

Altered Brain Activity Underlies Knee Motor Control for Those with Patellofemoral Pain

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Introduction: Patellofemoral pain (PFP) is a common knee condition afflicting young girls that limits their physical activity and contributes to debilitating osteoarthritis. Current therapies have been mostly ineffective, as they do not target the neural drivers of pain. Using functional magnetic resonance imaging (fMRI), we aimed to uncover the neural mechanisms of PFP to identify potential neural-therapeutic targets for adjunctive therapy.

Hypothesis: Congruent with other neuroimaging studies of pain, we hypothesized that females with PFP would have decreased sensorimotor and increased prelimbic brain activation compared to those with no knee pain during both open kinetic chain (OKC) movements (leg flexion/extension) and closed kinetic chain (CKC) movements (hip-knee flexion/extension against resistance).

Methods: Girls diagnosed with PFP (OKC: $n=9$, 15.11 ± 3.9 yrs, CKC: $n=7$, 15.57 ± 4.3 yrs) completed fMRI scans using a 3T Philips Ingenia scanner. OKC and CKC movements were independently performed for 5 minutes on their left leg using a blocked design (rest/move at 1.2hz). PFP subjects were matched to control subjects with no knee pain that completed the same tasks. Second level mixed-effects (FLAME 1+2) independent sample t-tests contrasted brain activation between PFP and control for both tasks using a significance level set a priori at $p < .05$; Gaussian random field cluster corrected and z threshold set at $z > 1.5$.

Results: OKC movements revealed significantly increased activation in the right anterior cingulate cortex ($z = 3.99$, $p < .001$) and significantly depressed activation in the right parietal operculum cortex ($z = 4.52$, $p < .001$) for PFP. For CKC tasks, PFP participants showed significantly depressed activation in the right precentral gyrus ($z = 7.79$, $p < .001$) and supramarginal gyrus ($z = 3.83$, $p < .001$).

Conclusions: Our results parallel other pain studies demonstrating increased anticipatory fear (anterior cingulate cortex) with regards to movement. A decrease in the activation of sensorimotor regions (parietal operculum and precentral cortex) show dampening of knee sensory processing, possibly contributing to the poor biomechanics of PFP. Future research should investigate whether targeting these regions using adjunctive sensorimotor-based therapy could reduce pain and restore motor control for those with PFP.

Acknowledgements: The author would like to thank Dr. Kelsey Logan, Dr. Kate Berz, and Dr. Paul Gubanich and Katharine Nissen for their assistance with this study. This study was supported in part by NIH grant T35DK060444.