

Title: External Tibia Torsion and Passive Muscle Stiffness of Quadriceps as Two Important Contributors of Joint Loading during Walking in People With Knee Osteoarthritis

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Study Protocol

Excessive mechanical loading on the knee joint is the main cause for the onset and progression of knee osteoarthritis (OA), a degenerative disease causing pain and functional disabilities in the elder. Malalignment of the lower limb and muscle insufficiency are the contributing factors that might induce excessive mechanical loading during gait on knee joint. The inter-action of joint alignment, muscle properties and joint loading on gait has not been well explored.

Comprehensive understanding of knee joint alignment and muscle properties could enhance knowledge of pathogenesis of knee osteoarthritis and provide scientific evidence for the prevention and rehabilitation of knee osteoarthritis.

Taken advantage of gait analysis system, dynamic joint loading distribution can be indirectly presented as external knee adduction moment (KAM), revealing biomechanical perspectives of knee joint during gait. Increase in KAM was reported in individuals with knee osteoarthritis, and it is associated with pain and disease progression. Such information is important for prevention and rehabilitation for knee osteoarthritis. Increase in muscle tension can induce excessive compressive loading on the knee joint. Passive tension is of tremendous importance in skeletal muscle function, attributing to total tension production in lengthening conditions and affecting joint range of motion as well as stability. Knee osteoarthritis possibly changes both muscular tissue and connective tissue of skeletal muscles which is muscle fiber types specific. In view of the different muscle fibre types in the muscle heads of the quadriceps femoris, it is possible that alteration in passive muscle tension is different in the muscle heads of the quadriceps. We are interested in investigating quadriceps passive tension of individuals muscle heads with Supersonic shearwave elastography, a relatively new technology for measuring shear modulus (an index of muscle tension). Exploration on possible increase in passive muscle tension of individual muscle heads of the quadriceps in individuals with knee osteoarthritis would shed light on the influence of passive muscle tension on pain and joint loading during gait.

Malalignment, such as varus deformities are commonly seen in individuals with knee osteoarthritis. Varus deformity is associated with pain and dysfunctions in individuals with medial knee osteoarthritis. More recently, torsional malalignment is also recognized in knee osteoarthritis. External tibial rotation decreases gradually with the progression of osteoarthritis. Nevertheless, there lacks solid evidence indicate the relationship between torsional alignment

and joint force transmission. Since malalignment plays a vital role in the determination of joint mechanical loading distribution, to clarify the attribution of different components of knee alignment could be beneficial to prognosis evaluation of osteoarthritis progression and function limitation.

The aim of this study is to investigate the inter-relationship between medial knee joint loading, knee alignment and muscle properties. The specific objectives of this study are: (1) to investigate the correlation between hip abduction strength and knee joint loading in individuals with medial knee osteoarthritis; (2) to explore passive tension alteration of superficial heads of quadriceps femoris and its link to joint loading and self-perceived pain; (3) to examine the relationship between knee alignment and joint loading as well as quadriceps passive tension.

Statistical analysis plan

Pearson's r test is used to identify the strength of correlation between the tested parameters. In the analysis of preliminary results, these correlations are assessed by Spearman's rho test. Single regression is used to examine predictability of the two parameters. The difference of parameters between elder with and without knee osteoarthritis is compared by independent t test.

Association between alignment parameters and KAM is assessed by linear multiple regression test.