Brain Activity For Stimulating The Painful Knee in Osteoarthritis Contrasted With Brain Activity For Back Pain and Acute Thermal Pain

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SFN 2005
Washington DC
53.10

INTRODUCTION

The mechanisms underlying chronic osteoarthritis (OA) pain remain obscure. In this study we examine the role of the cerebral cortex in OA pain using fMRI, by identifying brain activity in response to an acute painful pressure stimulus to the arthritic knee. We also contrast these findings with brain activity patterns for spontaneous chronic back pain (CBP) , and acute thermal pain in normal subjects.

METHODS

6 patients with knee OA were scanned while receiving painful pressure stimuli to both knees, one knee at a time.

Patients were trained to use the finger-span device to rate magnitude of either their spontaneous pain, or that of a moving bar (motor-cognitive control) (panel 1).

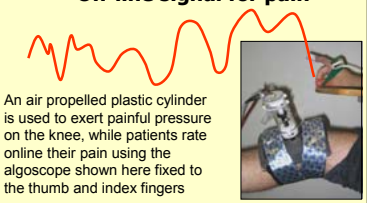
In the scanner the patients rated fluctuations of their pain (panel 2) Patients were scanned at multiple sessions (3 scans per subject).

The signals for pain and control scans are used to search for the BOLD signal and to control for various contaminants.

BOLD responses are determined using FSL software (fmrib, Smith et al. 2001).

The same method was used to collect data for the spontaneous fluctuations of CBP and for acute thermal painful stimulation of normal subjects (see Baliki et al., SFN 2002, 2003).

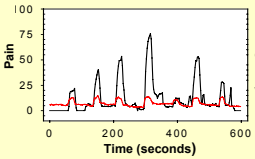
1 Experimental set up and On-line signal for pain



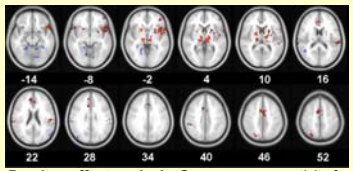
An air propelled plastic cylinder is used to exert painful pressure on the knee, while patients rate online their pain using the algoscope shown here fixed to the thumb and index fingers

A visual feedback of the patient's rating is projected on a computer screen with a scale from 0 (no pain) to 100 (worst imaginable pain)

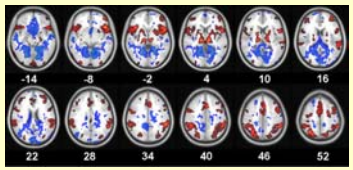
2 Brain activity for stimulating painful knee



Example of on-line pain rating in one patient. Pain is shown in black while stimulus is in red.

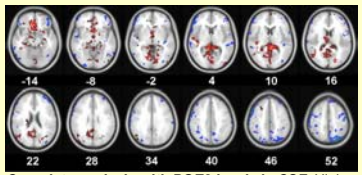


Random effect analysis: Group average activity for (pain – visual control) can be seen in bilateral insula, basal ganglia, thalamus, anterior cingulum and secondary somatosensory cortices.

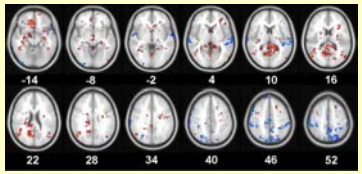


Fixed effect analysis: Activity is similar to above, however more activation can be observed in the posterior parietal areas and more deactivations can in frontal areas (visual control not subtracted)

3 Covariate analysis

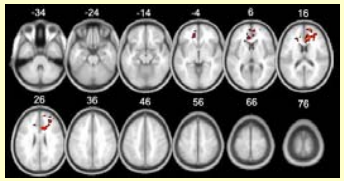


Covariate analysis with PGE2 levels in CSF. Higher level analysis showed that brain activity in the orbital frontal cortex , posterior cingulum and precuneus exhibit a positive correlation for OA pain and levels of PGE2 in CSF



Covariate analysis with WOMAC pain scale. Brain areas that correlates to pain intensity as determined by the WOMAC scale are similar to those that correlate with PGE2 concentrations in CSF (see above)

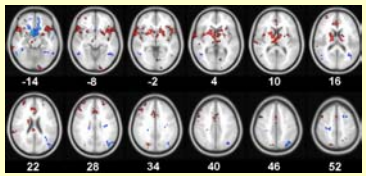
4 OA pain v.s. CBP pain



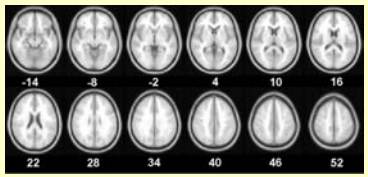
Average group brain activity for spontaneous CBP is 13 Chronic Back patients. Random effect analysis of (pain – visual control) shows that activity is limited to the medial prefrontal cortex and rostral anterior cingulate cortex.

Conjunction analysis between Brain activity for spontaneous back pain and stimulation pain for OA (panel 2) exhibits no overlap between the 2 maps.

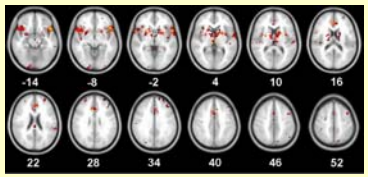
5 OA pain v.s. Thermal pain in Healthy Controls



Average group brain activity for Thermal pain in 16 Healthy Controls. Random effect analysis of (pain – visual control) shows that activity is mainly bilateral and seen in insula, basal ganglia, thalamus, and anterior cingulate cortex.



Contrast analysis between OA and thermal pain in Healthy Controls. Higher level contrast between the 2 groups revealed that there is no significant brain activity differences.



Conjunction analysis between PHN and thermal pain in Healthy Controls. Higher level conjunction between the 2 groups reveals that the bilateral insular regions and thalamus in addition to basal ganglia, anterior cingulate and secondary somatosensory cortex are commonly activated for the 2 pain conditions

CONCLUSION

- Brain activity pattern for osteoarthritis pain is similar to the activity seen for thermal stimulation pain in normal healthy subjects.
- This activity is distinct from that observed for spontaneous fluctuations of chronic back pain.
- Brain regions correlated to CSF PGE2 levels, to OA overall pain, and to WOMAC scores include orbital prefrontal cortex, a region more dorsal than the activity seen in back pain, and precuneus. These are brain regions important in emotional and attentional responses in relation to the self, implying that the OA pain impinges on these faculties.

Funded by NIH NINDS 35115