OP1-2-7

Machine Learning Approach of Classifying of Minimal Joint Disease Phenotype in Knee Osteoarthritis

Yong Jae Na[1], Jae Hyeon Park[2], Seong-ho Jang[2]*†

Hanyang University Medical Center, Department of Rehabilitation Medicine[1], Hanyang University Guri Hospital, Department of Rehabilitation Medicine[2]

Introduction

Knee osteoarthritis(OA) has a heterogeneous pathology and is caused by various causes. Also, prognosis of the disease is also known to be different. Therefore, there have been several attempts to distinguish different phenotypes of OA of the knee such as minimal joint disease (MJD), chronic pain, inflammatory, metabolic syndrome, bone and cartilage and malaligned biomechanical phenotype. Among these phenotypes, MJD represent a subgroup with low to mild symptomatology with intact stability over time and is associated with minor health care needs. Clinical classification of MJD has recently been proposed. However qualitative method to classify MJD phenotype is not well established. Now we investigate the possibility of classifying MJD by gait analysis through hip-knee cyclogram(H-K cyclogram) and which factors would contribute the classification of MJD. Finally, we expect to understand walking characteristics of MJD.

Methods

100 knee patients were recruited for this study. Among these patients, patients with VAS≦3, both KL≦2 or VAS≧3, both KL≦2 or VAS≦3, both KL≧2 were selected. Selected patients were classified into three classes(class 1, 2, 3). Class 1 corresponds to MJD patients who have VAS≦3 with both KL grades ≦2, class 2 corresponds to less degenerative change with more painful patients who have VAS≧3, both KL grades≦2, class 3 corresponds to degenerative change with less painful patients who have VAS≦3, both KL grades≧2. Each classes were 13, 21, and 13 patients each. Total 688 gait patterns were acquired. Inertial Measurement Unit (IMU) based gait analysis were used to measure gait patterns. These patterns were classified using H-K cyclogram. H-K cyclogram is, unlike conventional gait analysis, is a cyclo-kinematic graph that can simultaneously observe the angles of two joints as an angle-angle diagram consisting of hip range of motion as X axis and knee range of motion as Y axis. We used 61 mathematically meaningful feature of cyclograms and selected 33 features with relieff algorithm. The training consisted of 80% of training set and 20% of validation with cross-validation 5 fold. We organized the data set with k-Nearest Neighbor method and decided which feature is most influential.

Results

When classified with k-Nearest Neighbor, it showed 96% of accuracy in predicting class 1, 98% of accuracy in predicting class 2, 97% of accuracy in predicting class 3, and overall 96.8% of accuracy in classifying MJD patients. Additionally, one of the most contributing features were the long-axis slope of the knee-knee cyclogram and the width of the hip-hip cyclogram.

