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Comparative study on 3-dimensional lower limb kinematic during simplified integrated step test for knee osteoarthritis condition

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Introduction

Population ageing is one of the major issues worldwide and the prevalence of knee osteoarthritis (KOA) is estimated to reach a new high in coming years. Patients with KOA demonstrate loss of functional independence especially in high demand activities, for example, stair climbing. The understanding of changes in lower limb kinematics in this disease could improve the precision of diagnosis and implementation of rehabilitation strategy that contribute to promotion of quality of life and delaying disease progression.

Objectives

To examine the 3-dimensional (3D) kinematics of lower-limbs during execution of ascending and descending stair task in individuals with KOA, compared to asymptomatic controls.

Methodology

The intensity of knee pain measured by Numeric Pain Rating Scale (0-10) ranged 2-6/10 in KOA group with radiological evidence of degenerative changes categorized as grade II (n=6) to grade III (n=3) in Kellgren-Lawrence scale. Both KOA group and control group were asked to perform simplified integrated up-and-down step test with the testing leg stepped on a 8-inch block, followed by the contralateral leg crossed over the block and landed on floor in front. 5 successful trials of stair-climbing task were performed by each leg. The 3D kinematics including the peak angles of hip, knee and ankle joints was captured by the VICON™ system with reference to the static alignment. Customized MATLAB code was used for data processing and independent t-test was used for data analysis.

Result

10 adults (age 62.7±9.1) with diagnosis of KOA (bilateral: unilateral = 4:6) and 6 asymptomatic controls were recruited. KOA group took significantly longer time to

execute the ascending (1.71s [0.26] in KOA and 1.46s [0.23] in control group, $p < 0.001$) and descending phase (1.32s [0.18] and 1.28s [0.26] respectively, $p = 0.01$) of step-climbing compared to the control group. The ascending/descending time ratio in KOA group was significantly higher than in control group (1.31 [0.19] and 1.16 [0.16] respectively, $p = 0.04$). KOA group also displayed significantly greater knee-varus angle ($p = 0.014$) during ascending phase and significantly greater ankle-external-rotation angle ($p = 0.044$) during both ascending and descending phases. However, no significant between-group difference was found for the angles measured in sagittal plane across the three joints of the lower-limbs. Conclusion: The findings revealed that patients with KOA performed the stair-climbing task differently from the symptom-free subjects in which they moved significantly slower and with greater knee-varus and ankle-external-rotation angle. These specific movement patterns could potentially facilitate the development of rehabilitation program.