REVIEW ARTICLE

Combination of occupational therapy and neuromodulation for psychiatric disorders: literature review

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Abstract

Various clinical studies have been conducted in Japan and elsewhere on occupational therapy. Clinical studies in the psychiatric field in particular face various difficulties, and most reports are limited to case reports and qualitative comparative studies, and few objective and quantitative studies have undergone scientific verification. Conversely, there are various methods of neuromodulation, such as repetitive transcranial magnetic stimulation, transcranial direct current stimulation, electroconvulsive therapy, and vagus nerve stimulation, which have undergone remarkable development in recent years. These methods have been widely applied clinically, mainly in the fields of neurology and psychiatry. Although there have been many reports of intervention studies combining these neuromodulation methods with rehabilitation such as physical therapy and occupational therapy in the physical field, most of these studies have focused on motor function after cerebrovascular diseases. In psychiatry, however, only a few studies have combined neuromodulation and occupational therapy. Systematic research on combined therapy for psychiatric disorders is highly anticipated. In this article, we review clinical studies that used a combination of occupational therapy and noninvasive brain stimulation for psychiatric disorders, with discussion of the problems and prospects in this area.

Key words: *Occupational therapy, neuromodulation, psychiatry, repetitive transcranial magnetic stimulation, transcranial direct current stimulation.*

INTRODUCTION

About 50 years have passed since occupational therapists were first licensed in Japan, and today they play a central role in psychiatric rehabilitation. The Japan Occupational Therapy Association defines occupational therapy as treatment, guidance, and assistance focused on work, provided in the areas of medicine, health, welfare, education, and occupation to promote the health and well-being of people (2018). The role of occupational therapy is to promote people's overall health by helping them to smoothly and satisfactorily perform individual tasks, and it uses a variety of occupational activities as means of treatment, guidance, and assistance.

Occupational therapists are thus patient-centered health professionals involved in the promotion of health and improvement of life through occupational therapy. No longer limited to the field of mental health, their role has expanded to include the physical, developmental, geriatric and preventive fields, among others. The scope of occupational therapy and the roles demanded of occupational therapists by society are diversifying. The fields in which occupational therapists are expected to play an active role are steadily expanding to include medicine, health care, welfare, education, and occupation.

Although various clinical studies on occupational therapy are being conducted in Japan and elsewhere, clinical research in the psychiatric field in particular faces various difficulties, as most reports are limited to case reports and qualitative comparative studies, and relatively few objective and quantitative studies have undergone scientific verification. Reasons for this have been suggested to be the heterogenicity of mental disorders (particularly schizophrenia), the difficulty in standardizing effectiveness measures in quantitative studies because it is a treatment of daily life, distrust in quantitative research, tendency to treat groups rather than individuals as a matter of principle in psychiatric occupational therapy and difficulty in obtaining a subject's cooperation (Fukuhara, 2016).

Neuromodulation has undergone remarkable developments in recent years. Some of the various methods, detailed here, have been widely clinically

applied, mainly in the fields of neurology and psychiatry. Electroconvulsive therapy (ECT) is a treatment method aiming to improve psychiatric symptoms such as mood disorders and schizophrenia by inducing generalized convulsions through electric current to the head. Transcranial magnetic stimulation (TMS) is a method of magnetic stimulation of the cerebral cortex from the outside of the head based on Faraday's law. Repetitive TMS (rTMS) was approved as a treatment device for treatment-resistant depression in the United States in 2008, and the NeuroStar TMS device (Neuronetics Inc., USA) was approved in Japan in September 2017 as a novel treatment device for treatment-resistant depression in adults who do not respond to pharmacotherapy. Transcranial direct current stimulation (tDCS) is a simple, safe, and inexpensive neuromodulation technique, a noninvasive intervention that uses weak direct current. The tDCS typically involves placing an anode and a cathode on the subject's cranium and applying a current of 1 to 2 mA for several minutes. Vagus nerve stimulation (VNS) is a method of reducing the frequency and severity of seizures by implanting a stimulator in the left anterior thoracic region and stimulating the vagus nerve in the left neck with electrodes. Although it is palliative and not curative like craniotomy, its minimally invasive and modulatory nature is a major advantage, and it has been applied to psychiatric disorders in Europe and the United States.

