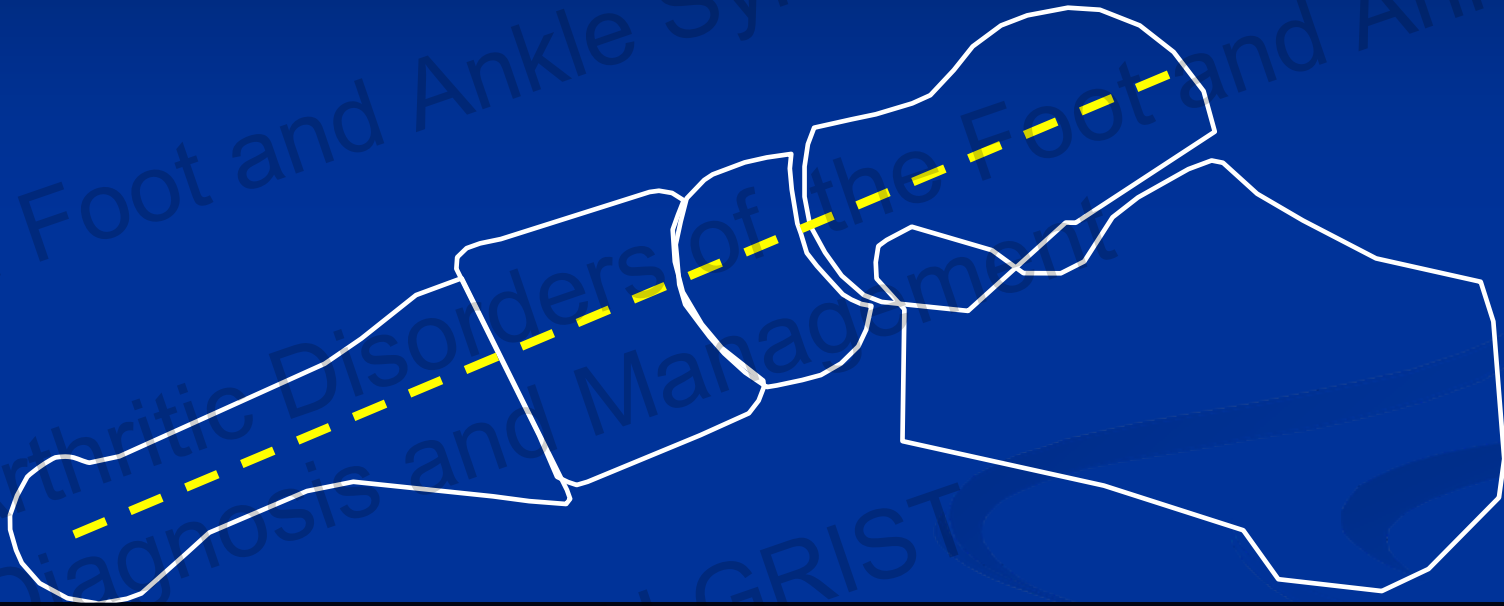


# Concept of Medial Column Stabilization



**Unstable Medial Column - precludes normalization  
of hindfoot alignment**

# Concept of Medial Column Stabilization



Arthrodesis of both the N-C joint and the 1<sup>st</sup> TMT is required to correct the deformity

# Outcomes

## ■ Isolated Medial Column Stabilization

(Greisberg et al. CORR: 435 (197-202 – 2005)

- Radiographic outcomes only
- 19 total - 13 patients with combined NC and 1<sup>st</sup> TMT for AAFD
- Improvement in both the Lateral 1st Talometatarsal angle and Talonavicular coverage

