INTRODUCTION

Lateral subluxation of the patella is commonly thought to be contributory to the development of patellofemoral pain (PFP).\(^1,2\) The tendency for the patella to track laterally is largely dictated by the angle between the resultant quadriceps force vector and patellar ligament force vector (i.e. Q-angle). Typically, the Q-angle is quantified statically using a goniometer. However, it has been recently proposed that segmental motions of the lower extremity during dynamic tasks may increase Q-angle and the lateral force acting on the patella (i.e. dynamic Q-angle).\(^3\) Using a subject specific 3D model of the patellofemoral joint,\(^4\) it is possible quantify the Q-angle during dynamic tasks. The purpose of this study was to determine if persons with PFP demonstrate higher dynamic Q-angles compared to pain-free controls during functional activities.

Figure 1. Segment motions that increase Q-angle during dynamic tasks

METHODS AND PROCEDURES

Twenty individuals with PFP and twenty pain-free controls were recruited for this study. All subjects underwent two phases of data collection: 1) MRI assessment of the knee, patellofemoral joint, and thigh, and 2) kinematic, kinetic and EMG analysis during walking (80 meters/min), running (200 meters/min) and ascending/descending stairs (50 steps/min).

Using data obtained from magnetic resonance imaging (MRI) and clinical measurements, a subject specific representation of the extensor mechanism was created using SIMM modeling software (MusculoGraphics, Santa Rosa, CA). Individual gait data were used to drive the model (via an optimization routine) and three dimensional vasti muscle forces and subsequent three dimensional PFJRF’s were computed (Figure 1). The following subject specific input variables were used in the model: 1) three dimensional kinematics of the lower extremity, 2) net knee joint moment in the sagittal plane, 3) hamstring and gastrocnemius EMG, 4) extensor mechanism lever arm, 5) vasti muscle orientation, 6) vasti muscle physiological cross-sectional area proportions, 7) patella flexion angle, and 8) patella ligament orientation.

The dynamic Q-angle was calculated as the frontal plane projection of the angle between the 3-D quadriceps force vector and the 3D patellar ligament force vector. Group differences in the average dynamic Q-angle across conditions were assessed using a 2-factor ANOVA (group x condition).
RESULTS

ANOVA results revealed a significant group effect (no interaction). When averaged across all conditions, the average dynamic Q-angle was significantly higher in the PFP group compared to the control group (34.9 vs. 22.3 degree). The average dynamic Q-angle difference was greatest during stair descent (39.1 vs. 24.2 degrees).

SUMMARY

Persons with PFP demonstrated greater average dynamic Q-angles compared to pain-free controls. This finding suggests that these individuals are more susceptible to laterally directed forces acting on the patella and is consistent with the clinical observations of lateral patellar subluxation in this population.

REFERENCES


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DISCUSSION

The higher dynamic Q-angles observed in the PFP group indicate that these individuals are more susceptible to lateral patella forces during dynamic tasks. The greatest group difference was observed during stair descent which happens to be the task most commonly associated with clinical symptoms. The average dynamic Q-angle values for both groups exceed previously reported values for “normal” static measurements (ie. 15-20 degrees). This finding reinforces previous assumptions that the pathomechanics associated with patellofemoral joint dysfunction may be related to dynamic function.