Preliminary non-invasive measurement of magnetic susceptibility of the frontal lobe: a possible antecedent marker for Alzheimer's disease.

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Magnetite in brain

According to [1], [2] , and [3] semiquantitative histological evaluation of brain iron have been performed in paraffin sections of human brain known to have suffered from Alzheimer disease symptoms. Magnetic work on disease brain tissue [4] has indicated presence of magnetite. There seems to be a direct relation between the iron rich compound precipitation and Alzheimer disease.

Iron alteration in Alzheimer disease

The distribution of iron between (II) and (III) oxidation states depends on the availability of cellular reducing species [3]. [3] also suggests that such cellular reducing species may also be responsible for generation of the free radicals. The source of iron associated with lesions (see Figure 1) is unknown, however.

Iron alteration associated with Alzheimer disease (Figure 1) could generate new set of tools for detection of altered iron.

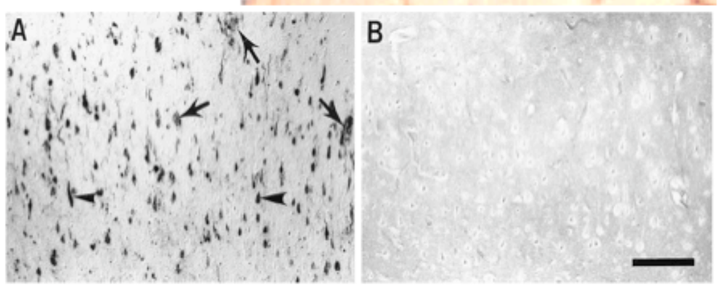

Figure 1: (A) Histochemical detection of iron in Alzheimer disease is compared with (B) control case. Images show association of iron with neurofibrillary tangles (arrowheads) and senile plaques (arrows). This Figure is taken from Smith et al.,1997 [3].

Magnetometer to measure rock specimens

We measured magnetic susceptibility of living brain (frontal lobe) using sensitive susceptibility meter SM30 (Figure 2). This is very simple and speedy observation normally made by geologists to investigate rock outcrops. used to measure rock specimens (Figure 2). Preliminary measurements were performed on 53 persons that included several Alzheimer patients.

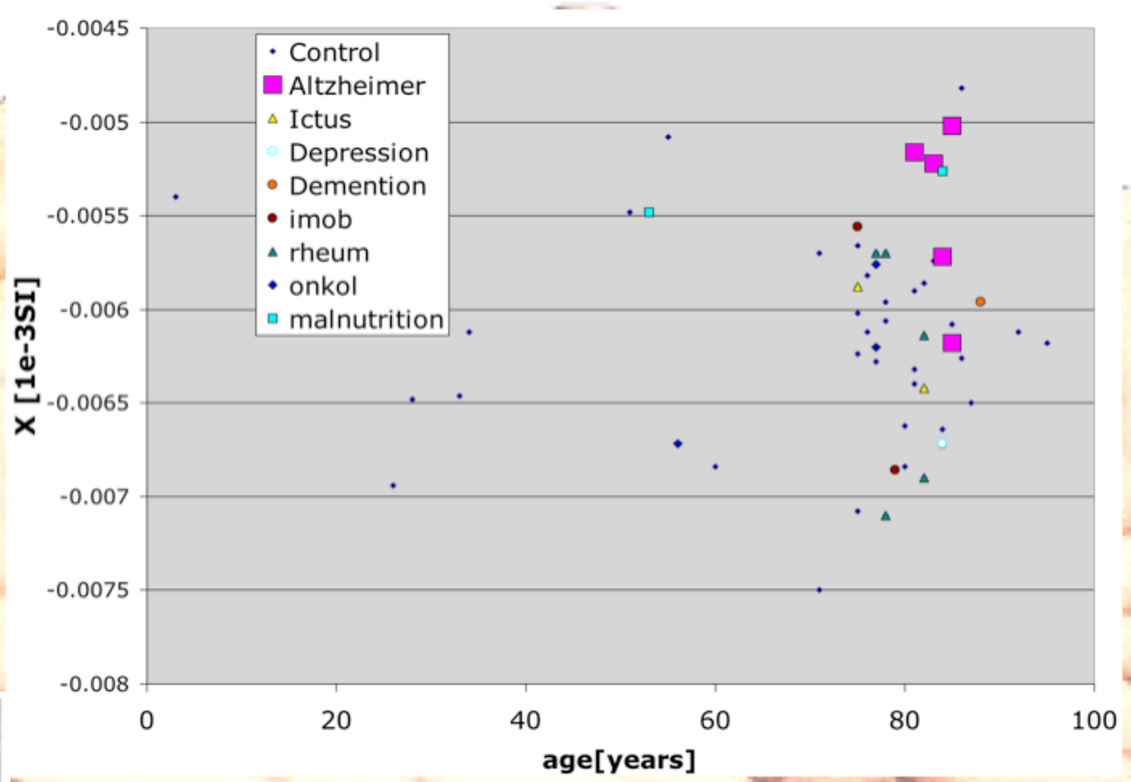

Figure 3: Magnetic susceptibility of 53 human subjects, measured in frontal lobe, using sensitive magnetic susceptibility meter SM30, placed against the forhead.

Figure 2: Magnetic susceptibility is measured by using sensitive magnetic susceptibility meter SM30, placed against the forehead. Sensitivity is 1e-7 SI units. Meter consists of 50 mm pickup coil, placed parallel with the bottom part of the cover (not seen in this figure). Weight 0.018 kg, Operating frequency: 8 kHz, Operating range -20C to 50C, Battery: 2 lithium 3V type CR2430. The meter contains an oscillator with the pickup coil. The frequency of the oscillator depends on the distance of the meter from the sample. The change in frequency is proportional to the amount of susceptibility of the rock.

Measurement results on human subjects

The magnetic susceptibility is negative, reflecting the dominant diamagnetism of brain tissue. The positive susceptibility of ferromagnetic material present therefore reduces this negative number.

Interestingly magnetic susceptibility of 3 Alzheimer patients was among the 5 lowest negative susceptibilities measured. This pattern suggest that there may be possible to detect small amount of iron by this simple magnetic measurement. The mean value of magnetic susceptibility of the population is close to (-6.1+/-0.6) e-6 SI units. Alzheimer patients show slightly higher values, closer to (-5.5 +/-0.5) e-6 SI units. The susceptibilities of the Alzheimer patients can be distinguished at one standard deviation from the whole population tested. The mean susceptibility of the Alzheimer's patients is also greater than the mean value from the patients of the same age group, but it cannot be distinguished at one standard deviation. We speculate that the source of the positive susceptibility contribution may be magnetite. We suggest that extensions of this observation may serve as an antecedent marker of the onset of Alzheimer disease.

References

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