# Outcomes

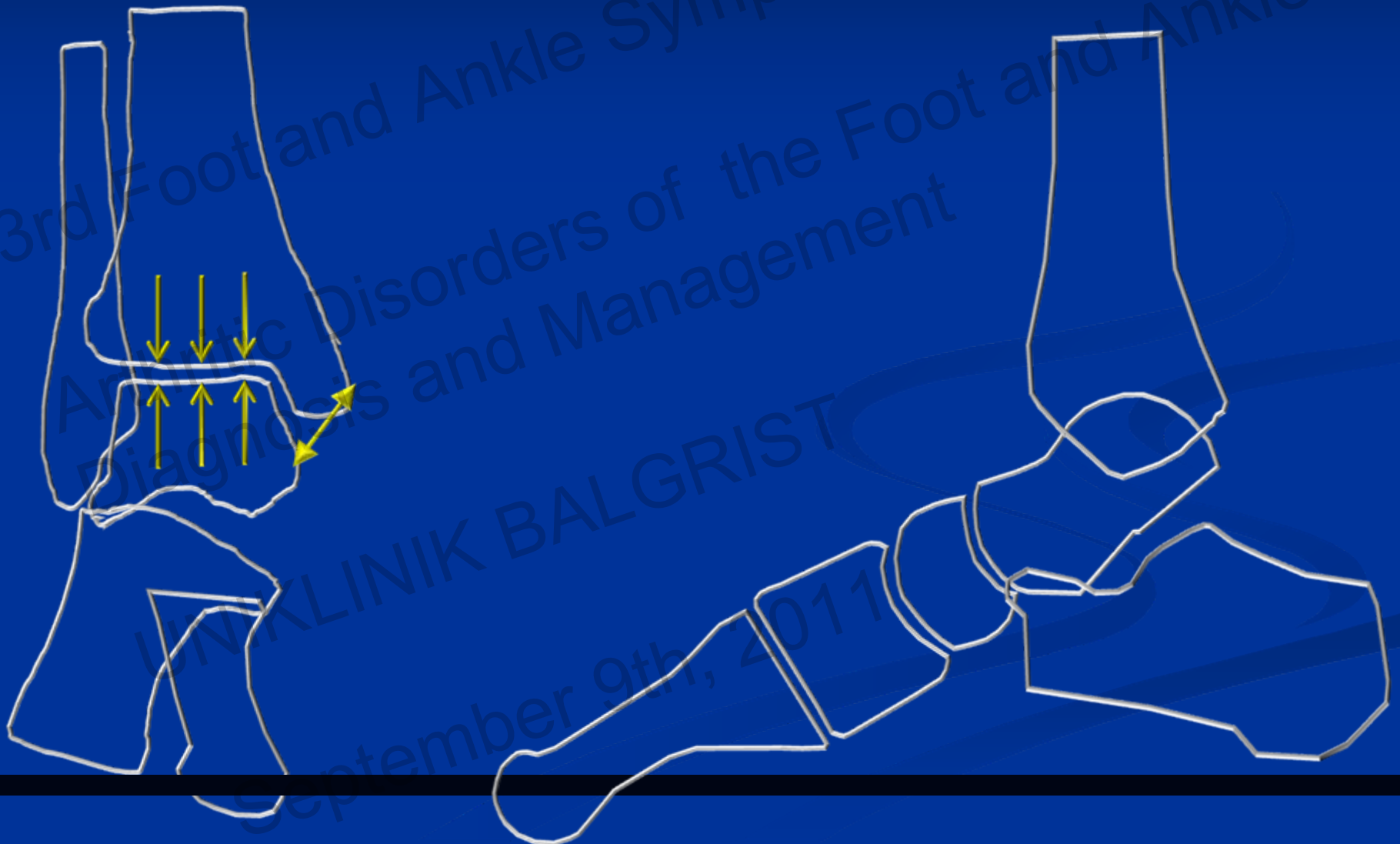


# Joint Forces



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## MCO

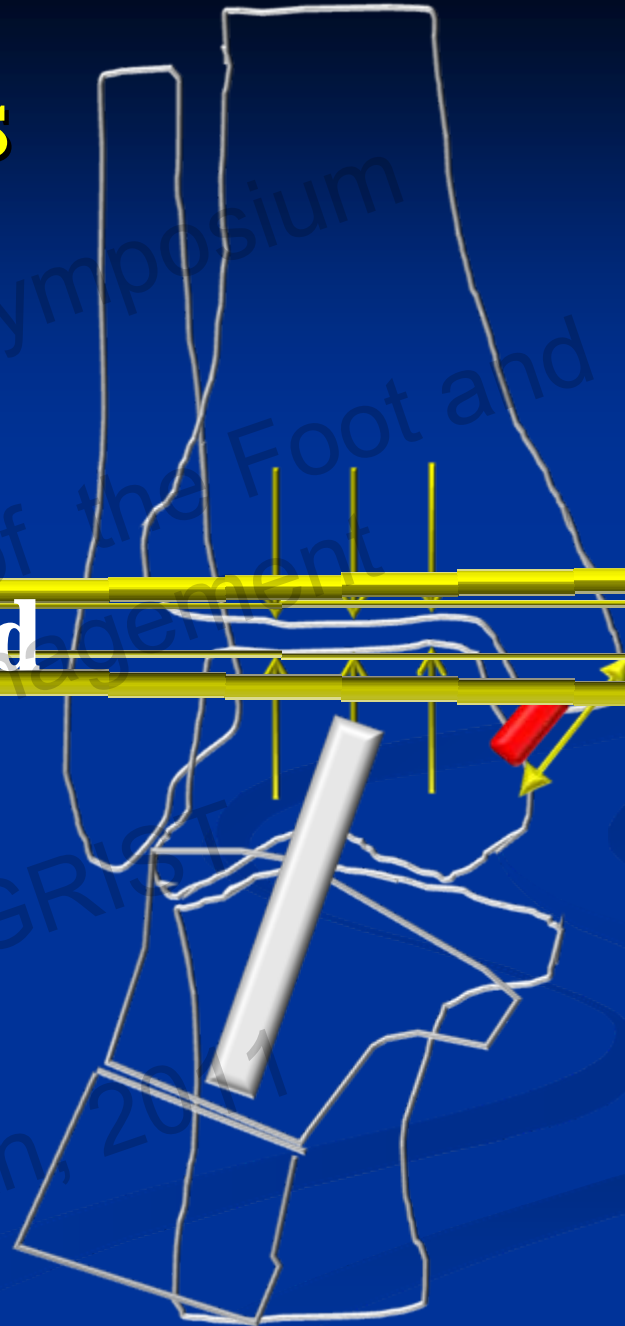
- Correction occurs through ST joint with minimal effect of Ankle



# Triple Arthodesis

## MCO

- Deformity correction focused at the ankle joint



# Valgus Deformity

- **Surgical Strategies – Overall Concepts**
  - **Flexible**
    - **Medial Column stabilization critical**
      - **Correct Hindfoot deformity**
      - **Minimize stress on the deltoid ligament**
      - **Decrease and realign peak pressure**
  - **Rigid**
    - **Triple arthrodesis with Medial slide**
      - **Decrease strain on the deltoid ligament**
    - **Correct residual forefoot varus**

# Varus Deformity



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# Varus Deformity

- **Assymmetric load**

- **Abnormal forces**

- **Medial**

- **Increased pressure on articular cartilage**

- **Accelerated wear**

- **Lateral**

- **Increased tension on ATFL/CFL**

- **Attenuated/Incompetent lateral restraint**



# Varus Deformity

- **Not just the opposite of a Valgus deformity**
  - **No instability between the talus and calcaneus**
    - **Increasing deformity => Increased stress on CFL**
  - **HSMN must be considered**
    - **Associated tendon transfer may be required**
    - **Deformity may progress over time despite bony rebalancing**
  - **Limited hindfoot eversion**
    - **Orthotic management difficult**

# Varus Deformity

- **Increased Peak Pressure** (Krause F, et. al. JBJS Br. 2007)

