Intra-subject variability of kinetic and kinematic gait parameters in individuals with knee osteoarthritis during stair ascent and descent

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Summary

This study analyzed data from 116 KOA individuals and 53 age-matched healthy controls. Participants completed stair ascent and descent tasks, with lower limb kinematic and kinetic gait variability parameters obtained via a three-dimensional motion capture system and an instrumented staircase. A mixted between-within subject analysis of variance was conducted to evaluate group (KOA vs. control), condition (ascent vs. descent), and interaction effects. KOA individuals demonstrated significantly greater kinematic variability during both conditions, while greater kinetic variability was observed only in knee and hip joint moments and powers during stair ascent. Both groups exhibited greater variability in knee-and-below parameters and lower variability in upper-knee parameters during ascent compared to descent. KOA individuals displayed distinct adaptation mechanisms between stair ascent and descent, particularly in kinetic parameters. Stair ascent and kinetic parameters are highlighted as sensitive dynamic task and markers.

Introduction

Gait variability is crucial for assessing motor function and fall risk in knee osteoarthritis (KOA) individuals [1]. Gait variability in individuals with KOA has been primarily investigated during level-ground walking, focusing on variability in temporal parameters, joint angles, moments and powers of the lower limb joints and pelvis. However, the normative data and pathological gait variability patterns in KOA individuals during stair walking, which is often the first to be affected, remain under explored.

Methods

This study is based on retrospective data from 116 subjects with KOA (age: 58.49±5.97 years; height: 1.60±0.06 meters; mass: 59.94±8.10 Kg) and 53 age-matched healthy controls (age: 59.00±5.97 years; height: 1.62±0.07 meters; mass: 61.42±9.36 Kg). Standard biomechanical experiments were conducted to record the kinematic and kinetic data during both stair descent and stair ascent in KOA subjects and healthy controls. A customized eight-steps staircase was designed and manufactured, featuring two force plates (9260AA, Kistler) embedded in the third and fourth steps to measure ground reaction forces at a sampling frequency of 2000 Hz during stair walking. A three-dimensional motion capture system (3DMC) consisting of ten infrared high-speed cameras was used to record kinematic data during stair walking at a sampling frequency of 100 Hz. The intra-subjects gait variability was quantified using the coefficient of variation (CV), defined as the standard deviation of a series values divided by their absolute mean [2]. For both stair descent and ascent, the intra-subject CVs of all selected kinematic and kinetic parameters were calculated and averaged across the entire gait cycle.

Results and Discussion

The intra-subject CVs of lower limb joint angles, moments, and powers, as well as GRFs in the sagittal, frontal, and transverse plane were presented in Figure 1.

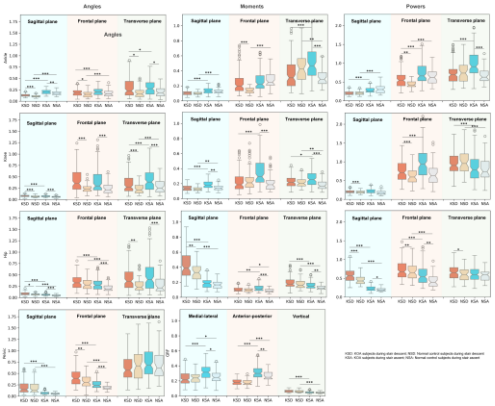

Figure 1: The intra-subject CVs of lower limb joint angles, moments, and powers as well as GRFs in sagittal, frontal, and transverse plane. *, ** and *** represent $p<0.05$, $p<0.01$ and $p<0.001$.

Conclusions

We presented a normative dataset and investigated the pathological gait variability patterns in KOA subjects during stair walking. We found that the KOA individuals exhibited greater variability than their healthy controls. Both groups exhibited greater variability in knee-and-below parameters and lower variability in upper-knee parameters during stair ascent compared to descent. Stair ascent and kinetic parameters emerges as more sensitive dynamic task and marker for motor functional assessment. Inventions should incorporate both balance and strength training for the lower limbs and trunk to benefit both KOA patients and healthy individuals.

References

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