

# Possibility of knee adduction moment estimation during walking by four anatomical landmarks on video

Yuzuha Kawai<sup>1</sup>, Yasumitsu Ohkoshi<sup>2</sup>, Kengo Ukishiro<sup>1</sup>, Takahiro Inoue<sup>1</sup>, Kensaku Kawakami<sup>3</sup>, Kota Miura<sup>1</sup>,  
Tatsunori Maeda<sup>2</sup>, Koji Iwasaki<sup>2,4</sup>, Rikiya Baba<sup>2,4,5</sup>, Yuki Suzuki<sup>2,6</sup>, Junki Shiota<sup>2,6</sup>,  
Taiki Tokuhiko<sup>2,6</sup>, Tomohiro Onodera<sup>6</sup>, Eiji Kondo<sup>7</sup>, Norimasa Iwasaki<sup>6</sup>

<sup>1</sup>Dept. of Rehabilitation, Hakodate Orthopedics Clinic, Hokkaido, Japan

<sup>2</sup>Dept. of Orthopedic Surgery, Hakodate Orthopedics Clinic, Hokkaido, Japan

<sup>3</sup>Dept. of Production Systems Eng., National Institute of Technology, Hakodate college, Hokkaido, Japan

<sup>4</sup>Dept. of Functional Reconstruction for the Knee Joint, Faculty of Medicine, Hokkaido University, Hokkaido, Japan

<sup>5</sup>Dept. of Orthopedic Surgery, Iwamizawa Municipal General Hospital, Hokkaido, Japan

<sup>6</sup>Dept. of Orthopedic Surgery, Faculty of Medicine and Graduate School of Medicine, Hokkaido University, Hokkaido, Japan

<sup>7</sup>Center for Sports Medicine, Hokkaido University Hospital, Hokkaido, Japan

kawai@hakodate-seikei.com

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## INTRODUCTION:

The knee adduction moment (KAM) is one of indices that expresses medial compartment loading of the knee joint during gait<sup>[1]</sup>. A three-dimensional motion analysis system is typically used to calculate KAM. However, the equipment is expensive, requires a large measurement space, and imposes a time-consuming burden on patients, limiting its use in daily clinical practice. Estimating KAM easily from video without using the equipment would be significant. It has been reported that the KAM lever arm (LA) strongly correlates with the KAM<sup>[2]</sup>. Knowing the LA length on the video image at the first peak of the KAM (KAM1) could help estimate the KAM. During the stance phase, the ground reaction force (GRF) vector shifts with the movement of the center of gravity (COG) and center of pressure (COP), which also changes the LA length. Therefore, it is necessary to know the COG and COP positions in KAM estimation. The study aims to determine the virtual LA length (V-LA1) on the video images at KAM1 and correlation V-LA1 with KAM1.

## METHODS:

Forty-two knees of 42 patients with knee OA (10 males, 32 females, 67.2±9.0 years old, 66.2±9.4 kg, Kellgren-Lawrence classification: II 10 cases, III 22 cases, IV 5 cases, V 5 cases) were included in this study. Three-dimensional gait analysis using optical motion capture technology and inverse dynamics calculation, and video recording were performed for all patients at the same time. Skin markers were attached to 59 anatomical feature points. The measurement equipment consisted of eight infrared cameras and two force plates. The measurement frequency was set at 120 Hz, and the stance phase was normalized to 100%. KAM and LA, as well as GRF passing points on pelvis and foot in the coronal plane were calculated. COG position was calculated using the segment centroid method. The pelvic passing point of the GRF was defined as the intersection of the GRF vector and the line connecting both ASIS, expressed as a percentage of right-sided origin. Similarly, the foot passing point of the GRF was defined as the intersection of the GRF vector and the line connecting the lateral and medial malleolus, expressed as a percentage of left-sided origin. The COG1 was defined as GRF pelvis passing point at KAM1, and COP1 was defined as the foot passing point at KAM1. Next, we identified four skin markers, right and left ASIS and lateral and medial malleolus (four anatomical landmarks; 4-ALs) on the video image at KAM1 in each subject, and V-COG1 and V-COP1 were determined from the values of COG1 and COP1, respectively. The GRF at KAM1 on the video image was determined as V-GRF1. V-LA1 was calculated from V-GRF1. The relationships between KAM1 and LA1, and between KAM1 and V-LA1 were statistically examined. (Pearson's correlation coefficient, *p*-values of <0.05 were statistically significant.).

## RESULTS:

A significant positive correlation was observed between KAM1 and LA1 ( $r = 0.873$ ,  $p < 0.001$ ). COG1 was located at an average of 43.6% and COP1 at an average of 36.6% (Fig.1). The average V-LA1 was 57.5 ± 12.5 mm when V-COG1 was 43.6%, and V-COP1 was 36.6% on the video image for each subject (Fig2). The correlation between V-LA1 and KAM1 was moderately significant ( $r = 0.636$ ,  $p < 0.001$ ) (Fig. 3).

## DISCUSSION:

We estimated virtual LA length on video image at KAM1 and found a moderate correlation between V-LA1 and KAM1. This study showed that KAM could be estimated from 4-ALs (right and left ASIS and lateral and medial malleolus) on video images. In the future, it is necessary to investigate other factors related to the KAM value and improve the accuracy of the KAM estimation.

## SIGNIFICANCE:

V-LA1 obtained on video images may be a promising predictor of KAM.

## REFERENCES:

[1] Zhao et al., Journal Orthopaedic Res 2007. [2] Hunt et al., J Biomechanics. 2006.

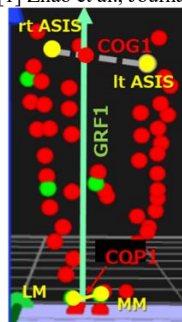
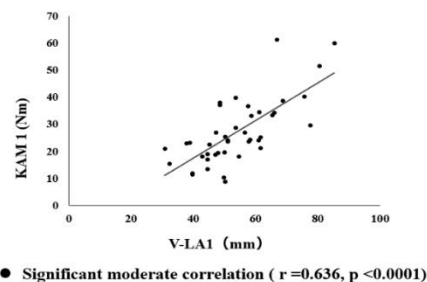


Fig.1 COG1 was located at an average of 43.6% and COP1 at an average of 36.6%.



Fig.2. The average V-LA1 was 57.5 ± 12.5 mm when V-COG1 was 43.6%, and V-COP1 was 36.6% on the video image for each subject.



● Significant moderate correlation ( $r = 0.636$ ,  $p < 0.0001$ )

Fig.3 Correlation between the external knee internal reaction moment 1stpeak (KAM1) and the virtual lever arm (V-LA1).