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CASE REPORT

Does oral care contribute to brain activation?: One case of functional near-infrared spectroscopy study in patients with a persistent disturbance of consciousness

Wataru Fujii[1,2], Daisuke Kanamori[2], Chisato Nagata[1], Kiyomi Sakaguchi[1] & Risa Watanabe[3]

[1]Department of Dental Surgery, Fujita Health University Nanakuri Sanatorium, Tsu, Mie, Japan
[2]Department of Dental Surgery, School of Medicine, Fujita Health University, Toyoake, Aichi, Japan
[3]Department of Dental Surgery, Fujita Health University Hospital, Toyoake, Aichi, Japan

Correspondence
Wataru Fujii, Department of Dental Surgery, Fujita Health University Nanakuri Sanatorium, 424-1 Ohtori, Tsu, Mie 514-1295, Japan. Tel: +81-59-252-1555; Fax: +81-59-252-1383; E-mail: wataru@fujita-hu.ac.jp

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Key Clinical Message

We used functional near-infrared spectroscopy (fNIRS) to measure cerebral blood flow during oral care in a patient with persistent disturbance of consciousness. We experienced that cerebral blood flow to frontal area increased during oral care, suggesting that oral care may have a potential role in rehabilitation for the brain.

Keywords

Functional near-infrared spectroscopy, oral care, persistent disturbance of consciousness, prefrontal area.

Introduction

In order to examine the effect of oral care on the brain, we used functional near-infrared spectroscopy (fNIRS) to measure cerebral blood flow in the prefrontal area during oral care in a patient with persistent disturbance of consciousness. With respect to brain activity resulting from oral stimulation, and so on, showed to increase cerebral blood flow in healthy individuals. However, it remains unknown whether oral care contributes to brain activation in patients with persistent disturbance of consciousness. The patient with persistent disturbance of consciousness was a 75-year-old man who had suffered a brain stem infarction 7 months previously. Cerebral blood flow is seen in the prefrontal area during oral care measurements made with a functional near-infrared imaging device. In this report, we experienced that cerebral blood flow to the frontal area increased during oral care, suggesting that oral care may be useful not only for preventing pneumonia and maintaining oral function, but also might have a potential role in rehabilitation for the brain as a whole, by improving the state of consciousness and cognitive function. Our reports suggest that oral care may contribute to brain activation. The fNIRS is useful for measuring variations in cerebral blood flow as a result of oral care.

Oral care and training to improve oral function have been reported to contribute to the prevention of pneumonia, [1, 2] improvement of cognitive function [3], and improvement of nutritional status [4]. With respect to brain activity resulting from oral stimulation, taste stimuli [5], stimulation of the oral cavity by tooth brushing [6], and fitting partial dentures [7] have been shown to increase cerebral blood flow in healthy individuals. However, it remains unknown whether oral care contributes to brain activation in patients with persistent disturbance of consciousness. In order to examine the effect of oral care on the brain, we used fNIRS to measure cerebral blood flow in the prefrontal area during oral care in a patient with persistent disturbance of consciousness, which we report here.

Patient and Methods

The patient was a 75-year-old man who had suffered a brain stem infarction 7 months previously. He was

bedridden with persistent disturbance of consciousness, scoring 4 on the Glasgow Coma Scale (GCS), required total assistance with activities of daily living (ADL), and was unable to communicate even by answering "Yes" or "No." He was fed via a gastrostomy tube. His mouth contained five remaining maxillary and seven mandibular teeth, and he did not use either upper or lower partial dentures, and anytime open. Everyday oral care was performed with the assistance of a nurse.

Oral care was performed by a dental hygienist and comprised the same oral routine as was normally used, consisting of cleaning the tooth surfaces with a toothbrush, cleaning between the teeth with an interdental brush, cleaning the tongue with a tongue brush, and cleaning the palate and buccal mucosa with a sponge brush. The procedure took ~10 min.

Cerebral blood flow measurements were made with a functional near-infrared imaging device (SMARTNIRS; Shimadzu Corporation, Kyoto, Japan) at three wavelengths: 780, 805, and 830 mm. A forehead holder (Flexible Adjustment Surface Holder [FLASH]; Shimadzu Corporation) was used for the fNIRS probe (Figs. 1, 2). The probe used a 3×7 rectangular grid (30 mm between light transmitters and detectors), which was fitted so that the center of the top row coincided with T3 according to the international 10–20 electrode system, with measurements performed using 32 measurement channels. "Rest" was defined as the resting condition, during which oral care was not performed and variations in oxygenated hemoglobin concentrations (oxyHb) were measured. The time delay in detecting elevated oxyHb associated with neural activity was set at 4 sec in accordance with the Gaussian theorem, on the basis of previous reports [8].

