ISAKOS Congress 2023

HOKKAIDO UNIVERSITY

The Effect Of Medial Closing Wedge Distal Femoral Varus Osteotomy On Contact Stress Distribution Pattern Of The Femorotibial Joint

[1]Masanari Hamasaki, [2]Eiji Kondo, [3]Koji Yabuuchi, [4]Koji Iwasaki, [1]Yuki Suzuki, [1]Masatake Matsuoka, [1]Tomohiro Onodera, [3]Kazunori Yasuda, [3]Tomonori Yagi, [1]Norimasa Iwasaki

[1]Department of Orthopaedic Surgery, Faculty of Medicine and Graduate School of Medicine, Hokkaido University, Sapporo, Japan
[2]Center for Sports Medicine, Hokkaido University Hospital, Sapporo, Japan
[3]Department of Orthopaedic Surgery, Yagi Orthopaedic Hospital, Sapporo, Japan
[4]Department of Functional Reconstruction for the Knee Joint, Faculty of Medicine, Hokkaido University, Sapporo, Japan

COI Disclosure Information

HAMASAKI Masanari

My disclosure along with my co-authors is listed in the disclosure index on the ISAKOS website.

I have no conflicts.

Distal Femoral varus Osteotomy (DFO)

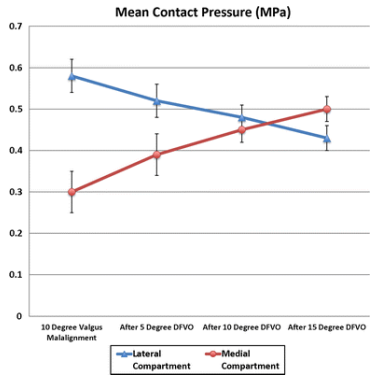
- A well-established treatment option for patients with valgus malalignment

Weil et al KSSTA 2017

- Medial closing wedge (M) -DFO
  - ✓A useful procedure in patients with meniscus deficiency, focal chondral defects and OA in lateral compartment

Sheehan et al JAAOS 2017

- Cadaveric studies have confirmed the role of M-DFO in correcting the mechanical axis of the lower limb and unloading the lateral compartment.



Quirno et al KSSTA 2017

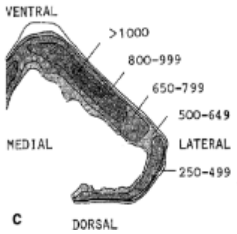
- ✓ No *in vivo* studies have been conducted to clarify the stress distribution patterns of the FT joint after M-DFO.

The distribution pattern of subchondral bone density reflects the distribution of the stress acting on the joint surface under actual loading conditions.

CT-osteoabsorptiometry (OAM)

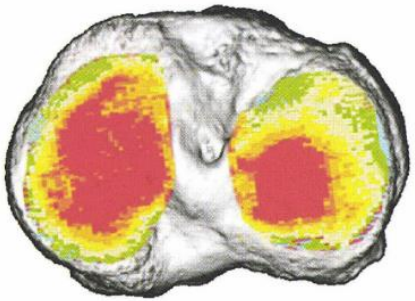
– An analytical method for assessment of the stress distribution at joints through the subchondral bone density

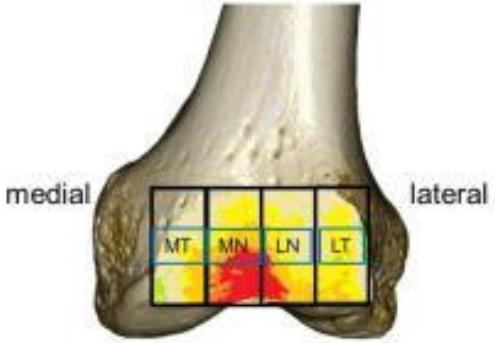
Muller-Gerbl et al Skeletal Radiol 1989, J Bone Miner Res 1992

