PATELLOFEMORAL KINEMATIC DIFFERENCES EXIST BETWEEN HIGH-LOAD AND LOW-LOAD CONDITIONS IN PATIENTS WITH PATELLOFEMORAL PAIN

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INTRODUCTION

Patellofemoral pain is a common knee disorder accounting for 25% of knee injuries seen in some sports medicine clinics [1]. Despite the incidence of this disorder, accurate diagnosis and effective treatment remain challenging.

Approximately 50% of patients with patellofemoral pain are diagnosed with abnormal motion, or maltracking, of the patella that is thought to lead to pain [2]. This diagnosis is typically performed by observing the motion of the patella during seated knee extension with no externally applied load to the joint. Pain typically arises during highly-loaded activities and it remains unclear how accurately patellofemoral joint kinematics measured during unloaded joint motion reflect joint kinematics during functional tasks.

The goal of this study was to compare upright, weight-bearing patellofemoral joint kinematics to supine, low-load patellofemoral joint kinematics.

METHODS

We examined the patellofemoral joints of 12 subjects with patellofemoral pain (8M, 4F). Subjects were between 20-32 years of age and had no prior surgery or traumatic knee injuries. Single-slice, spiral real-time MR images [3] of their knees were obtained during supine, knee flexion/extension with no externally applied load (low-load) and during an upright, weight-bearing squat. The supine, low-load images were obtained using a 1.5T Signa CV/i scanner (GE Healthcare) and the following scan parameters: FOV: 24cm, pixel size: 1.1mm, frame rate: 10 fr/s, 70 interleaves, readout trajectory: 2.4ms. The weight-bearing images were obtained using a 0.5T Signa SP open-MRI scanner (GE Healthcare) fit with a backrest to stabilize subjects in an upright position. The following scan parameters were used: FOV: 16cm, pixel size: 1.88mm, frame rate: 6 fr/s, 6 acquisitions/frame, readout trajectory: 16ms. In both scanners a body coil was used for RF transmission and a surface coil was used for signal reception. Subjects performed knee flexion/extension from 0° to 30° of knee flexion and back at a rate of 6°/s. An oblique-axial image through the widest portion of the patella was acquired (Figure 1).

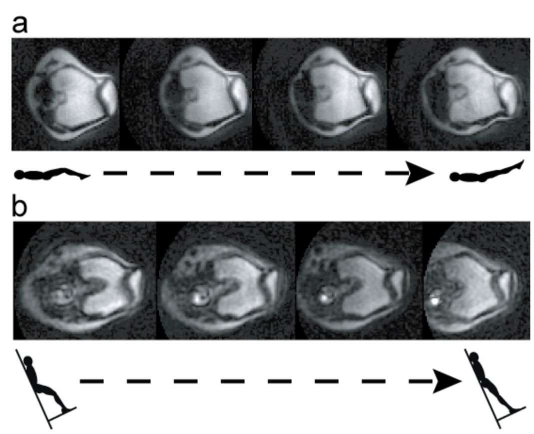

Figure 1: Real-time MR images of patellofemoral joint during (a) supine, low-load knee extension and (b) upright, weight-bearing knee extension.

Patellofemoral joint kinematics were measured by identifying bony landmarks on all real-time images. Bisect offset describes the medial/lateral position of the patella and is the percentage of the patella lateral to the midline of the femur. Patellar tilt is the measure of the angle formed by lines joining the posterior femoral condyles and the maximum width of the patella (Figure 2).

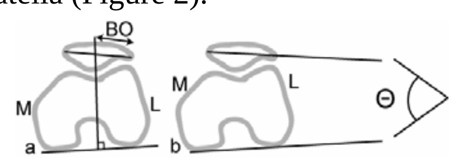

Figure 2: Diagram of (a) bisect offset (BO) and (b) patellar tilt (Θ) measurements

RESULTS AND DISCUSSION

Due to the variability in patellar motion, the subjects were separated into two groups based on weight-bearing joint kinematics: a) those with normal patellar tracking and b) those with maltracking relative to pain-free controls [4]. Six of the subjects (4M, 2F) exhibited excessive lateral translation of the patella (Bisect offset > 64% at full extension) and seven subjects (5M, 2F) exhibited excessive lateral tilt (Tilt > 9° at full extension).