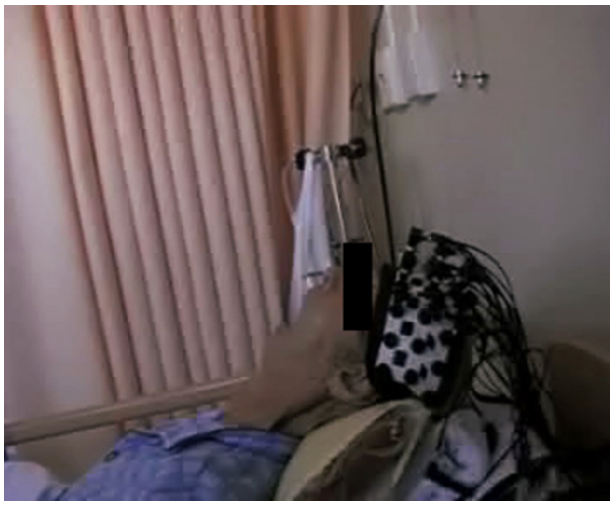

Figure 1. The patient with persistent disturbance of consciousness had suffered a brain stem infarction. The fNIRS probe was fitted to be measured cerebral blood flow in the prefrontal area during oral care.

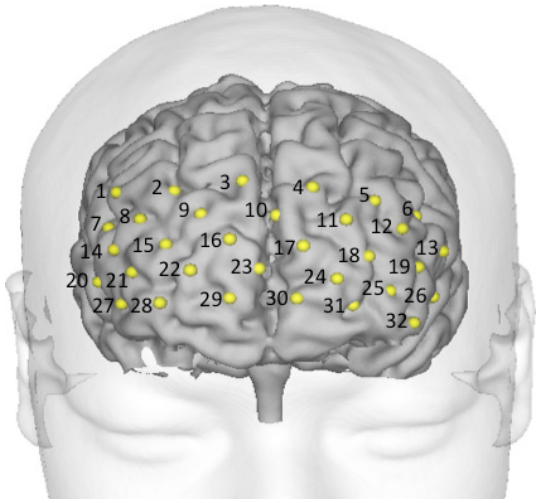

Figure 2. Projection of the fNIRS 32 channels onto the brain surface, we measured cerebral blood flow in the prefrontal area during oral care.

This case report was screened and approved by the ethics committee of our hospital (No. 108). Because the patient was unable to express his wishes himself, measurements were performed after a family member had provided an informed consent in writing as his representative.

Results

Cerebral brain flow in the prefrontal area of a patient with persistent disturbance of consciousness exhibited an increased oxyHb in 19/32 (59.4%) channels, while oral care was being performed, compared with at rest (Fig. 3).

Discussion

Variations in cerebral blood flow

Increased cerebral blood flow in the prefrontal area during oral care was evident in a patient with persistent disturbance of consciousness. This result is similar to the findings of previous functional magnetic resonance imaging (fMRI) and fNIRS studies that have demonstrated that cerebral brain flow increases in healthy individuals during taste stimulation, stimulation of the oral cavity by tooth brushing, and wearing partial dentures. Functional magnetic resonance imaging has also revealed brain activation in patients with persistent disturbance of consciousness similar to that seen in healthy individuals, even

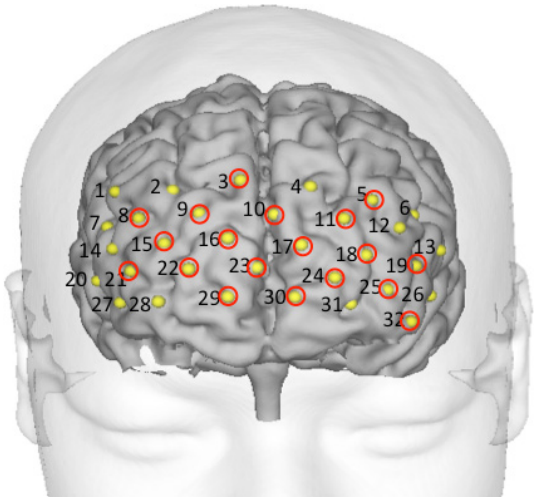

Figure 3. Red circle: Increased channels of oxyHb. Cerebral brain flow in the prefrontal area exhibited an increased oxyHb in 59.4% channels, while oral care was being performed, compared with at rest.

though this may not be superficially visible [9]. Musicokinetic therapy has also been reported to have improved the state of consciousness [10]. The prefrontal region has neural connections to the thalamus, other associative areas, the cingulate gyrus, the nucleus accumbens, and the lower brain stem, and has been shown to be involved in a wide range of fields, including reading aloud, calculations, language acquisition, associative learning, attention and time perception, emotional expression, goal-directed behavior, psychological interactions, voluntary movement, and mastication [11].