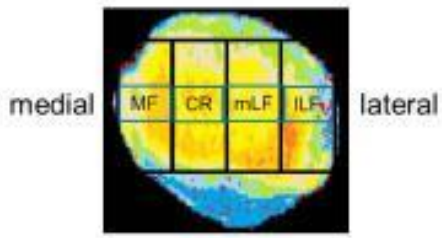


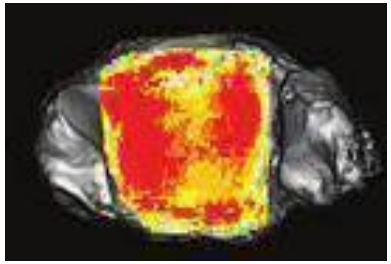
✓ A useful method for evaluation of *in vivo* stress distribution of various joints

Iwasaki et al	*J Hand Surg 2000*
Nishida et al	*Am J Sports Med 2012*
Iwasaki et al	*Am J Sports Med 2021*
Kameda et al	*OJSM 2021*
Matsubara et al	*Am J Sports Med 2021*









Hypothesis

- M-DFO alters the stress distribution across the articular surface of FT joint.

Purpose

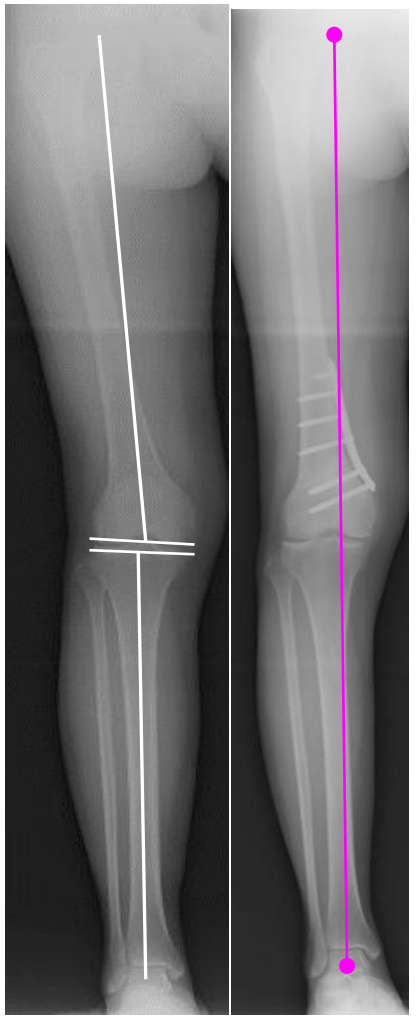
- To evaluate change in the distribution pattern of subchondral bone density of the FT joint in patients with valgus knee before and after M-DFO

