Chapter 22

Functional Optical Hemodynamic Imaging of the Olfactory Cortex in Patients with Parkinson’s Disease

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ABSTRACT

Olfactory dysfunction is a frequent non-motor symptom in Parkinson’s disease (PD). This symptom is considered to be an early manifestation of the disease. The aim of this study was to establish the cortical basis of olfactory function in patients with PD. This study was conducted on ten healthy, normosmic subjects and seven patients with PD (one with subjective olfactory dysfunction and nine without subjective olfactory dysfunction). We employed a 22-channel near-infrared spectroscopy (NIRS) device with eight light-incident fibers and seven light-detector fibers, each with an inter-optode distance of 2.5 centimeters on the frontal head. Isovaleric acid was used as the odor stimulant. We measured the change in total hemoglobin concentrations (totalHb) from pre-baseline values and compared the results obtained for healthy normosmic subjects and patients with PD. In all healthy normosmic subjects and three patients with PD, isovaleric acid caused remarkable changes in (totalHb), especially in the lower areas of the frontal cortex. However, in four patients with PD, isovaleric acid caused no changes. This
INTRODUCTION

Olfactory dysfunction is a frequent non-motor symptom in Parkinson’s disease (PD) that is considered to be an early manifestation of the disease. Olfactory dysfunction in PD has been previously reported in some studies (Ross et al., 2008; Kranick & Duda, 2008; Doty, 2007). In a general clinical setting, many methods used in the evaluation of olfactory function are subjective tests (Kondo et al., 1998; Doty et al., 1984). On the other hand, functional magnetic resonance imaging (fMRI) (Sobel et al., 1998; Hummel et al., 2003) and positron emission tomography (PET) (Doty et al., 1984) are objective methods that can be used to evaluate olfactory function. Objective olfactory testing is very rare. Recently, near-infrared spectroscopy (NIRS) has been used to study the functional activation in various areas of the brain (Kusaka et al., 2004; Hoshi & Tamura, 1993). NIRS is a noninvasive method for detecting changes in oxygenated hemoglobin [oxyHb], deoxygenated hemoglobin [deoxyHb] and total hemoglobin [totalHb]. NIRS is useful as a clinical testing device because of its convenience and compact size. In a previous study, we used multi-channel NIRS (MNIRS) to perform functional brain imaging of olfactory activity (Savic, 2004). The aim of this study was to establish the cortical basis of olfactory function in patients with PD.

MATERIALS AND METHODS

Multi-Channel Near-Infrared Spectroscopy

The 22-channel near-infrared spectroscopy device (Hitachi Medico Co., Japan) that we employed has seven light-incident fibers and eight light-detector fibers, each with an inter-optode distance of 2.5 centimeters. The light sources were two 0.5 mW continuous laser diodes with wavelengths of 780 and 830 nm. Figure 1 shows the 22 measurement positions in which the 15 fibers were placed in a 5 centimeter by 10 centimeter field over the frontal cortex. These channels could measure changes in concentrations of oxyHb, deoxyHb and totalHb from the pre-baseline values.

Subjects

This study was conducted on ten normosmic subjects (four males and six females: mean age, 28.9 years; range, 22-39 years) and seven PD patients (five males and two females: mean age, 66.8 years; range, 58-77 years). Among the PD patients, one had subjective olfactory dysfunction. All subjects understood the aim of this study and gave informed consent for participation, and the study’s proto-
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