A New Diagnostic Method for Alzheimer's Disease Using Pupillary Light Reflex

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Abstract. We has developed a lightweight glass-shaped measurement apparatus composed of two CCDs to capture eye images and four white LEDs for light stimulus to diagnose Alzheimer's disease (AD). The AD patients showed significantly smaller miotic rate and longer miotic time than the normal elderly controls for miotic reflex in our clinical experiment.

1 Introduction

Alzheimer's disease (AD) is a neurodegenerative disorder of the central nervous system. As acetylcholine (Ach), a main neural transmitter activating miotic reflex is decreased in the brain of AD than the normal elders, it is considered that the miotic-reflex of AD would be weaker than the normal elders [1].

2 Methods and Materials

In order to lighten the burden imposed on subjects during measurement, a lightweight glass-shaped apparatus for measuring pupil size has been developed, which includes two CCD cameras for both eyes to capture both eye images. The apparatus also includes four controllable white LEDs placed in front of each eye for light stimulus. In the experiment, each eye was stimulated by the flashing light for 0.1 seconds at the intensity of 0.64 cd in a semi-darkened room [2]. The pupil images are transmitted to image processor (60 images/s) and the data are kept with computer. We studied 19 AD patients (mean age 79.4 years, S.D. 8.5 years), 13 Vascular Dementia (VD) patients (mean age 78.9 years, S.D. 8.9 years) and 19 normal elder controls (mean age 80.9 years, S.D. 7.6 years).

3 Results

AD patients showed significantly poor pupillary light reflex on parameters Initial pupil diameter (D_0 , $p < 0.05$), Maximum miotic ratio ($p < 0.05$), 10%-50% recovery time ($p < 0.05$), 10%-50% recovery velocity (RV, $p < 0.05$) and Time interval

from 90% miosis to 10% recovery than the controls. VD patients showed significantly smaller D_0 ($p < 0.01$) and RV ($p < 0.05$) than the controls also. Specially, on the parameter RV/MV (MV=10%-90% miotic velocity), the AD patients showed significantly smaller than not only the controls but also the VD patients, suggested that the AD patients owned poor recovery phase more than miotic phase.

4 Discussions

In the experiment AD patients showed significantly poor pupillary light reflex than the controls. It is presumably because the neurotransmitters Ach, effecting miotic phase and norepinephrine (NE), effecting recovery phase of miotic reflex are clearly decreased in AD patients' brains comparing to the controls. VD patients showed significantly smaller D_0 and RV than the controls also. Future investigations are expected to study the amount of ACh in the VD patients. On the parameter RV/MV, the AD patients showed significantly smaller than not only the controls but also the VD patients, suggested that the AD patients owned poor recovery phase more than miotic phase.

5 Conclusions

As the new method (miotic-reflex) is not only simple but also harmless, it may be a new objective method to diagnose and to evaluate senile dementia in the clinical routine in the near future. Matsushita Electric Works is now producing a commercial system of this type.

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References

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