Conclusion

A gait analysis using machine learning, especially with H-K algorithm is a new valid method to distinguish phenotype of knee OA. With the wider arrange of sample size study, the parameter ranking by the patient's severity classification is expected to make it possible to understand the walking characteristics of MJD.
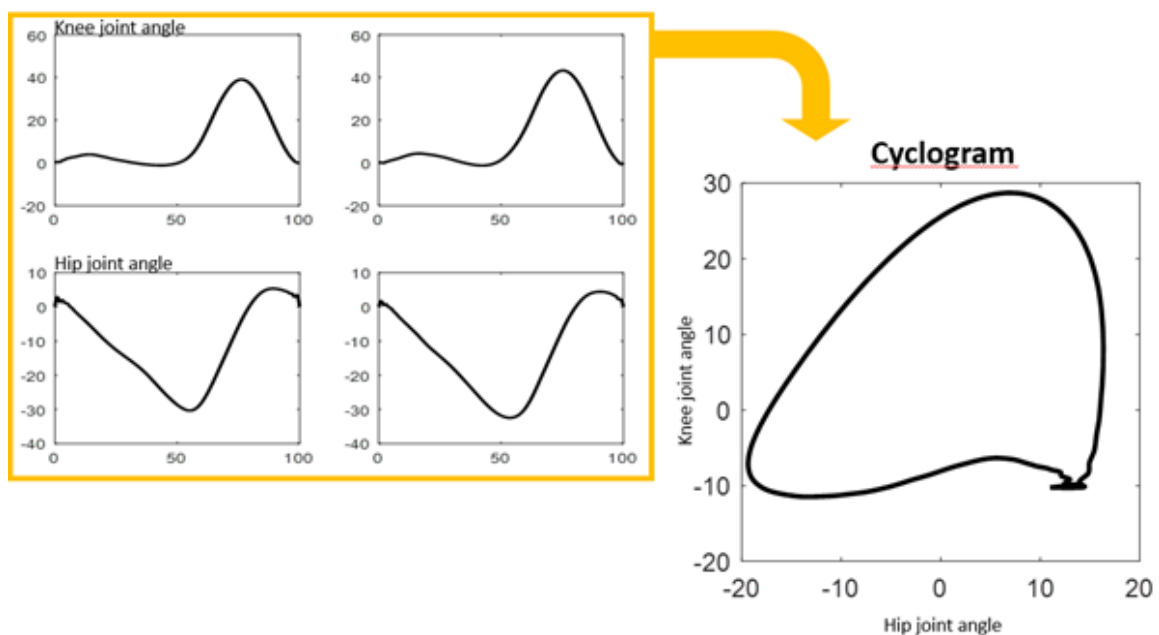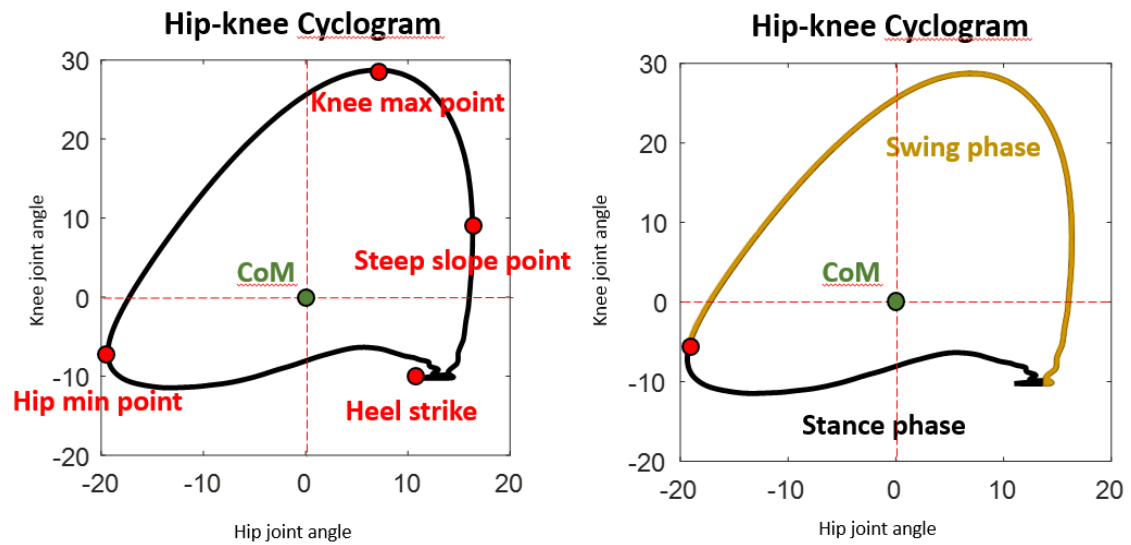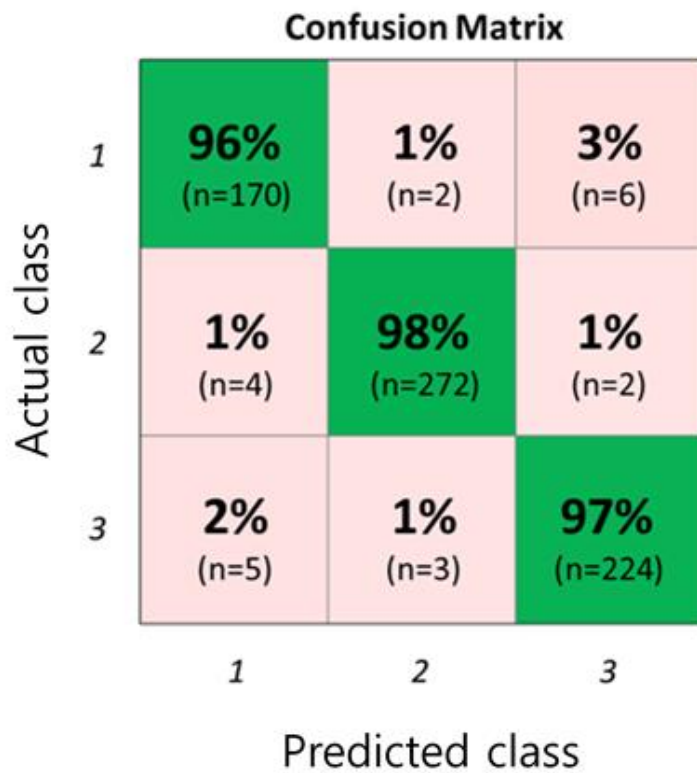

Fig 1. Graph of angle change per gait cycle of hip and knee in sagittal plane(left), cyclo-kinematic graph simultaneously observing the angles of two joints as an angle-angle diagram consisting of hip joint angle as X axis and knee joint angle as Y axis(right).

Graph showing the relationship between gait cylce and H-K cyclogram. (CoM: Center of Mass)

Confusion matrix of predicted class and actual class.