There have been many reports of intervention studies combining neuromodulation and rehabilitation, such as physical therapy or occupational therapy in the physical domain, most of which have focused on motor function after cerebrovascular diseases. In psychiatry, however, only a few studies have combined neuromodulation and occupational therapy. Systematic research on combined therapy for psychiatric disorders is highly anticipated. In this article, we review clinical studies that featured the combination of occupational therapy and noninvasive brain stimulation for psychiatric disorders, and we discuss problems and prospects in this area.

MENTAL ILLNESS

In recent years, much evidence has been reported on the association between depression and cognitive decline (Prince, 2014). rTMS stimulation of the dorsolateral prefrontal cortex (DLPFC) has been reported to slightly improve performance on the Trail Making Test (Martin, 2017), and it was suggested that the combination of cognitive training and rTMS should be investigated to see if their synergistic effects can further improve clinical outcomes (Baeken, 2019).

Occupational therapists also apply cognitive behavioral therapy and cognitive training when developing rehabilitation (Tanaka, 2019), and combinations of noninvasive brain stimulation methods and occupational therapy approaches have been reported with cognitive behavioral therapy and cognitive training. A reported observational study included 196 patients with depression who were simultaneously treated with cognitive-behavioral therapy-based psychotherapy and rTMS. The results compared favorably with those of previous studies, showing that about 60% of patients had sustained benefit at six-month follow-up (Donse, 2017). rTMS therapy was summarized in another study as adjunctive therapy for refractory depression, with the suggestion that rTMS therapy and psychotherapy might target similar neural circuits and that changes in neuroplasticity induced by rTMS therapy might enhance the effects of psychotherapy (Yamazaki, 2020).

POST-ISCHEMIC DEPRESSION

Post-ischemic depression is defined in DSM-V as "a mood disorder due to cerebrovascular accident with depressive features, major depressive-like episodes, or mixed features" (Robinson, 2016), and a meta-analysis in 2013 reported a 29% prevalence of PID at any time within five years after cerebrovascular diseases (Ayerbe, 2013).

A systematic review and meta-analysis of randomized controlled trials of rTMS for post-ischemic depression demonstrated its usefulness, but cited the heterogeneity and potential bias of the included studies as limitations. The need for other center RCTs of rTMS treatment for post-ischemic depression and the need for investigation of validated stimulation parameters and target brain areas were noted (Shen, 2017). Another systematic review of treatments and their efficacy in the rehabilitation field for post-ischemic depression demonstrated the potential of rTMS to reduce depression (Hori, 2018).

Elsewhere, the efficacy of rTMS was demonstrated in 92 patients with vascular depression (VD) with a history of cerebrovascular diseases and who were unresponsive to antidepressant treatment. rTMS was shown to be effective in the patients with VD, and responsiveness to rTMS was negatively correlated with age yet positively correlated with frontal gray matter volume (Jorge, 2008). rTMS (10 Hz) to the left DLPFC was reported to significantly improve BDI and HAM-

17 in patients with VD, and the effect persisted and was seen at the four-week follow-up (Gu, 2017). rTMS was also performed in six patients with subacute cerebrovascular disease with Hamilton Depression Rating Scale scores >7 and there was significant improvement in Hamilton Depression Rating Scale after rTMS and sustained effects at three-month follow-up (Frey, 2020). In summary, rTMS might be beneficial for VD, and studies reporting long-lasting effects have been conducted in recent years, but the number of reports remains small.

It may also be necessary to examine the effects of noninvasive brain stimulation methods in combination with cognitive behavioral therapy (Wang, 2018) and other treatments thought to be effective for depression after cerebrovascular diseases.

