Introduction: Malalignment of the patella has been hypothesized as being contributory to patellofemoral pain (PFP). Weightbearing exercises (i.e. partial squats) are commonly prescribed for patients with PFP, as they appear to be better tolerated than non-weightbearing exercises (i.e. terminal knee extension or straight leg raises). This clinical observation implies that patellar subluxation may be more pronounced during non-weightbearing movements compared to weightbearing movements. The purpose of this study was to evaluate patellar kinematics during weightbearing and non-weightbearing movements in persons with documented patellar subluxation.

Methods: Six female adults (8 knees, mean age 25 years; mean mass 63 kg) participated. Axial images of the PFJ were obtained using Kinematic MRI. Kinematic MRI was performed using a 0.5-Tesla MR system (General Electric Medical Systems, Milwaukee, WI) that was specially designed for interventional MR procedures. This special MR system permitted acquisition of MR images during active knee extension (non-weightbearing, 5% body weight) and a unilateral squat (weightbearing) from 0° to 30° of knee flexion. The following MR imaging parameters were used to obtain images at the rate of 1 image per 0.75 sec (20 images in 15 sec.): fast spoiled gradient recalled echo in the steady state (fast spoiled GRASS) pulse sequence; axial plane; repetition time (TR) 10.3 msec; echo time (TE), 2.7 msec; flip angle, 40 degrees; field of view 35 cm x 18 cm; matrix size, 256 x 128; number of excitations; 2.

Measurements of patellar displacement (bisect offset) and patellar tilt (patellar tilt angle) were obtained at mid-patellar image sections in 3° increments from 0° to 30° of knee flexion using a custom written macro for NIH image software (National Institute of Health, Bethesda, MD). Medial and lateral patellar displacement was assessed using the bisect offset measurement as described by Powers and colleagues (Powers et al, 1998). Medial and lateral patellar tilt was measured using a modification of the technique described by Saski and Yagi (Saski and Yagi, 1986). Briefly, bisect offset characterizes patellar displacement relative to the femur as a percentage of the total patellar width that lies lateral to the deepest portion of the trochlear groove. Patellar tilt angle was measured as the angle formed by the lines joining the maximum width of the patella and the line joining the posterior femoral condyles. Repeated measures ANOVA was used to compare lateral patellar displacement and lateral patellar tilt during the two movements.

Results: When compared to the non-weightbearing condition, there was significantly less lateral patellar displacement in the weightbearing condition between 12° and 30° of knee flexion (60% vs. 71% of patella lateral to midline; p= 0.008, figure 1). No differences in lateral patellar displacement were observed between 0° and 12° of knee flexion between the two movements. In addition, there was significantly less lateral patellar tilt during the weightbearing movement compared to the non-weightbearing movement when averaged across all knee flexion angles (9° vs. 14°; p= 0.02, figure 2).
Figure 1. Sitting versus standing patellar displacement

Figure 2. Sitting versus standing patellar tilt
**Discussion:** These data demonstrate that patellar malalignment was more prominent during non-weightbearing movements compared to weightbearing movements at comparable knee flexion angles. The observed disparity in patellar kinematics is likely attributable to biomechanical differences between the two movements. For example, the higher quadriceps demand commonly associated with non-weightbearing terminal knee extension compared to weightbearing terminal knee extension may cause the patella to laterally displace and laterally tilt to a greater degree in the non-weightbearing condition. These findings suggest that improved tolerance to weightbearing exercises in persons with PFP may be due, at least in part, to improved patellar alignment during such activities.

**References:**

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