Methods

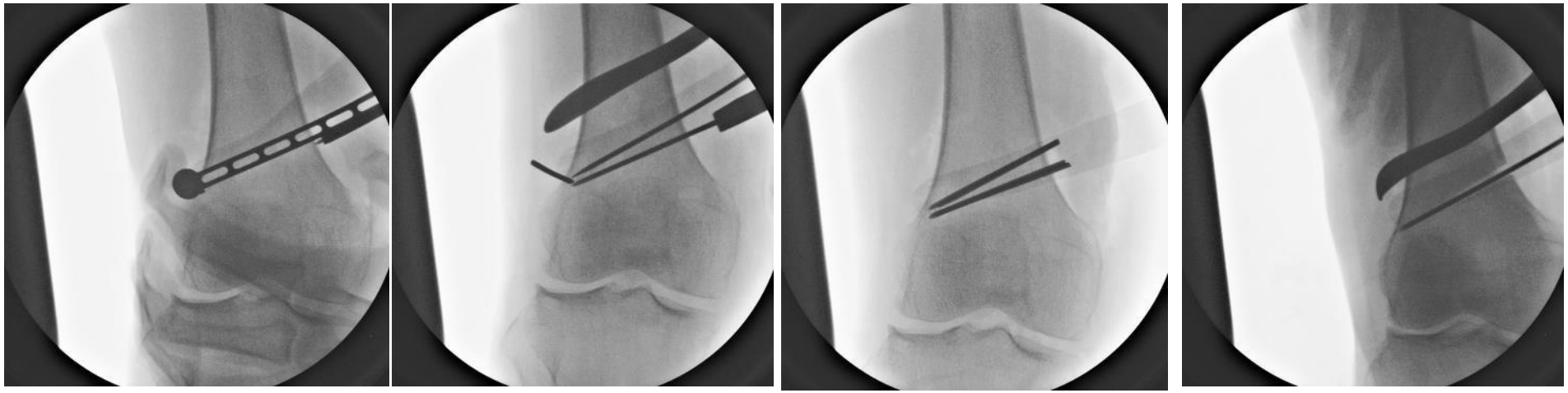
Study design

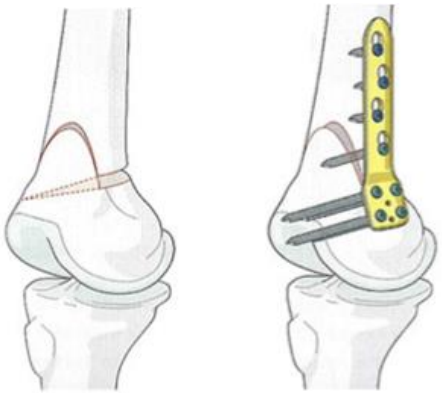
- 13 patients (14 knees)：2016-2020
  - ✓ M-DFO for lateral compartment OA or SONK
  - ✓ 2 men, 11 women
  - ✓ 43 (14-73) years
- Clinical and radiological examinations were performed before and 2 years after surgery.
  - ✓ Radiographic evaluation
    - ✓ HKA, FTA, mechanical axis (MA), mLDFA
    - ✓ CT

