



# Changes in Relative Contributions of Each Moment Components at the Knee after Medial Open-wedged High Tibial Osteotomy

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No COI with regard to the current presentation.



DEPARTMENT OF ORTHOPEDIC SURGERY



External knee moment and high tibial osteotomy (HTO)

- ✓ KAM: Knee adduction moment
- ✓ KFM: Knee flexion moment
- ✓ KRM: Knee rotation moment
- HTO not only changes the coronal alignment (KAM) but also sagittal and horizontal alignment

*Lind et al. KSSTA 2014 Deie et al. The Knee 2014* 

- However, it is important to consider the relative contributions of each moment to the total joint
   moment at the knee
   Asay et al. JOR 2018
- The purpose of this study was to clarify the change of relative contributions of each moment components to TJM before and after HTO





## Methods

 55 patients (55 knees) who underwent medial open-wedge HTO (MOWHTO) for osteoarthritis (OA) and gait analysis before and after 1-year surgery (2014-2019)

✓ 25 men, 30 women						
✓ 58.3 ± 6.1 years			Preoperative	Postoperative	p value	
<ul> <li>✓ Height :</li> <li>✓ Body weight:</li> </ul>	161.4 ± 0.8 cm 69.3 ± 9.2 kg	HKA (degrees)	$-3.9 \pm 2.3$	3.6 ± 1.4	< 0.01	
		%MA	31.3 ± 9.7	$63.8 \pm 6.5$	< 0.01	
Operation ✓ Performed by single surgeon ✓ Target mechanical axis was 62 to 65%		Gait speed (m/s)	1.2 ± 0.2	$1.2 \pm 0.2$	= 0.01	
		JKOM total	33.5 ± 14.0	11.2 ± 7.5	< 0.01	
		KSS total	90.8 ± 21.0	132.8 ± 22.9	< 0.01	

HKA, Hip-knee-ankle angle; %MA percentage of mechanical axis; JKOM, Japanese knee osteoarthritis measure score; KSS, knee society score





## Gait analysis

- Self-selected speed
- Optical motion capture system
- 3-dimensional gait analysis machine: 8 infrared cameras and 2 force plates (120 Hz each)
- Point Cluster Technique: 6 degrees of freedom knee joint kinematics
- Three moment components at the knee joint calculated by inverse dynamics
  - ✓ KAM, KFM, KRM
  - ✓ Total joint moment (TJM): TJM =  $\sqrt{(KAM^2 + KFM^2 + KRM^2)}$
  - ✓ Peak value (TJM, KAM, KFM, KRM)
  - ✓ Relative contributions of each components @maximum TJM
    - %KAM, %KFM, %KRM

$$ex) \% KFM = \frac{KFM^2}{T.IM^2} \times 100$$



- ✓ Gait cycle was defined as percentage maximum 100%
- Statistical analysis: Paired t-test was carried out for comparing pre and postoperative results
  - ✓ Significance: P < 0.05



#### Knee external moment



Pre vs post operative KAM through whole gait cycle (P < 0.0001). No significance in KFM.





# TJM



No significance in peak value of TJM between pre vs post operatively.





### Relative contribution of each moment components



Pre vs post operative KAM in both 1<sup>st</sup> and 2<sup>nd</sup> peak (P < 0.0001). Pre vs post operative KFM in both 1<sup>st</sup> and 2<sup>nd</sup> peak (P < 0.0001). Pre vs post operative KRM in 1<sup>st</sup> peak (P < 0.0001).





### Summary of the results

- The KAM decreased significantly at both the 1<sup>st</sup> and 2<sup>nd</sup> peak postoperatively
- The KFM increased significantly at 1<sup>st</sup> peak and had same tend at the 2<sup>nd</sup> peak
- There was no significant difference in TJM between pre and post operation
- The relative contribution of KAM significantly decreased and that of KFM increased





External moments and relative contribution

- Coronal alignment
  - ✓ The 1<sup>st</sup> and 2<sup>nd</sup> peak of KAM decreased significantly after MOWHTO
    - > MOWHTO reduced total stress to medial knee compartment in stance phase
  - ✓ Increase of KAM is related to pain in medial OA Birmingham et al. Arthritis Care Res 2018
    - Improvement of subjective scale might result from coronal kinetics change by valgus correction of MOWHTO
  - ✓ This study presented the transition from KAM to KFM dominance without the alteration of TJM
    - The function of the quadriceps, which is an antagonist of the external flexion moment, was improved by the increase of a KFM, supporting the previous study
      Lind et al. KSSTA 2014





- The present study analyzed gait kinetics before and after MOWHTO, and clarified the relative contributions of each moment components to TJM before and after MOWHTO
- There was the transition from a KAM to a KFM dominance without the alteration of TJM postoperatively
- Our results suggest that alignment correction by MOWHTO resulted in not only the pain relief but an improvement of the knee joint function by the conversion of KAM to KFM



