Introduction: Patellofemoral (PF) pain is the most common complaint affecting the knee and is characterized by anterior knee pain that is exacerbated by activities such as stair descent, prolonged sitting and squatting. Patellar maltracking is defined as abnormal dynamic patellar positioning and is believed to contribute to PF pain (1). Common clinical measures provide both static (Q-angle) and dynamic (lateral mobility and "J" sign) indicators of patellar malalignment and maltracking, respectively. However, the causative link of these measures to PF pain is questionable. Moreover, clinical presentation is often subtle and inconsistent, making it difficult to demonstrate how patellar alignment and tracking may relate to PF pain (1). Patellar malalignment and maltracking patterns that may be related to PF pain are defined as abnormal dynamic patellar positioning and is believed to contribute to PF joint pain (2). The larger Q-angle creates a larger lateral quadriceps force, but the malalignment group appeared to have a dynamic compensation strategy. By internally rotating the tibia during extension, the lateral quadriceps force was lessened and the patella tracked more medially (3). The larger Q-angle creates a larger pull of the quadriceps was lessened and the patella tracked medial. Data have been collected for 12 additional knees (not yet analyzed) in order to determine if these trends hold over a larger cohort. However, the appearance of statistical significance with such a small sample size indicates that there may be two sets of PF and TF kinematics within subjects that complain of PF joint pain, which potentially could lead to a more targeted intervention for PF pain syndrome.

Materials and Methods: Subjects (n=6, 5 female, 1 male) with history of PF pain were recruited. Subjects were excluded if they had a recent history (>1 yr) of lower extremity surgery or other knee pathology or if they had any contraindications to MRI. Based on measures of Q-angle, lateral mobility and "J" sign, each knee was assigned to one of 3 groups: patellar malalignment (Q-angle>15° only, n = 3), patellar maltracking (lateral hypermobility of the patella and/or "J" sign, n = 7) and no clinical signs (n=2). The latter group was excluded from further analysis, resulting in 10 total knees. Fast-PC images (anatomic, x, y and z velocity) over 24 times frames (covering the entire motion cycle, scan time = 2:48min) were acquired while the subject extended & flexed their knee at 35 cycles/min, guided by an auditory metronome. Data for both flexion and extension were temporally collected and interpolated to a single degree of knee angle increments, but only extension was reported for clarity. For comparisons between the PF pain and able-body groups and between the malalignment and maltracking groups statistical significance was set at α=0.05.

Results: There were significant differences in both PF and TF kinematics (9 out of 12 DOF) between the able-body group and the subjects with PF pain. There were no differences in PF med/lat tilt, TF sup/inf translation and TF ext/flex. More importantly, there were significant differences between the malalignment and maltracking groups (Figure 1) for 4 of 12 DOF. The malalignment group demonstrated a significantly more medial and inferior patellar location throughout extension and a more internally rotated tibia with a more medial tibial origin than the maltracking group. Additionally, the malalignment group demonstrated little or no clinical signs (n=2). The latter group was excluded from further analysis, resulting in 10 total knees. Fast-PC images (anatomic, x, y and z velocity) over 24 times frames (covering the entire motion cycle, scan time = 2:48min) were acquired while the subject extended & flexed their knee at 35 cycles/min, guided by an auditory metronome. Data for both flexion and extension were temporally collected and interpolated to a single degree of knee angle increments, but only extension was reported for clarity. For comparisons between the PF pain and able-body groups and between the malalignment and maltracking groups statistical significance was set at α=0.05.

Discussion: Patellar alignment and maltracking are believed to be significant contributors to PF joint pain, however accurate methods of capturing this information clinically makes it difficult to study this phenomenon. The accuracy and precision of fast-PC MRI in quantifying 3D in vivo PF and TF kinematics allows for the evaluation of patellar maltracking beyond the classic 2D static measures, demonstrating differences in PF and TF kinematics between the PF pain group and the normal volunteers in nearly all the DOF. If these trends hold for a larger cohort, these data will likely be crucial for making clinical decisions in the management of PF pain; because they demonstrate that maltracking is associated with PF pain, involving both joints and nearly all 12 DOF. These results may suggest different treatment approaches based on patient specific PF and TF kinematics.

More importantly, these preliminary results suggest that it may be possible to classify subjects with PF pain into two distinct groups: malalignment and maltrackers. The medialized patella and externally rotated tibia of the malalignment group offers potential insights into the use of Q-angle as a clinical diagnostic measure. Specifically, when a patient demonstrates no other sign of patellar maltracking other than Q-angle, this may indicate a more normative dynamic tracking pattern. The Q-angle is most affected by the medial location of the patella, with a more medial patella resulting in a larger Q-angle (2). The larger Q-angle creates a larger lateral quadriceps force, but the malalignment group appeared to have a dynamic compensation strategy. By internally rotating the tibia during extension, the lateral pull of the quadriceps was lessened and the patella tracked more medially. Data have been collected for 12 additional knees (not yet analyzed) in order to determine if these trends hold over a larger cohort. However, the appearance of statistical significance with such a small sample size indicates that there may be two sets of PF and TF kinematics within subjects that complain of PF joint pain, which potentially could lead to a more targeted intervention for PF pain syndrome.

References: