PRINCIPLES OF FUNCTIONAL MAGNETIC RESONANCE IMAGING (FMRI)

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Functional MRI (fMRI) is currently one of the most widely used techniques for basic and clinical neuroscience. It is an extension of MRI that measures changes in cerebral blood flow and oxygen level that reflect localized changes in brain activity induced by various tasks including motor, sensory or cognitive. Unlike other MRI images used to form high resolution pictures of brain structure, the series for functional images are specifically tuned to contrast chemical changes that are dependent to neural activity. The fMRI measures changes in blood flow and oxygen level by measuring small differences in MR signal.

FMRI studies are divided into two separate classes:

1. The contrast techniques, those that require the intravenous administration of a paramagnetic agent;

Figure 1: A simplistic mechanism of changes in the blood oxygen level dependent

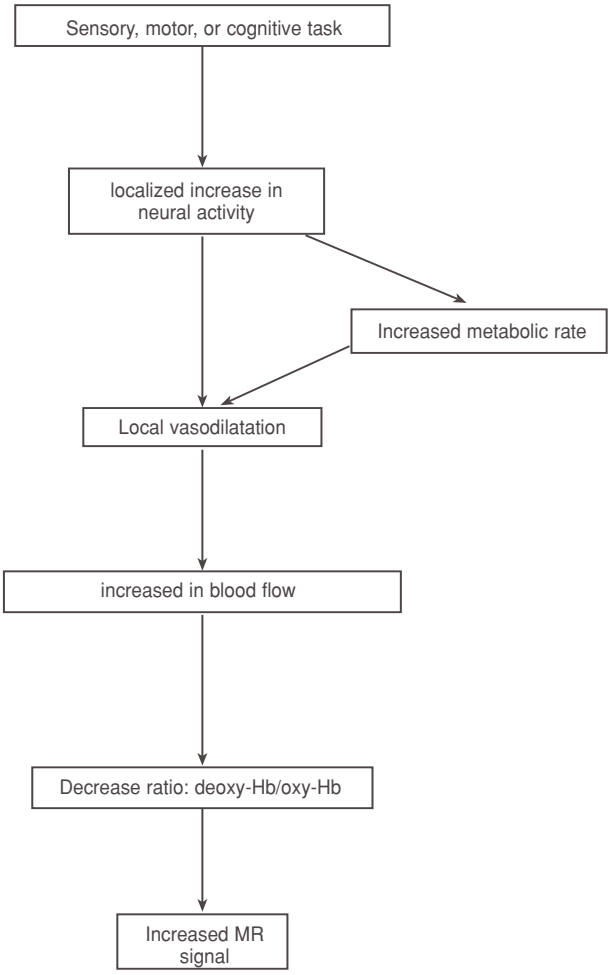
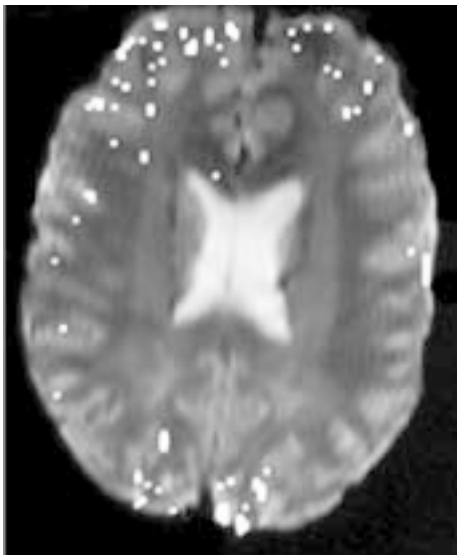


Figure 2: The image of a 36 years old healthy woman, during a highly complicated mental (mathematical-working memory) task. Middle frontal (mainly left) and occipital cortices are active during the task ***(1.5 T Siemens Magneton, Ege University School of Med. Neuroradiology Dept)***



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2. Noncontrast techniques, those that make use of endogenous physiological factors to detect changes in cerebral activation.

As far back as 1936, it has been known that deoxy-hemoglobin is a paramagnetic factor in the blood though oxy-hemoglobin is magnetic. T2-weighted pulse sequences are generally used to detect changes in the local concentration of paramagnetic deoxy-hemoglobin. The latter method has been referred to as BLOOD OXYGEN-LEVEL DEPENDENT (BOLD) imaging. Thus, a decrease in the T2 decay rate, which is measured as an increased MR signal, is largely due to localized increase in the ratio of oxy-hemoglobin to deoxy-hemoglobin a few seconds after increase in the neuronal activity in the region.

The basic principle of BOLD is largely depending on neuronal activity related to increase in blood flow (Fig.1).

Increase in neuronal metabolism, by direct or indirect mechanisms causes a local vasodilatation. One should keep in mind that any vascular disease may have direct effect on local vasodilatation.