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XXIV-5. PET LOCALIZATION OF RESPONSE TO THERMAL STIMULI IN HUMAN

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INTRODUCTION: Cerebral localization of response to painful thermal stimui has been recently studied in humans non-invasively using positron emission tomography (1,2). This study was conducted to confirm previously reported results and to distinguish cerebral responses to thermal change from those due to perception of pain. This was accomplished with stimuli of same thermal amplitude from different base line temperatures.

METHODS: In the first group of nine healthy subjects (20 to 39 yrs), stimuli of 50 °C and 40°C were delivered to the left forearm at six sites repetitively (mean resting skin temperature 31.8°C) while positron emission tomographic (PET) image sets were obtained following intravenous administrations of 66 mCi of O-15 water. Three scans in each subject were acquired during 50°C and three during 40°C stimuli, alternatively. All subjects estimated 50°C and 40°C stimuli to be painful and non-painful, respectively. In the second group of nine healthy subjects (20 to 41 yrs), the forearms were cooled to approximately 22 °C using water bags, then stimuli of 42°C and 32°C were delivered in the same manner. All subjects estimated both stimuli to be non-painful. After normalizing each image set to whole brain counts, mean cerebral blood flow (CBF) images were created for each condition by stereotactic anatomical standardization techniques. The images were then compared by t statistics on a pixel-by-pixel basis. A statistical threshold was determined by multiple comparison adjustment using estimated image smoothness (3), and significant changes ($p < 0.05$) were identified throughout the brain.

RESULTS: When comparing 50°C painful stimuli to 40°C stimuli in the first group, significant CBF increases were observed in the contralateral anterior cingulate (percentage increase in normalized CBF: 2.1%); midbrain (2.1%); cerebellar vermis (2.4-3.2%); contralateral thalamus (3.1%); contralateral secondary sensory cortex (SII) (2.3-3.3%). Non-significant trends towards increased CBF were observed in the contralateral lenticular nucleus - insula (2.1%); ipsilateral thalamus (3.0%); ipsilateral SII (2.0%). CBF increase in the contralateral primary sensory cortex (SI) was 1.9% but did not reach the adjusted p threshold. When comparing 42°C stimuli to 32°C stimuli in the second group, there were no significant increases in CBF in the structures responding to the 50°C (painful) stimulus. The only significant increase during the 42°C stimulation was in the contralateral inferior temporal area.

COMMENTS: In the literature, increased CBF during painful thermal stimuli was observed in the contralateral cingulate (1,2), thalamus, lenticular nucleus (1), and SII (2), which are concordant with our results. CBF increase in the contralateral SI (1) was much less significant in our study. We have also found significant increases of CBF in the midbrain and cerebellar vermis, the former area probably corresponds to the periaqueductal gray matter in the spinomesencephalic pathway. These findings strongly indicate the role of subcortical and limbic structures in pain perception. On the contrary, the 42°C stimuli, which have the same amplitude as the 50°C stimuli from base line, did not show significant changes in these structures, suggesting that the increased CBF during the painful stimuli was not caused by temperature change alone.

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