In this case, we experienced that cerebral blood flow to the frontal area increased during oral care, suggesting that oral care may be useful not only for preventing pneumonia and maintaining oral function, but also might have a potential role in rehabilitation for the brain as a whole, by improving the state of consciousness and cognitive function. Our results also suggest that the investigation and development of more effective methods of oral care may be worth pursuing.

Oral care may, however, result in excessive fluctuations in blood pressure. Increased blood flow to the cerebral area is also reported to occur during uncomfortable visual stimulation [12]. In this case, we did not investigate differences due to different locations and intensities of stimulation during oral care, and further detailed studies are, therefore, required. Moreover, since our study only involved a single patient, further studies should both examine changes over time in single patients and investigate multiple subjects in a clinical trial.

Usefulness of fNIRS

There have been a few reports of investigations of brain activity during oral stimulation using fMRI or position emission tomography (PET); however, these are large devices and scanning is performed with patients in the supine position inside the cylinder during measurements, meaning that they cannot be used for measurements during oral care in actual clinical settings. The fNIRS used in this study is a comparatively small device compared with fMRI and PET, and is easily operated for measurements at the bedside and elsewhere [13, 14]. Because measurements are made only with the probe, it is also completely noninvasive. This means it can be used for measurements at washbasins and in dental treatment rooms, making it suitable for clinical use. Changes in cerebral blood flow during the performance of oral care in everyday situations can therefore be measured in real time in a way that has hitherto been impossible, making fNIRS an extremely useful method.

Conclusion

Our case report suggests that oral care may contribute to brain activation. Moreover, further studies should both examine changes over time in single patients and investigate multiple subjects in a clinical trial. The fNIRS is useful for measuring variations in cerebral blood flow as a result of oral care.

Acknowledgment

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Conflict of Interest

None declared.

References

1. Yoneyama, T., M. Yoshida, T. Matsui, et al. 1999. Oral care and Pheumonia. Lancet 354:515.
2. Bassim, C. W., G. Gibson, T. Ward, et al. 2008. Modification of the risk of mortality from pneumonia with oral hygiene care. J. Am. Geriatr. Soc. 56:1601–1607.
3. Kikutani, T., T. Yoneyama, K. Nishiwaki, et al. 2010. Effect of oral care on cognitive function in patients with dementia. Geriatr. Gerontol. Int. 10:327–328.
4. Kikutani, T., R. Enomoto, F. Tamura, et al. 2006. Effects of oral functional training for nutritional improvement in Japanese older people requiring long-term care. Gerodontology 23:93–98.

5. Masako, O., D. Haruka, C. Lester, et al. 2009. Activation in ventro-lateral prefrontal cortex during the act of tasting: an fNIRS study. Neurosci. Lett. 451:129–133.
6. Shimazaki, T., T. Otsuka, S. Akimoto, et al. 2012. Comparison of brain activation via tooth stimulation. J. Dent. Res. 91:759–763.
7. Narita, N., K. Kamiya, K. Yamamura, et al. 2009. Chewing-related prefrontal cortex activation while wearing partial denture prosthesis: pilot study. J. Prosthodont. Res. 53:126–135.
8. Jasdzewski, G., G. Strangman, J. Wagner, et al. 2003. Differences in the hemodynamic response to event-related motor and visual paradigms as measured by near-infrared spectroscopy. Neuroimage 20:479–488.
9. Owen, A. M., and M. R. Coleman. 2008. Using neuroimaging to detect awareness in disorders of consciousness. Funct. Neurol. 23:189–194.
10. Noda, R., Y. Maeda, and A. Yoshino. 2004. Therapeutic time window for musicokinetic therapy in a persistent vegetative state after severe brain damage. Brain Inj. 18:509–515.
11. Grafman, J. 2002. Handbook of Neuropsychology, 2nd ed. Elsevier, Amsterdum.
12. Hoshi, Y., J. Huang, S. Kohri, et al. 2011. Recognition of human emotions from cerebral blood flow changes in the frontal region: a study with event-related near-infrared spectroscopy. J. Neuroimaging 21:e94–e101.
13. Taussky, P., B. O'Neal, W. P. Daugherty, et al. 2012. Validation of frontal near-infrared spectroscopy as noninvasive bedside monitoring for regional cerebral blood flow in brain-injured patients. Neurosurg. Focus 32: E2.
14. M. J. H., Aries, Coumou, A. D., and J. W. J. Elting, et al. 2012. Near infrared spectroscopy for the detection of desaturations in vulnerable ischemic brain tissue a pilot study at the stroke unit bedside. Stroke 43:1134–1136.