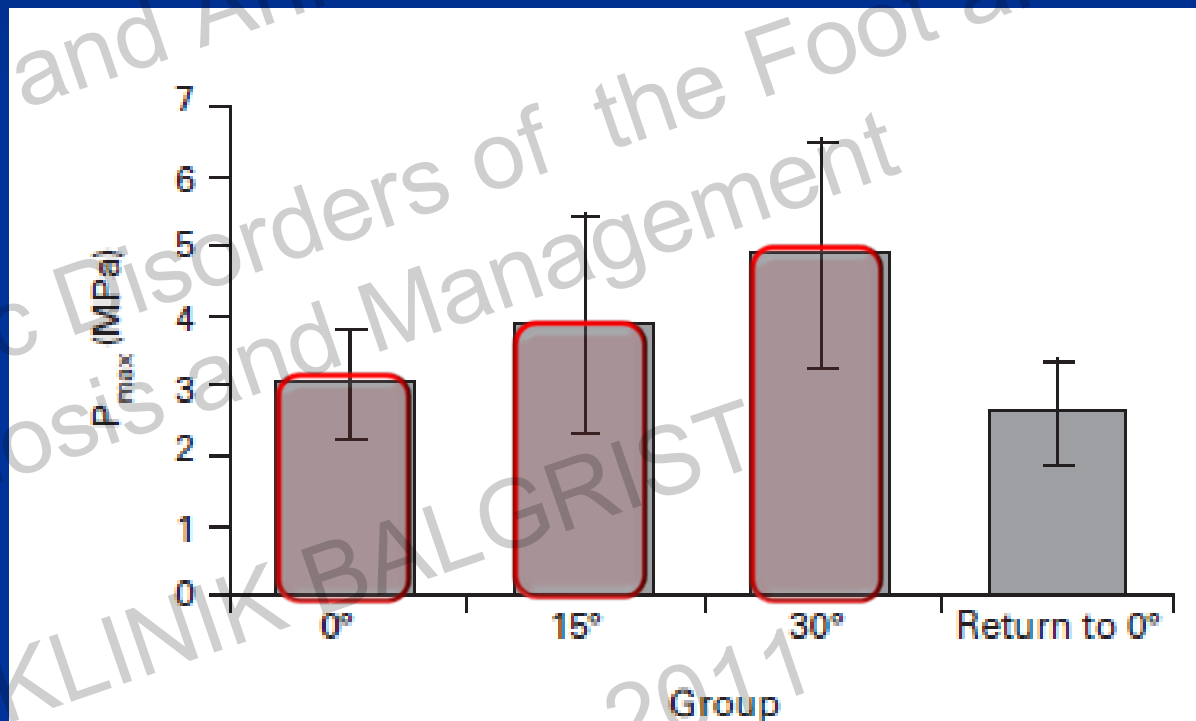


Fig. 4

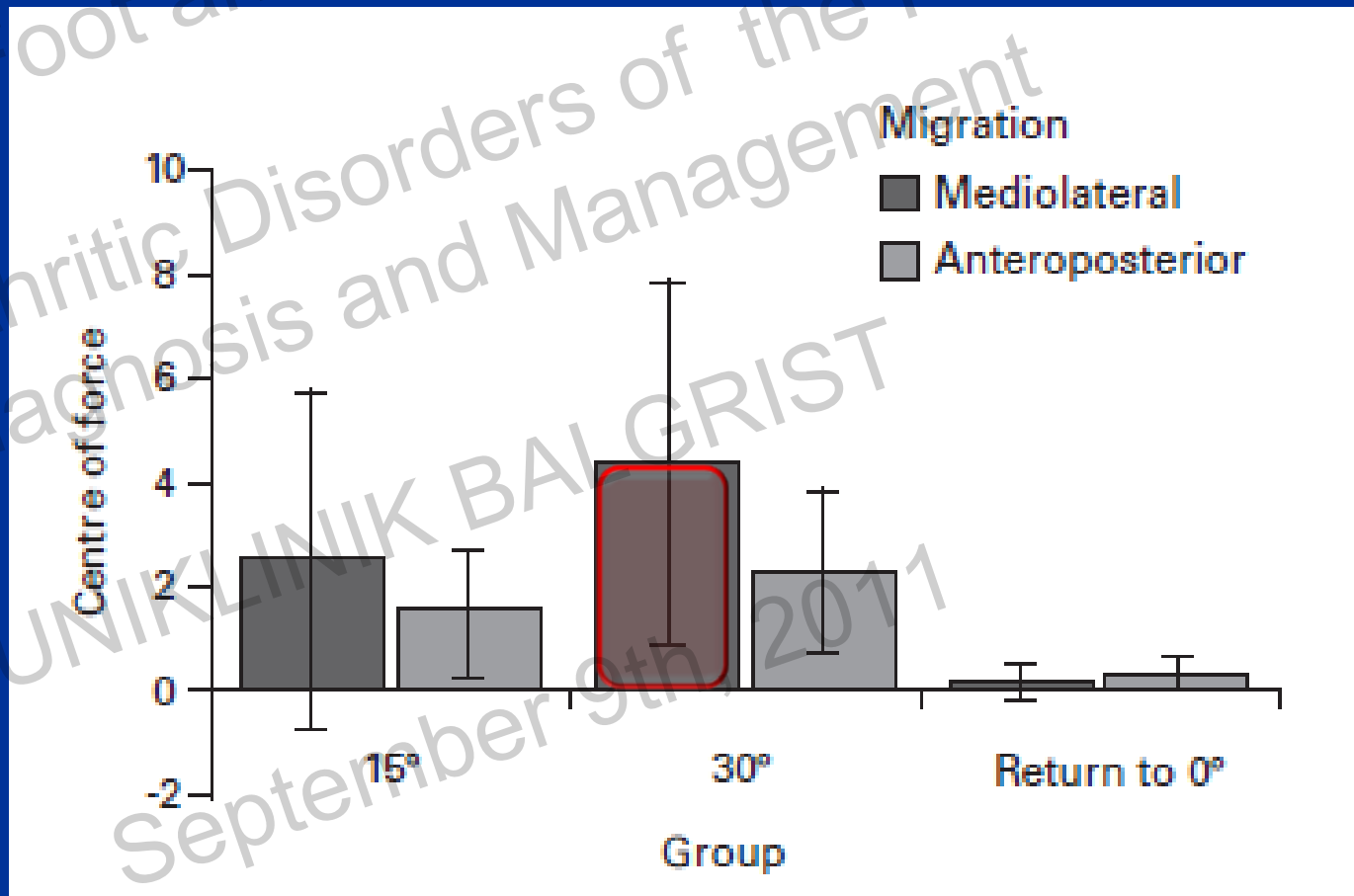
Peak pressures ( $P_{max}$ ) for all study groups (mean with standard deviation indicated by error bars).



