



# Assessing the Relationship between Knee Joint Biomechanics and Trunk Posture According to Osteoarthritis Severity

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No COI with regard to the current presentation.



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Knee Osteoarthritis (KOA) and biomechanics

## Gait analysis in KOA

- There are many reports on coronal parameters such as knee adduction moment (KAM). Sharma et al. Arthritis Rheum 1998 Miyazaki et al. Ann Rheum Dis 2002
- Recently, sagittal parameters (eg. trunk posture and knee flexion moment (KFM) have been put light for better understanding in KOA.
   Favre et al. OARSI 2013 Meireles et al. PLoS One 2017
- However, three-dimensional joint biomechanics and trunk posture according to severity of medial KOA remains unknown.
- Purpose: To clarify the relationship between three-dimensional joint biomechanics and trunk posture according to severity of KOA.



# Subjects

- 75 patients (95 knees) with medial KOA and underwent gait analysis between November 2014 and October 2018
- Radiological classification (Kellgren-Lawrence (KL) classification)

Grade 2	20 patients (24 knees)
Grade 3	25 patients (28 knees)
Grade 4	30 patients (43 knees)

• Exclusion criteria

Those who are unable to walk, have neurological deficit or past history of other orthopaedic operation



## Outcome measures

- Background data
  - Age, height, body weight, body mass index (BMI)
- Physical examination
  - Gait speed
  - Knee range of motion
- Radiological evaluation
  - Femoro-tibial angle (FTA)
  - Percentage of mechanical axis (%MA)
  - Posterior tibia slope angle





# Outcome measures

# Gait analysis

- External knee moment
- Total knee joint moment (TJM)
  - $\checkmark$  TJM =  $\sqrt{(KFM^2 + KAM^2 + KRM^2)}$
  - ✓ TJM Peak value
- Relative contributions of each components @maximum TJM
  - ✓ %KFM, %KAM, %KRM
- Trunk flexion angle
- Statistical analysis
  - Bonferroni test for comparing each stage, significance p < 0.05



ex) %KFM =  $\frac{KFM^2}{T_JM^2} \times 100$ 



# Gait analysis

- Optical motion capture system
- Self-selected speed
- 3-dimensional gait analysis machine
  - ✓ 8 infrared cameras & 2 force plates (120 Hz each)
- Point Cluster Technique: 6 degrees of knee joint kinematics
- 3 moment components at the knee joint calculated by inverse dynamics
  - ✓ Standardized by height and body weight
- Gait cycle was defined as percentage maximum 100%







Background and Clinical and radiographic assessment data	* : P < 0.05,	† : P < 0.01
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Grade	2	3	4
Age (years)	$60.0 \pm 8.1^*$	$62.0 \pm 8.2$	67.9 ± 10.6*
Sex (Male (knees) :Female (knees))	10 (11) : 10 (13)	11(11) : 14 (17)	6 (9) : 24 (34)
Height (cm)	$161.1 \pm 7.2$	$159.8 \pm 9.8$	$155.2 \pm 9.2$
Body weight (kg)	$66.4 \pm 11.0$	$64.7 \pm 9.5$	65.4 ± 11.3
BMI (kg/m²)	$25.5 \pm 3.4$	$25.3 \pm 2.6$	$27.2 \pm 4.3$
Knee maximum extension angle (°)	-3.1 ± 5.3 * †	$-3.4 \pm 5.6 *$	-7.3 ± 5.1 *†
Knee maximum flexion angle (°)	145.0 ± 5.5 *	143.0 ± 8.5 *	134.9 ± 13.3 *
Gait speed (m/s)	$1.2 \pm 0.2$ <sup>+</sup>	$1.1 \pm 0.2$	$1.0 \pm 0.2^{+}$
FTA (°)	177.3 ± 1.4 <sup>†</sup>	$178.5 \pm 2.1$ <sup>+</sup>	$180.8 \pm 3.0$ <sup>+</sup>
%MA	$32.9 \pm 9.6$ <sup>+</sup>	$28.7 \pm 10.9$ <sup>+</sup>	$18.3 \pm 13.1$ <sup>+</sup>
Posterior tibia slope angle (°)	$81.6 \pm 3.6$	81.7 ± 3.0	$80.1 \pm 3.3$





#### Results

# Moment



 $\checkmark$  KAM was higher in severe grade.

 $\checkmark$  KFM tend to be lower in severe grades at 1<sup>st</sup> peak



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#### Results



✓ Trunk flexion was observed in grade 4 throughout gait cycle





- OA severity and biomechanics
  - Coronal parameters
    - High KAM with severe varus deformity due to elongation of the lever arm of
      the moment.
       Sharma et al. Arthritis Rheum 1998
  - Sagittal parameters; Trunk flexion
    - Compensation for quadriceps weakness due to pain and disuse
    - Flexion contracture

Harato et al. The knee 2008

Miyazaki et al. Ann Rheum Dis 2002

- Spinal degenerative deformity
  - ➡ Trunk flexion ➡ Shortening of the moment lever arm ➡ Low KFM



Debbi et al. BMES 2014 DEPARTMENT OF ORTHOPEDIC SURGERY



# KOA progression

#### Early KOA: pain quadriceps weakness

Sharma et al. JOR 2006

KOA progression

■ Trunk flexion ➡ KFM decrease ➡ quadriceps weakness

- ➡ flexion contracture ➡ kyphotic deformity
- Quadriceps weakness and trunk flexion = important exacerbating factors of KOA
- ✓ Conservative treatment for early KOA may be important for preventing KOA progression.
- Surgical treatment may be effective for severe KOA cases in the point of improving total sagittal imbalance







# Conclusion

- We clarified the relationship between three-dimensional joint biomechanics and trunk posture according to severity of medial KOA.
- Relative contribution of each moment components converted from KFM to KAM dominance in sever KOA.
- Flexion contracture and trunk flexion were observed in severe OA.
- Conservative treatment for early KOA for OA progression, and surgical intervention for severe KOA from the perspective of treating spinal disorders may result in improving total sagittal imbalance.



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