外 国 語 要 旨

Knee osteoarthritis (OA) is an aging-related health complication. Eighteen percent of women and 10% of men aged over 60 years old present knee OA-related symptoms. These people suffer from knee pain and experience a progressive impairment of walking abilities, subsequently impacting quality of life.

X-ray is the preferred method for the diagnosis of knee OA. However, X-ray is costly and cannot be used a regular basis for screening senior community dwelling people. In most of cases, the diagnosis occurs when the patient already experienced pain and/or a significant impairment of the physical function. Therefore, a method able to detect knee OA at early stage and available in community dwellings is needed.

Biomechanical factors, such as abnormally high dynamic loading of the knee joint, are associated with both the progression and onset of knee OA. However, few studies only have considered the closed kinematic chain that links together the motion of knee and foot. In this thesis, we hypothesize that predicting knee OA would be possible by observing the foot posture and motion. We aim to 1) determine which factors are related to the knee OA severity, and 2) design a prediction model for the early detection of the disease. In addition, a novel in-shoe plantar pressure measurement device has been developed to measure foot posture and dynamic foot function during standing posture and walking.

Experiment #1:

Twenty-seven knee OA patients participated in the first study. Knee OA severity was determined radiographically using the femorotibial angle (FTA), which is an index of lower limb alignment in standing position. Plantar pressure measurements were performed both during static standing position and walking using the newly developed in-shoe plantar pressure system. The results were compared with FTA values for each patients. People presenting greater FTA also had greater midfoot pressure, suggesting foot pronation during standing and walking. In the past, foot pronation has already been suggested as a compensatory mechanism for the increased knee loading in patients with knee OA. Finally, both midfoot plantar pressure during standing and single support phase duration during walking were found to be independent predictors of FTA ($R^2 = 0.53$, $p < 0.01$).

Experiment #2:

One hundred-twenty-one people with knee OA and 121 age, sex and BMI-matched controls were recruited. Plantar pressure was assessed during both walking and standing in order to test the prediction model suggested by the results of the first experiment. Differences between healthy subjects and knee OA patients were also investigated. People with knee OA presented a higher midfoot pressure during walking and standing, reflecting foot pronation. Both midfoot plantar pressure during standing and single support phase duration during walking were able to predict knee OA in the studied population.

Experiment #3:

Pain intensity is one of the main factors driving the detection of knee OA. However, observations showed that pain level is not necessarily associated with the actual development stage. Painful episodes usually occur during activities. Therefore, the in-shoe plantar pressure measurement device was used to investigate center of pressure excursion index (CPEI) during walking as an indicator of dynamic foot function. Usually, higher CPEI is associated with foot supination. Results were compared with knee pain, which was assessed using a visual analog scale (VAS). The study was conducted in 79 people, 39 of them were diagnosed with knee OA. Thirty-four people scored a non-zero value on the scale. Among these subjects, a trend for a positive relation between the VAS score and CPEI ($r = 0.27$, $p=0.11$) was noted. However, a significant correlation was observed when the only two subjects presenting maximal pain score were removed from the analysis ($r = 0.43$, $p<0.05$). Because higher CPEI was also observed in the subjects presenting gait-related pain (most of them being knee OA patients), one may hypothesize that people with pain are the ones who are not able to compensate higher knee loading with foot pronation when walking.

In the present thesis, the dynamic loading of the knee joint has been assessed using motion analyzer such as 3D motion capture system and force plate. These methods have contributed to understand the basic foot motion kinetic parameters, but cannot be used in senior community dwellings. The new method and analysis model suggested in the above-described studies have been developed to be user-friendly. Plantar pressure measurements and CPEI, either assessed in standing position or during walking, has been linked to knee OA development stages. It is therefore expected that this new in-shoe plantar pressure system could improve the early detection of knee OA in the future.