- Statistical analysis
  - Paired Student t-test
  - $p = 0.05$

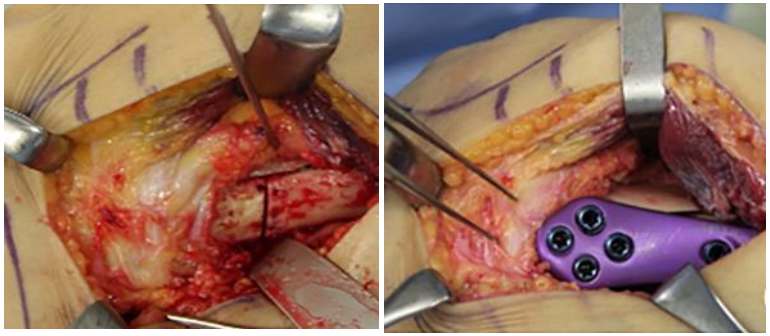


Surgical procedure





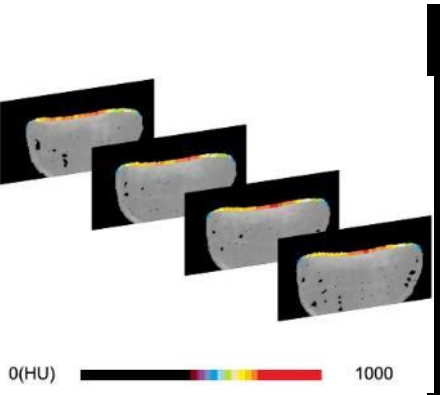
Heerwaarden et al. KSSTA 2011

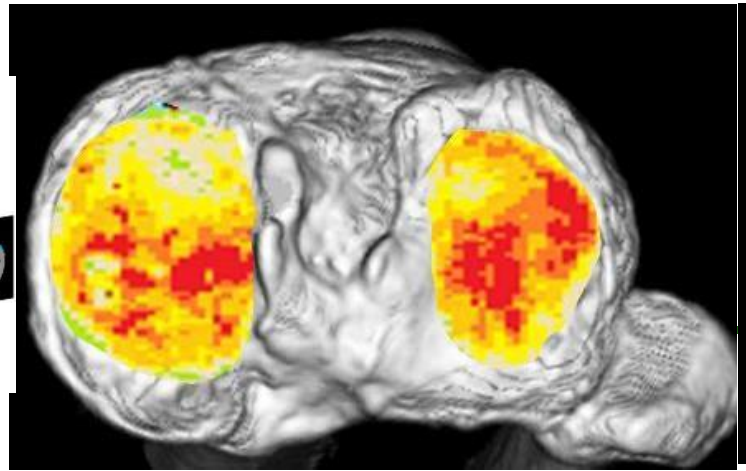


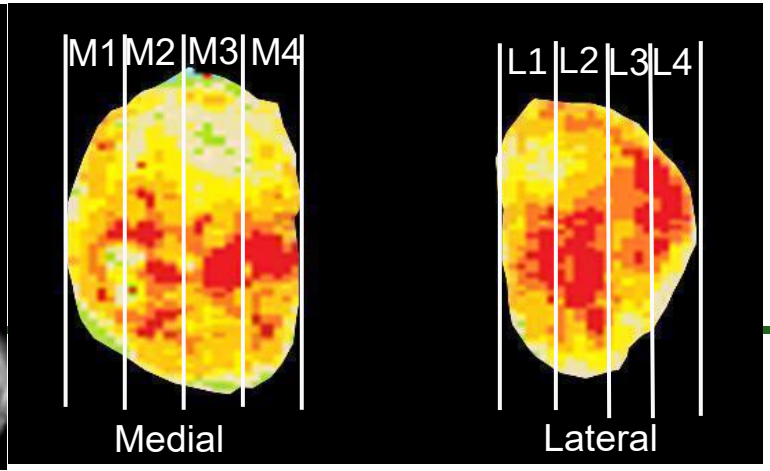
Kaibara et al. JOS 2021

CT-OAM

- Hounsfield units were measured using our original software.
- A distribution map was created.
- The upper 30% area in Hounsfield units value on the medial and lateral compartments was defined as the High bone Density Area (HDA).
- Both the medial and lateral compartments of the proximal tibia were divided into 4 subregions.
  - ✓ The %HDA in each subregion was analyzed.







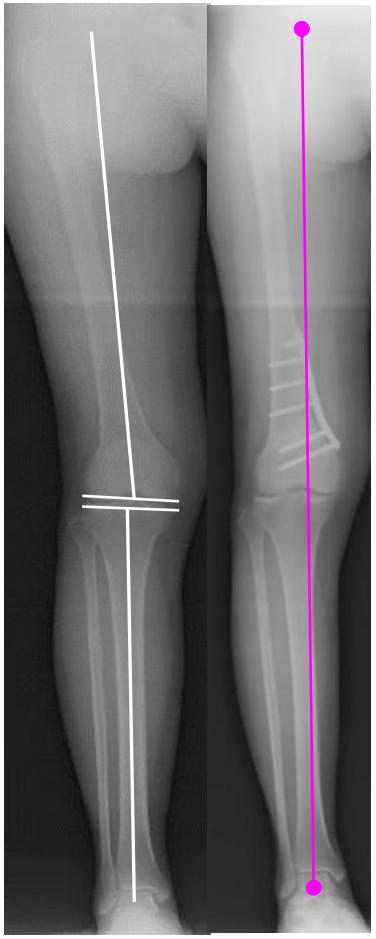
Results

Radiological evaluations

	Pre-operative	Post-operative	P value
Correction angle (degree)	N/A	7.1 (1.5)	
HKA (degree)	6.3 (4.9)	-1.9 (3.0)	**<0.001**
FTA (degree)	168.2 (4.3)	176.6 (3.6)	**<0.001**
MA (%)	74.6 (19.5)	38.0 (12.7)	**<0.001**
mLDFA (degree)	81.7 (4.0)	89.4 (3.7)	**<0.001**