# Varus Deformity

## ■ Medial Translation of the Peak Pressure

(Krause F, et. al. JBJS Br. 2007)

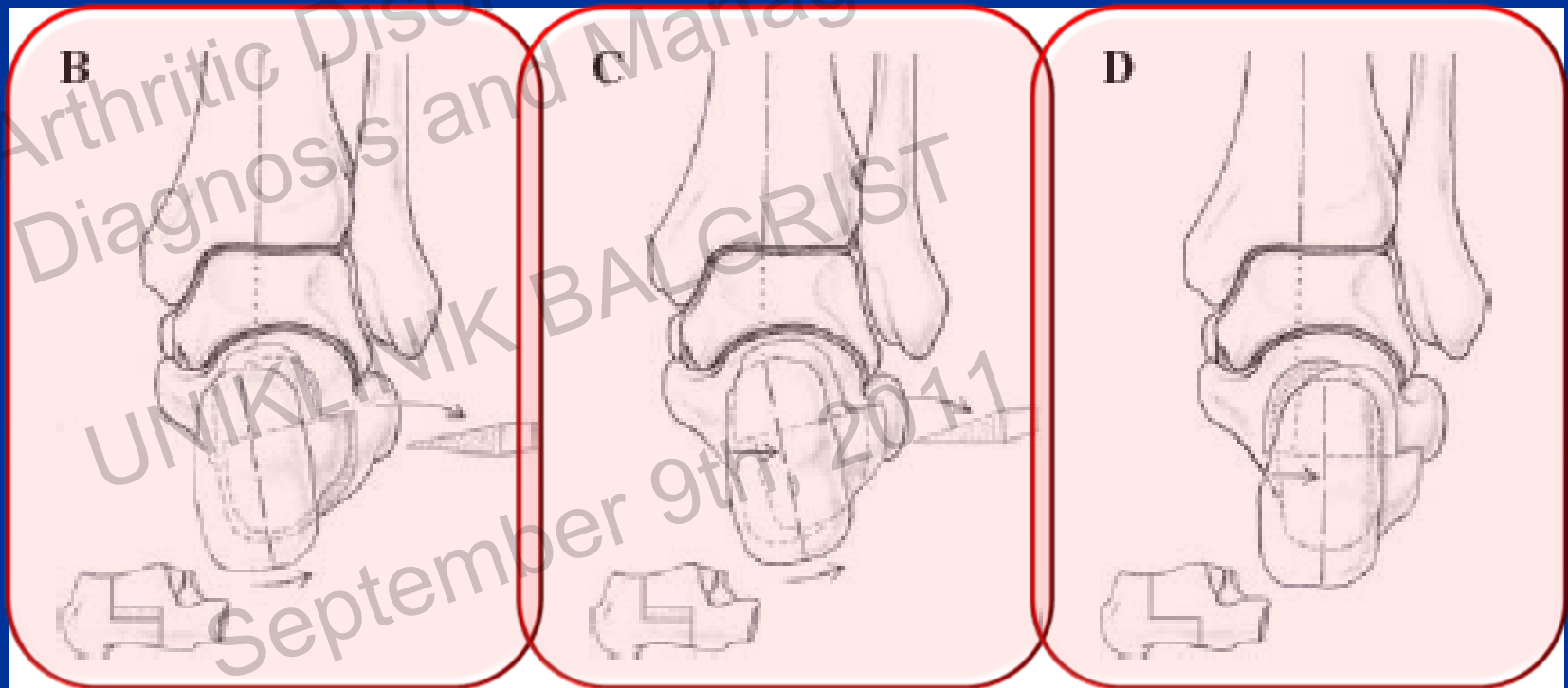


# Varus Deformity

- **Ankle Pressure s/p Calc Osteotomy**

(Krause F, et. al. Foot Ankle Int. 2010)

- **Cavovarus model - Analysis of 3 osteotomies**



# Varus Deformity

- Z lateral closing wedge with lateralization >
- Z with isolated lateral translation >
- Z lateral closing wedge
- Each showed significant pressure shift laterally.

**Take home – Shift is key.**

# Address Hindfoot Only?



# Ligament Reconstruction and Calcaneal Osteotomy for Osteoarthritis of the Ankle

Ho Seong Lee, MD, PhD; Keith L. Wapner, MD; Soo Sung Park, MD; Jin Sam Kim, MD; Dong Ho Lee, MD; Dong Wook Sohn, MD  
*Seoul, Korea*

- **Operative Intervention – 22.3 mos mean f/u**
  - **Joint debridement**
  - **Medial ligament release**
  - **Lateral collateral reconstruction (Brostrom)**
  - **Lateral calcaneal slide osteotomy**

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# Results

**Table 3:** Preoperative and last followup clinical and radiological parameters

No.	Gender	Age (years)	Talar tilt (degrees)		Clear space ratio		Heel alignment ratio		Takakura stage		AOFAS score	
			pre op	post op	pre op	post op	pre op	post op	pre op	post op	pre op	post op
1	F	57	1	1	0	0.84	0.57	0.49	3a	2	54	87
2	F	63	3	3	0.13	0.8	0.47	0.22	3b	2	26	80
3	F	56	6	4	0.13	0.6	0.33	0.17	2	1	56	97
4	F	49	5	3	0	0.93	0.65	0.58	3a	1	21	83