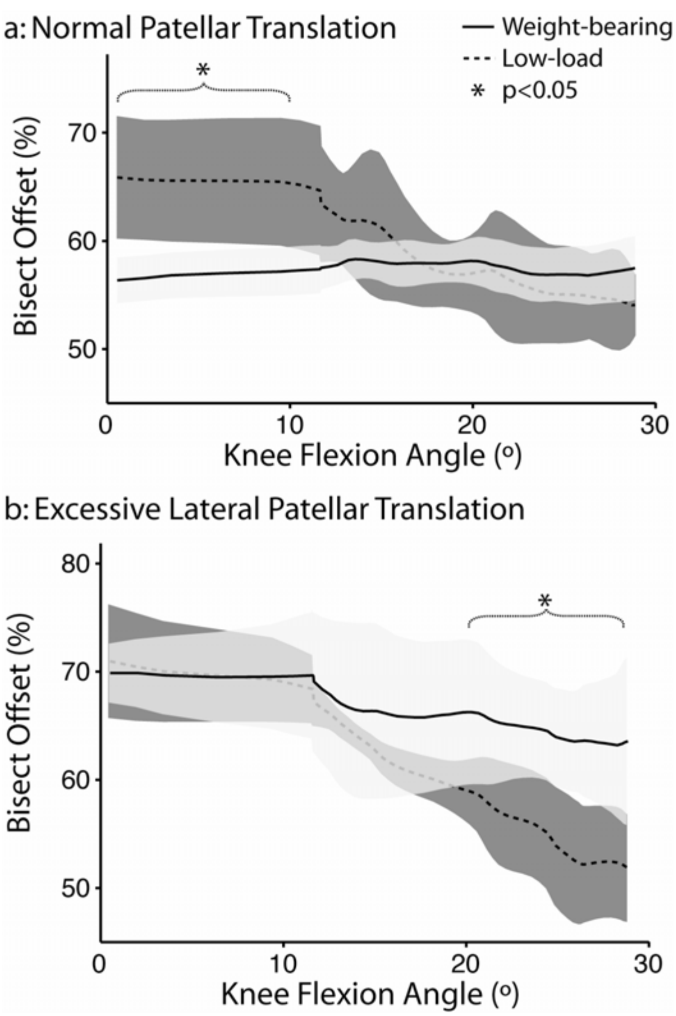

Figure 3: Relationship between bisect offset and knee flexion angle during low-load and weight-bearing knee extension. (a) Subjects without excessive lateral translation of the patella (n=6). (b) Subjects with excessive lateral translation of the patella (n=6). Larger bisect offset indicates that the patella is more lateral relative to the femur.

We detected significant differences in bisect offset between low-load knee extension and weight-bearing knee extension in both groups (p=0.001); however, the range of knee flexion angles over which these differences occur varied. In subjects with normal patellar translation, bisect offset during low-load knee extension was increased by an average of 9% compared to weight-bearing bisect offset between knee flexion angles of 0-10° (Figure 3a). In subjects with excessive lateral translation of the patella, bisect offset during low-load knee extension was on average 9% smaller than weight-bearing bisect offset between knee flexion angles of 20-30° (Figure 3b). Patellar tilt varied between loading conditions only in the group with excessive lateral patellar tilt. In this group, patellar tilt during low-load knee extension was on average 5° smaller compared to tilt during weight-bearing between knee flexion angles of 20-30°.

CONCLUSIONS

These results indicate that patellofemoral joint kinematics measured during supine knee extension with no externally applied load may not reflect the kinematics occurring during upright, weight-bearing movement. These results have implications in the study of joint mechanics as well as in the diagnosis and treatment of patellofemoral pain.

Maltracking of the patella is typically defined during seated knee extension. However, due to the effect of joint load on the medial/lateral translation of the patella, some patients with normal weight-bearing patellar tracking may appear to have excessive lateral patellar translation during low-load knee extension and might be misdiagnosed. Assessment of patellar maltracking during weight-bearing knee extension may be more appropriate.

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