HKA, hip-knee-ankle angle FTA, Femoral tibial angle
MA, mechanical axis mLDFA, mechanical lateral distal femora angle

Mean (SD)
N/A: Not applicable



Clinical evaluations

	Pre-operative	Post-operative	P value
Lysholm score (points)	58.7 (19.8)	87.4 (7.0)	**0.0014**
JOA score (points)	64.9 (14.6)	87.2 (8.5)	**<0.001**

JOA,Japanese Orthopedec Association
Aoki et al JBJS Br 2006

Mean (SD)
N/A: Not applicable

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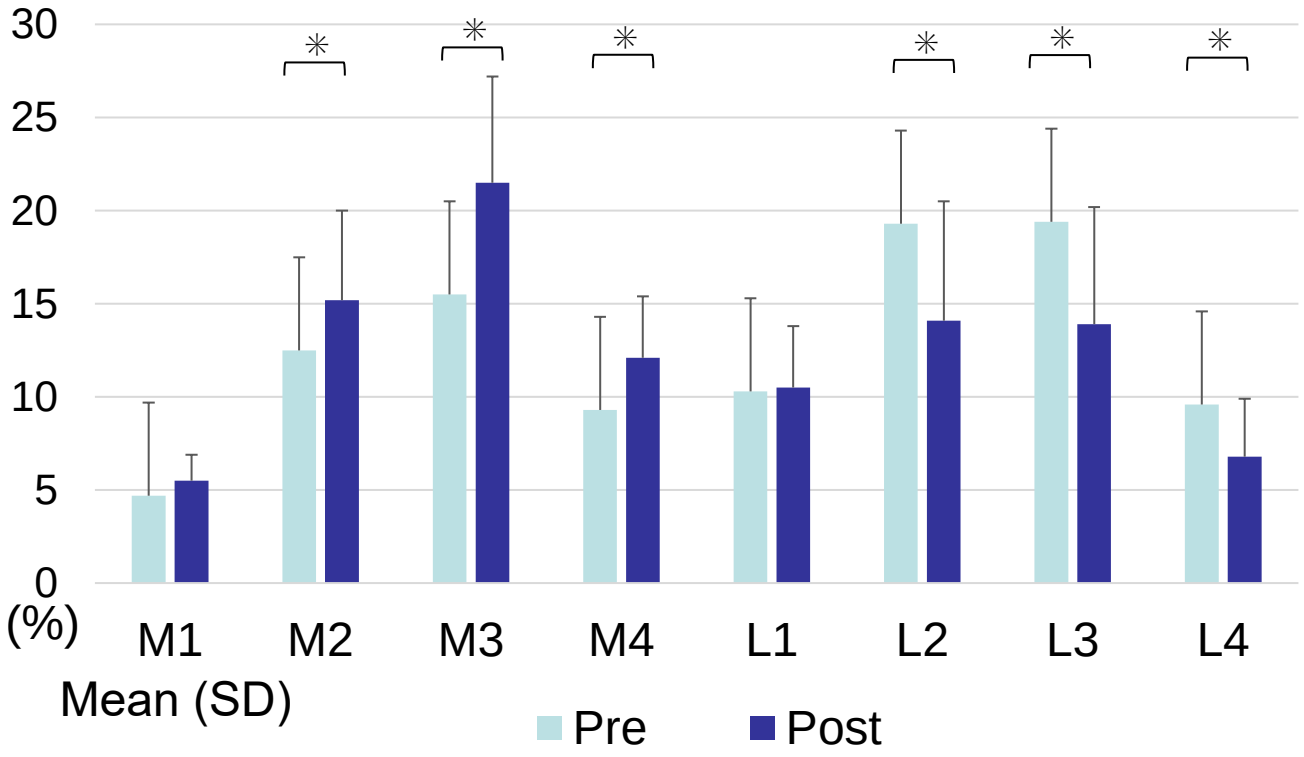
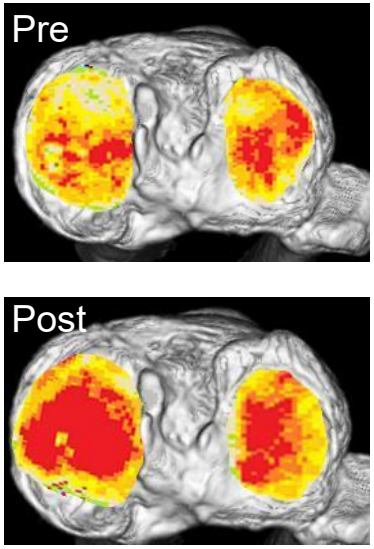
Results

