Patellar maltracking is prevalent among patellofemoral pain subjects with patella alta: an upright, weightbearing MRI study

Saikat Pal[1], Thor Besier[2], Michael Fredericson[1], Gary Beaupre[3], Scott Delp[1], and Garry Gold[1]

[1]Stanford University, Stanford, California, United States, [2]University of Auckland, New Zealand, [3]VA Palo Alto, Palo Alto, California, United States

INTRODUCTION

Patellofemoral pain (PFP) is common, accounting for 1 in 4 knee ailments diagnosed in sports medicine clinics [1]. Patella alta (greater than normal patella height relative to the tibia or femur) is considered a predisposing factor in the development of lateral patellar maltracking and pain [2]. However, evidence supporting a relationship between patella height and patellar tracking is limited. The **purpose** of this study was to evaluate the relationship between patella height and patellar tracking in pain-free control and PFP subjects classified into maltracking and normal tracking groups.

METHODS

We recruited 52 subjects in this study: 37 (17M, 20F) with chronic PFP (> 3 months) but no prior surgery or knee injuries, and 15 (7M, 8F) pain-free controls. The PFP subjects were diagnosed by a clinician with over 20 years of experience. All subjects were between 18-42 years of age, and there were no statistical differences in age, height or weight between gender-specific PFP and control subjects.

We measured patella height from sagittal plane images acquired during upright, weightbearing imaging in a 0.5T Signa SP open-MRI scanner (GE Healthcare) [3]. The scan parameters were: repetition time, 33 milliseconds; echo time, 9 milliseconds; flip angle, 45°; matrix, 256 X 160 interpolated to 256 X 256; field of view, 20 X 20 cm; slice thickness, 2 mm; scan time, ~2 minutes. The scanner was fit with a low-friction backrest to stabilize a subject in an upright position (knee flexed ~5°) while supporting ~90% of one's own bodyweight. A sagittal scan plane corresponding to the apex of the patella was selected (Figure 1). We measured patella height using the four most established indices: 1) the Caton-Deschamps [4], 2) the Blackburne-Peel [5], 3) the Insall-Salvati [6], and 4) the modified Insall-Salvati [7] (Figure 1). These four common indices provide a measure of the height of the patella relative to the proximal tibia. In order to acquire a direct measure of patella height relative to the femoral trochlea, we used the Patellotrochlear index [8]. All patella height measurements were blinded and performed twice, on separate days, by the same investigator. Intra-rater reliability was measured using the Concordance Correlation Coefficient (CCC). Average patella heights from the two measurements were reported.

All subjects were classified into normal tracking and maltracking groups based on tilt and bisect offset measured from an oblique-axial plane image identified from the 3D MRI volume (Figure 2) [3]. The oblique-axial plane intersected the center of the patella and the most posterior points of the femoral condyles [3]. A gender-specific classification using a Weibull model and its 75th percentile was used to determine thresholds for maltracking [3]; a subject was classified as a maltracker if his/her tilt or bisect offset was greater than the gender-specific thresholds. Differences between groups were evaluated using two-tailed, unpaired t-tests.

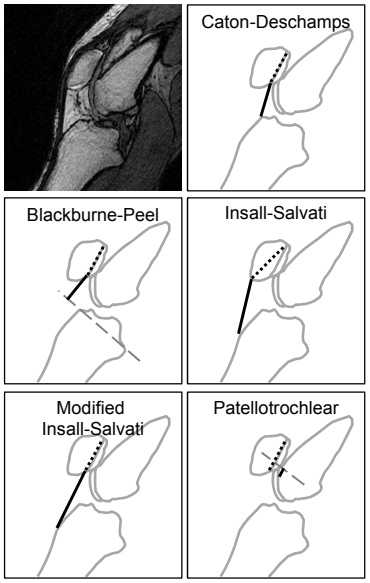

Figure 1. Measurement of patella height using common indices (ratio of lengths of the solid and dotted lines).