5	F	60	7	5	0	1.01	0.61	0.36	2	2	54	87
6	M	61	11	8	0	0.82	0.83	0.43	3b	2	25	78
7	M	64	13	10	0	0.75	1.19	0.47	3b	2	27	80
8	F	56	10	10	0.07	0.2	0.35	0.27	2	2	56	100
9	F	52	12	10	0.08	0.1	0.68	0.4	3b	3b	41	61
10	F	65	2	2	0.2	0.6	0.27	0.15	2	2	59	90
11	M	48	11	9	0	0.13	0.53	0.4	3b	3b	52	67
<b>Mean</b>		<b>57.4</b>	<b>7.4</b>	<b>5.9</b>	<b>0.06</b>	<b>0.62</b>	<b>0.59</b>	<b>0.36</b>			<b>42.8</b>	<b>82.7</b>
<b>SD</b>		<b>5.9</b>	<b>4.4</b>	<b>3.5</b>	<b>0.07</b>	<b>0.32</b>	<b>0.26</b>	<b>0.14</b>			<b>15.1</b>	<b>11.6</b>

SD : standard deviation

# Address Hindfoot Only?





# Address Hindfoot Only?





# Joint Forces



# Joint Forces



# Joint Forces



# Joint Forces



# Joint Forces



# Conclusion

- **Hindfoot Deformity is critical to evaluate in the setting of asymmetric ankle arthritis**
  - **2 primary causes**
    - **Collateral ligament strain and laxity**
      - (Incongruent Joint)
    - **Supra physiologic pressure on articular cartilage**
      - (Congruent Joint)
  - **Combined**

# Conclusion

## ■ Valgus

- **Medial column stabilization**

- **Medial slide osteotomy**

- May be used in flexible deformity (minimal shift on articular pressure)
- Critical in triple arthrodesis

## ■ Varus

- **Lateral slide calcaneal osteotomy**

- Proven to shift pressure laterally

- **DF osteotomy 1<sup>st</sup> metatarsal**

- In setting of DJD, perform both to “over-correct”

- **Concomitant soft tissue reconstruction as indicated**



**Thank You**