In CT-OAM evaluation, the %HDA of the L2, 3 and 4 regions were significantly decreased after M-DFO surgery.

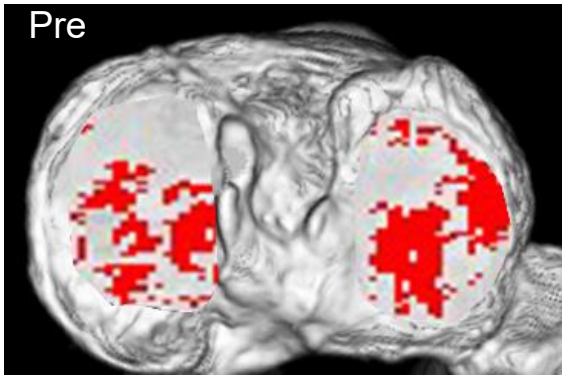
In contrast, the %HDA of the M2, 3, and 4 regions were significantly increased after surgery

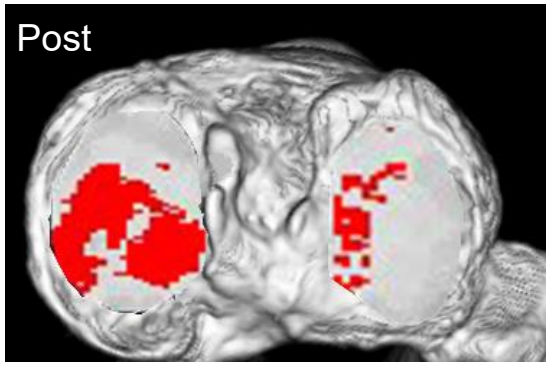




Discussion

- Clinical scores significantly improved after M-DFO.
- Using CT-OAM, M-DFO significantly decreased %HDA in the lateral compartment and increased %HDA in the medial compartment.
  - ✓ These results indicated that M-DFO shifted the stress of the lateral compartment of the proximal tibia toward the medial compartment.





Discussion

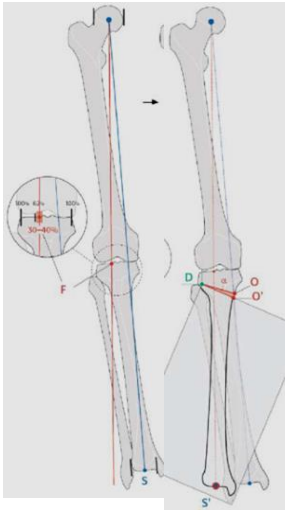
- The goal of correction angle of valgus HTO has been well studied and established.

Fujisawa et al Clin Orthop North Am 1979

- The goal of varus correction angle of the knee remains unknown.
- Favorable clinical outcomes in varus DFO were reported to be obtained in the alignment within MA of 36-43%.