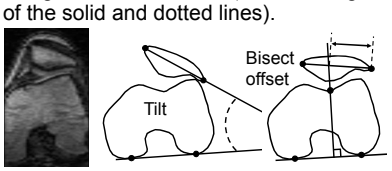

Figure 2. Patellar tracking measures from an oblique-axial plane image.

RESULTS

Intra-rater CCC varied from fairly good to excellent. Average patella height for the PFP subjects classified as maltrackers was 32% and 16% greater than the control and PFP subjects classified as normal trackers, respectively, using the Caton-Deschamps index (Figure 3A). Similar trends were observed using the Blackburne-Peel, Insall-Salvati, and Modified Insall-Salvati indices (Figures 3B-D). Average patella height was similar for the groups using the Patellotrochlear index (Figure 3E).

Average patella height for all PFP subjects grouped together was 20%, 29%, 30%, and 27% greater than the controls using the Caton-Deschamps, Blackburne-Peel, Insall-Salvati, and Modified Insall-Salvati indices, respectively (Figures 4A-D). Average patella height was similar for the groups using the Patellotrochlear index (Figure 4E).

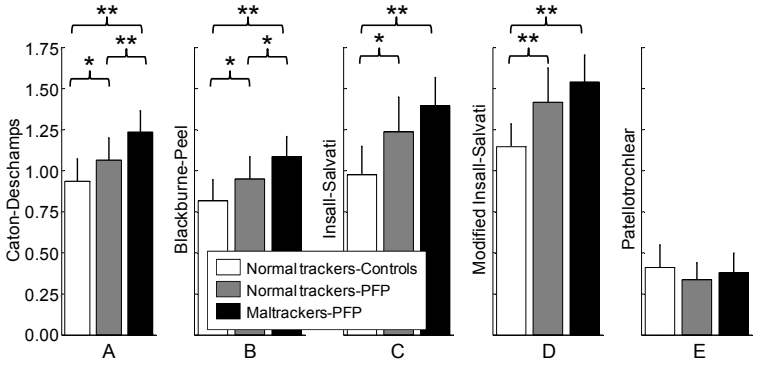

Figure 3. Average (+1 SD) patella height for pain-free control and PFP subjects classified into normal tracking and maltracking groups (* $p < 0.017$, Bonferroni corrected; ** $p < 0.001$).

DISCUSSION

This study overcomes a critical barrier in understanding the mechanisms behind PFP by providing new evidence relating patellar maltracking to patella height. The results demonstrate consistently greater patella height in maltracking PFP subjects compared to normal tracking PFP and control subjects (Figure 3), and in all PFP subjects grouped together compared to pain-free controls (Figure 4), using the four most established indices. The consistency between the four indices in our study is likely due to the fact that we measured patella height under upright, weightbearing conditions. Although the Patellotrochlear index is a direct measure of patella height relative to the femoral trochlea, we found no difference between the groups using this index.

This study highlights the importance of accurate determination of patella height and patellar tracking prior to clinical intervention.

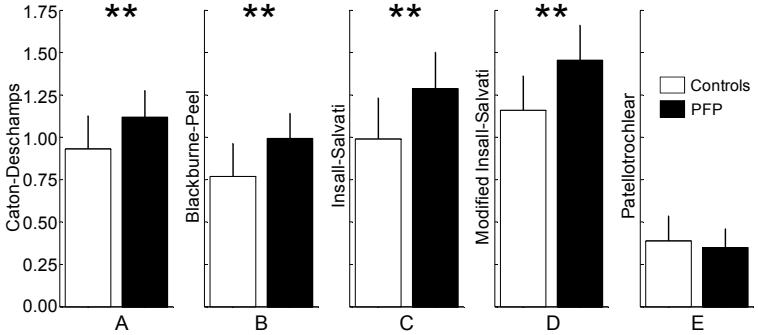

Figure 4. Average (+1 SD) patella height for pain-free control and PFP subjects using the five indices (** $p < 0.001$).

ACKNOWLEDGEMENTS

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