



The Relationship Between Pain and Pressure in Knee Osteoarthritis

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INTRODUCTION

• Osteoarthritis (OA) is the most common type of arthritis, and a leading cause of disability worldwide (Sharma et al., 2006).

• Pain is the primary complaint associated with OA (Felson et al., 2005) and is a predictor of physical dysfunction and muscular strength in patients suffering from the condition (Miller et al., 2001; O'Reilly et al., 1998).

• To date, OA studies have been limited to pain threshold determinations. In this study we examined continuous above threshold pressure-induced pain in reported good and bad knee joints in OA patients and healthy controls.

• The knee joint stimulation related brain activity was determined in OA and healthy subjects using fMRI.

• We hypothesized that OA should show distinct functional activity for knee joint pressure-induced pain.

METHODS

• 14 patients with unilateral knee OA and 9 healthy subjects participated in this study.

• Patients were included based on the American College of Rheumatology classification of OA (Altman, 1986) and reported spontaneous pain intensity of at least 3 out of 10 for a duration greater than 6 months.

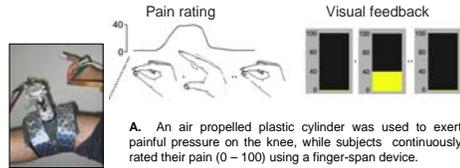
• Participants used a finger device to continuously report changes in pain intensity. Pressure was delivered at the knee using a custom made device propelled by pressurized air and equipped with a sensor to measure the amount of applied pressure.

• Pressure stimuli and brain activity were collected for both knees in all subjects.

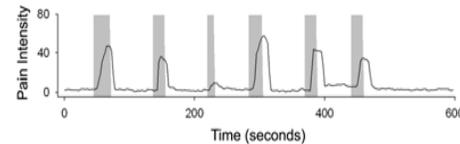
• Functional data was acquired in a 3T magnet in four interleaved scans each lasting 10 minutes. The signals for pain scans were used to search for the BOLD signal and control for various contaminants.

• Data was analyzed using general linear modeling in FSL software (fmrib, Smith et al. 2001).

1 Experimental set up and knee pain rating

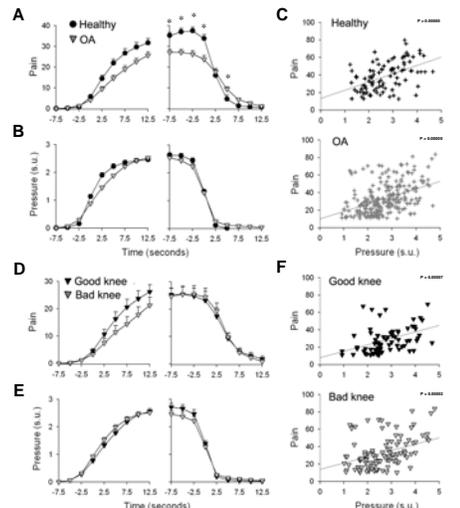


A. An air propelled plastic cylinder was used to exert painful pressure on the knee, while subjects continuously rated their pain (0 – 100) using a finger-span device.



B. Example of pain rating from one OA subject. Shaded areas represent epochs of pressure stimulation. In OA patients, the probe was placed at the most painful spot on the joint.

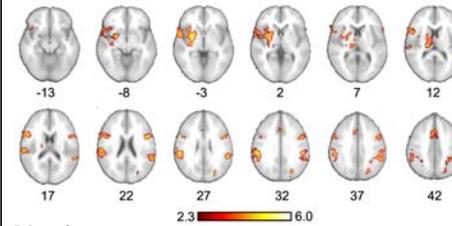
2 Ratings of pressure induced knee pain



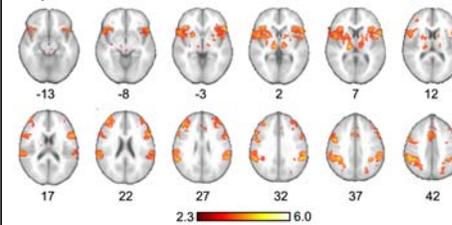
- Pressure intensity, averaged across knees and subjects in standardized units (z-scores), was matched between controls and OA patients (B), and between knees in OA (E).
- The rise phase of pain ratings was not different between controls and OA (A), or between knees in OA (D, first panel).
- Healthy subjects had more pain at stimulation end, whereas OA patients showed a small after effect (A, second panel).
- Correlations between pain and pressure were significantly positive but their slopes did not differ between groups (C, F).

3 Brain activity for knee pain ratings

Healthy subjects

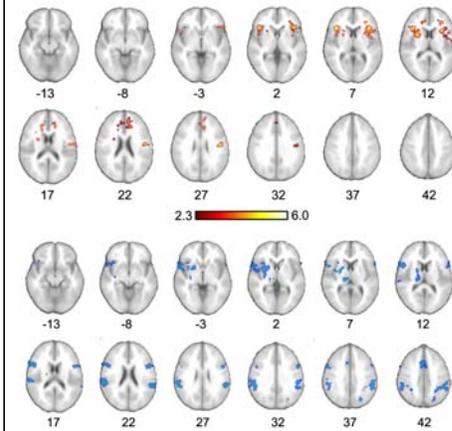


OA patients



Healthy subjects show activation of the insula, basal ganglia, and thalamus contralateral to the stimulated knee. OA patients' brain activity was similar to controls, but was stronger and more bilateral.

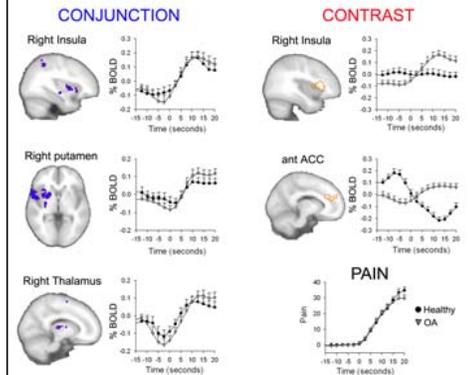
5 Contrast and conjunction analyses



Top panel: Contrast analysis (OA > Healthy, unpaired t-test, random effects) reveals increased activity in bilateral insula and ACC/mPFC in OA.

Bottom Panel: Conjunction map (blue) shows brain regions commonly activated in OA and controls, and includes contralateral putamen/globus pallidum, thalamus, insula, and bilateral SII and posterior parietal cortices.

5 BOLD signal time course analysis



Average BOLD responses are similar between OA and controls for regions derived from the conjunction map (blue, left column), and distinct for regions from the contrast map (red, right column).

BOLD signals were averaged across all stimulation epochs and subjects. The average time course of the convolved pain response is shown in the lower right.

CONCLUSION

• We are surprised that knee joint pain ratings are essentially the same between healthy controls and OA patients, as well as between reported good and bad knees in OA patients.

• Although knee pain ratings were the same between OA patients and controls, resultant brain activity was more prominent in OA.

• Specifically, bilateral anterior insula was activated for knee pain only in OA. Moreover, parts of mPFC/ACC showed decreased activity only in OA.

• We conclude that while knee pressure pain is similar between normal subjects and OA patients, related brain activity shows significant differences.

• These results suggest that OA more similar to an intermittent nociceptive state than a chronic pain condition, especially when contrasted with chronic back pain (Geha et al. 2008; Baliki et al. 2006).

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