Chapter 30
Evaluation of Olfactory Impairment in Parkinson's Disease Using Near-Infrared Spectroscopy

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ABSTRACT

Hyposmia, psychiatric disorders, and cognitive problems are common non-motor manifestations of Parkinson's disease (PD), but how they are related to the progression of PD remains unclear. Olfactory dysfunction, which is a common non-motor symptom of Parkinson's disease, is considered to be an early manifestation of this disease. The aim of this study is to investigate the usefulness of near-infrared spectroscopy (NIRS) in measuring olfaction in PD patients and to establish the cortical basis of olfactory function in PD patients. This study was conducted on 9 healthy normosmic volunteers and 24 patients with PD. The authors employed a 22-channel NIRS device with eight light-incident fibers and seven light-detection fibers and placed fibers every 2.5 cm on the forehead of volunteers. Isovaleric acid was used as the odor stimulant. The authors measured the changes in total hemoglobin (tHb) concentration from baseline values and compared the results obtained from healthy normosmic volunteers with those from PD patients. PD patients had higher scores in the subjective olfactory test and smaller changes in tHb concentrations compared with normal volunteers. In particular, no changes in tHb concentration were detected in patients with the awareness of the sense of smell disorder.

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INTRODUCTION

Some patients, in whom hyposmia or anosmia was detected, were not aware of their olfactory impairment. In this study, we show that multi-channel NIRS (MNIRS) can be used to evaluate brain hemodynamic responses resulting from olfactory stimulation in PD patients. Olfactory impairment is considered to be an early manifestation of PD. Some patients, in whom hyposmia or anosmia was detected, were not aware of their olfactory impairment. Therefore, an objective test of olfaction is necessary to measure olfactory function of PD patients. In this study, we show that MNIRS can be used to evaluate brain hemodynamic responses resulting from olfactory stimulation in PD patients.

Parkinson's disease (PD) is characterized by motor dysfunction; however, it also has non-motor components, including olfactory and autonomic dysfunctions, sleep disturbances, depression, and visual and neuropsychological impairment. In particular, olfactory dysfunction, which is considered to be an early manifestation of the disease, is a common non-motor symptom in PD. Olfactory dysfunction in PD has been reported in several previous studies (Doty, 2007; Kranick, 2008; Ross, 2008). The ability of Japanese patients with idiopathic PD to identify smells was impaired, as determined by the odor identification test for Japanese (OSIT-J), as well as previous reports (Iijima, 2008).

In the general clinical practice, the methods available to evaluate olfactory function are subjective tests (T&T Olfactometer: TTO), OSIT-J, The test of intravenous injection of Alinamin). On the other hand, functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have been used for the objective evaluation of olfactory function. However, these objective olfactory tests are not generally available in the clinic. Recently, near-infrared spectroscopy (NIRS) has been used to study functional activity in various areas of the brain. NIRS is a non-invasive technique that can be used to detect changes in three types of Hemoglobin (Hb): ([oxyHb], [deoxyHb] and [totalHb]). NIRS has the potential to be useful as a clinical testing device because of its convenience and compact size.

The aim of this study is to establish the cortical basis of olfactory function in patients with PD. We have previously studied the olfactory function of PD patients (Karaki, 2011; Kobayashi, 2007; Kobayashi, 2009). In one study, we showed that multi-channel NIRS (MNIRS) can be used to evaluate hemodynamic brain responses after olfactory stimulation of PD patients. That study was conducted on ten normosmic healthy subjects and seven PD patients. However, the normosmic group included some young subjects. Therefore, we expected this previous study to need improvement. In the present study, 9 healthy older subjects and 24 patients with PD were used. The results of this study show the remarkable usefulness of NIRS as a test for olfactory function in Parkinson's disease.

METHODS

Participants

Participants comprised 24 patients with idiopathic PD (14 men and 10 women; mean age = 66.1 years) and 9 age-matched healthy volunteers who had not complained of any olfactory impairments (6 men and 3 women; mean age = 62.0 years). All patients were examined for naso-sinus diseases by sinus CT or MRI. Patients with nasal or paranasal sinus disease or with a history of olfactory diseases, post virus infective olfactory disorder, or head injury were excluded from the study.

Information documents and the Informed Consent Forms were approved by the Institutional Review Board, Faculty of Medicine, Kagawa University before being used (Approval No.: Heisei 21-52, Institutional Review Board, Faculty of Medicine, Kagawa University). Consents were obtained from the subjects after the Investigator