HIGHER BRAIN DYSFUNCTION

Higher brain dysfunction was defined in one study as a state of affairs in which, as a result of an organic etiology of the cerebrum, a patient presents with relatively well-defined focal cerebral symptoms, such as aphasia, apraxia of speech, apraxia of action, or apraxia of cognition, or deficiency symptoms such as attention disorders and memory impairment, psychiatric symptoms such as emotional disorders, hallucinations and delusions, impaired judgment and problem solving skills, and abnormal behavior. It is a factor that interferes with daily life and social life (Mimura, 2002).

A review of twelve studies on the effects of TMS and tDCS as rehabilitation for hemispatial neglect found theta burst stimulation to be promising. However, stimulus parameters, efficacy measures, and the timing of the start of TMS and tDCS adaptation differed between studies, and evidence for efficacy were said to be insufficient (Müri, 2013). Effects on attention and working memory have also been reported when tDCS was applied to the left DLPFC in patients with cognitive decline after cerebrovascular disease. Significant improvement in Go/No-Go test response accuracy was reported at one hour post-stimulation (Kang, 2009). An anodal effect on the left DLPFC tDCS reportedly significantly improved the number of correct responses and recognition accuracy in a two-back working memory task compared to baseline, suggesting that it may be related to improved working memory function (Jo, 2009). Regarding aphasia, tDCS was applied to the left frontotemporal region of patients with chronic non-fluent aphasia after cerebrovascular accidents. Improved accuracy on a picture name recognition task with cathodal tDCS was reported, attributed to the suppression of inhibitory interneurons in the cortex by tDCS and the de-inhibition of language areas damaged by cerebrovascular disease (Monti, 2008).

A combination of cognitive rehabilitation and tDCS was applied to the prefrontal cortex in a patient with posterior cortical atrophy and this combined approach was shown to lead to both cognitive improvement and neurophysiological adaptive changes (Gramegna, 2018). tDCS combined with cognitive training as rehabilitation for patients with suspected Alzheimer's disease (AD) were shown to delay cognitive decline, suggesting the potential of tDCS as an adjunctive tool for cognitive rehabilitation in AD (Penolazzi, 2015). The possibility of tDCS as an adjunctive tool for cognitive rehabilitation of AD is suggested, and further validation is needed.

As described above, noninvasive brain stimulation is thought to be effective for various higher brain dysfunctions that occur after cerebrovascular diseases. However, the number of publications, systematic reviews, and meta-analyses still remain quite small, and new results of studies in combination with conventional rehabilitation are also needed. Verification of the effectiveness of noninvasive brain stimulation in combination with various rehabilitation techniques that have approaches to higher brain dysfunction, such as occupational therapy, are desired.

FUTURE OUTLOOK

Further research is will aim to determine the optimal combination of noninvasive brain stimulation methods and behavioral interventions. Among the reports of studies of combination therapies reviewed here, most reported that adverse effects were limited to mild headaches, suggesting that these combination therapies can be considered safe.

However, most intervention studies that have combined rehabilitation, such as occupational therapy with noninvasive brain stimulation, have focused on motor function after cerebrovascular diseases, and few studies have combined occupational therapy and noninvasive brain stimulation in the psychiatric field. One reason for this may be that in examining the efficacy and mechanism of action of combined occupational therapy and brain stimulation, it is difficult to control subjects' symptoms, manage their medication status, and control the content of occupational therapy, and as a result, it is difficult to secure a sufficient sample size. In addition, as mentioned earlier, it is dif-

ficult to conduct objective and quantitative research on the effects of occupational therapy in the psychiatric field. The following were suggested as a solution (Fukuhara, 2016): Firstly, thorough examination of the effectiveness of individual occupational therapy is required. Secondly, quantitative intervention studies of functional recovery are also required, based on the premise that functional improvement improves the quality of life. Thirdly, there should be quantitative research using comparable evaluation methods for both intervention content and life changes.

Conversely, to enable reproducibility of research and interpretation of data, it is necessary to focus on and standardize the various parameters of non-invasive brain stimulation methods, such as timing, intensity, and site of neuromodulation stimulation. Systematic research on combination therapy will be conducted beyond the physical domain, such as motor function, toward clinical application and elucidation of pathophysiology in the psychiatric, developmental, and geriatric domains is highly anticipated.

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