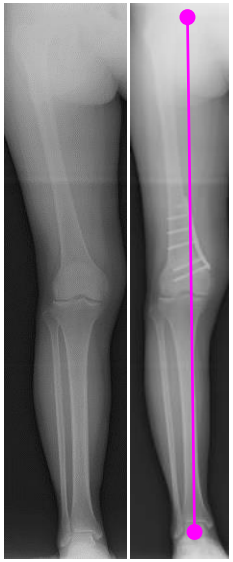
Shivji et al. KSSTA 2021

- In this study
  - ✓ MA was 38% and HKA -2 degrees.
  - ✓ Clinical scores significantly improved.



Fujisawa et al
Clin Orthop North Am 1979

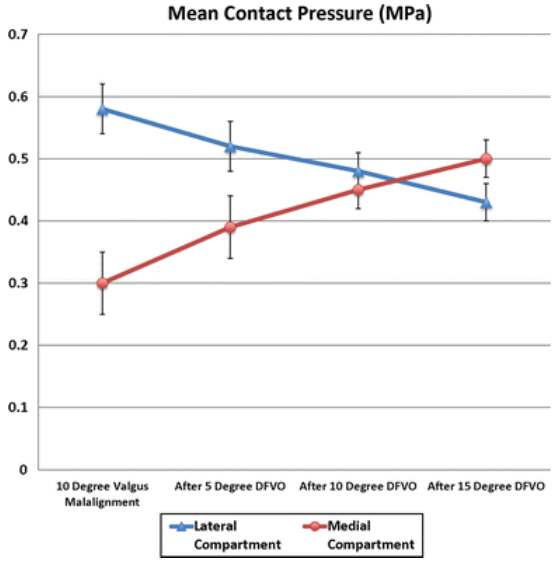
Forkel et al KSSTA 2014



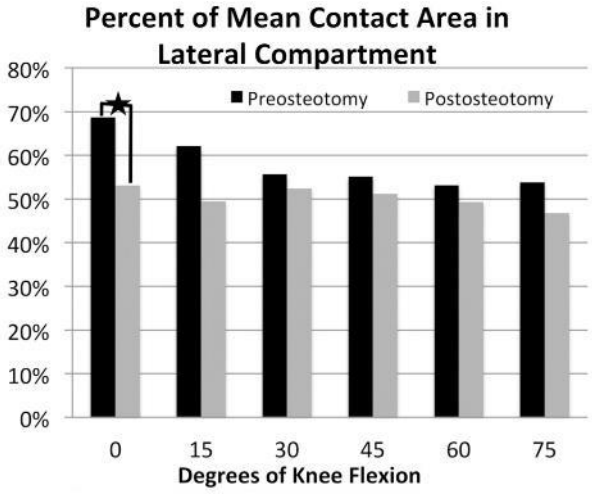
Discussion

- In cadaveric study
- ✓ DFO decreased lateral compartment pressure.
- ✓ Progressive unloading of the lateral compartment occurred with increasing DFO correction angles.

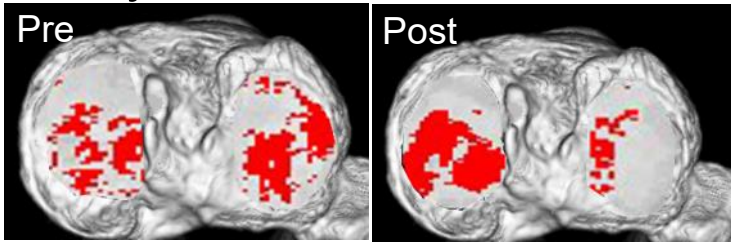
Quirno et al KSSTA 2017



Wylie et al Am J Sports 2018



- This study clarified *in vivo* stress distribution patterns of the FT joint were significantly shifted from medial to lateral by the M-DFO.



Conclusion

- This study showed in vivo stress distribution patterns of the FT joint before and after M-DFO using CT-OAM method by subchondral bone density.
- M-DFO significantly shifted stress distribution patterns of the lateral FT joint in patients with valgus malalignment.