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Transcranial Magnetic Stimulation Treatment for Depression

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Transcranial Magnetic Stimulation Treatment for Depression

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Abstract

This literature review provides research that looks at the treatment of depressive symptoms with transcranial magnetic stimulation. Depression affects many people directly by presenting symptoms that can become debilitating. Between 30% and 50% of people with depression encounter resistances to treatment, meaning their symptoms do not show improvement (Shanok et al., 2023). Transcranial magnetic stimulation (TMS) is an alternative treatment for depression that shows resistance to traditional medications and therapies. TMS utilizes magnetic fields to affect functions in the brain that can change the way people feel. Some researchers suggest that it could also be more widely used, even if patients are not showing signs of treatment resistance. Advancements in this field are possible, and TMS shows signs of further improving upon itself.

Keywords: depression, transcranial magnetic stimulation, major depressive disorder, treatment resistant depression

Transcranial Magnetic Stimulation Treatment for Depression

Depression is one of the leading reasons for disability among adults all over the world and can lead to a number of debilitating symptoms that can sometimes result in a person's death by suicide. According to the American Psychological Association (n.d.), depression is "extreme sadness or despair that lasts more than days [at least two weeks]. It interferes with the activities of daily life and can cause physical symptoms such as pain, weight loss or gain, sleeping pattern disruptions, or lack of energy." Depression affects people of all age groups and backgrounds and can be difficult to manage, causing difficulties in many aspects of life, including social, familial, professional, and academic responsibilities. In addition to this, traditional medications used to treat depression do not work for everyone. These medications also carry a risk profile associated with a multitude of side effects with the most common being nausea, sexual dysfunction, sleep disruption, and even new or worsening depressive symptoms. These symptoms can become difficult to manage, causing further distress and sometimes negating or hindering treatment. Additionally, the side effects of traditional antidepressants are more severe than those of Transcranial Magnetic Stimulation (TMS) and often make it difficult for patients to want to continue their treatment. There is also the possibility of experiencing withdrawal symptoms if a person discontinues their long-term use of traditional antidepressants. There have been a plethora of studies on the treatment of depression and depressive symptoms. Transcranial Magnetic Stimulation is described by the Mayo Clinic (n.d.) as "a procedure that uses magnetic fields to stimulate nerve cells in the brain to improve symptoms of major depression." Many studies look at the treatment of participants through TMS who have treatment resistant depression. This includes those who do not show improvement after being prescribed medication for their symptoms.

Many researchers argue that Transcranial Magnetic Stimulation is an effective treatment for participants who have treatment resistant depression because of how few side effects and low medical risks it has compared to traditional medication. Because of this some researchers suggest it could be used as a first response treatment of major depressive disorder and related symptoms, even before other treatments are ruled out due to treatment resistance (Sakheim et al., 2020). Although some risk factors do increase the likelihood of adverse reactions to TMS treatment. These factors include metal implants in the head or neck area, cochlear implants, a history of epilepsy or seizures, and substance use disorder (Razafsha et al., 2023). Researchers state that TMS is cost effective, safe, and available (Bouaziz et al., 2023). This literature review examines the effectiveness of TMS and how TMS works in the treatment of treatment resistant depression and related symptoms. Because TMS is most commonly used as a treatment for treatment resistant depression, the use of TMS as a first line treatment of depression will not be examined. Additionally, studies on treatments for depression that did not relate to TMS were not examined.

Methods

The research for this literature review was implemented through the tools provided by the University of California Merced library via the Psycinfo database through proquest. Key search terms used for the database search included TMS and Depression. Articles selected for this review were published between 2018 and 2023 with a focus on articles that examined the use of TMS as a treatment for major depressive disorder and depressive symptoms. There are a total of 12 sources included in this study.

Literature Review

How Does Transcranial Magnetic Stimulation Treat Depression?

TMS is a procedure that stimulates targeted parts of the brain with magnetic fields in

order to stimulate brain cells that are involved in the biological factors of depression such as mood regulation (Shanok et al., 2023). In other words, practitioners aim to activate parts of the brain associated with positive emotions and weaken parts of the brain associated with negative emotions that are correlated with depression. When used on a regular basis TMS is capable of making neurons stronger or weaker in order to create a state of plasticity that can have lasting effects on depression (Gogulski et al., 2023). This describes a possibility of the brain changing its physical aspects to better facilitate emotions that are associated with a decrease in depressive symptoms.

One portion of the brain associated with Major Depressive Disorder (MDD) is the dorsolateral prefrontal cortex. The dorsolateral prefrontal cortex is thought to have a major role in complex thought and emotion. Researchers have found that stimulating this area with TMS could allow for a more specific treatment of MDD (Razafsha et al., 2023). Stimulation of the dorsolateral prefrontal cortex could aid in facilitating stronger emotional regulation, leading to a decrease in extreme emotions, such as sadness, that are associated with depression. Another structure in the brain that has been associated with depressive symptoms is the subgenual anterior geniculate cortex (sgACC) (Raij et al., 2023). The sgACC is associated with the modulation of emotions including sadness that can become difficult to manage and lead to symptoms of depression.

There are many ways to create a more personalized treatment plan with TMS, including what part of the brain is being targeted, how many times a day it is being targeted, and the intensity of the magnetic stimulation (Gogulski et al., 2023). Gogulski et al. suggest the possibility that the limitations placed on TMS treatment by researchers and clinicians could be contributing to less than optimal results. These limitations come from existing research that

shows TMS to be relatively effective in its current state. Because of this, many researchers do not try to improve upon existing protocols due to the notion that TMS is effective as it is. Raij et al. (2023) suggest the possibility of targeted treatment of core emotional regions of the brain in order to more accurately affect networks associated with depression. There are many variations of TMS that can be tailored to each individual participant using the same equipment. A quick scan of brain activity with an electroencephalogram (EEG) can help clinicians determine which parts of the brain in each participant are associated with their specific case of depression (George et al., 2023). An EEG uses small metal discs, called electrodes, to measure the electrical activity in the brain. This is often used to create a map of brain activity as neurons, the nerve cells of the brain, use electricity to communicate with each other. There is also a form of neuroimaging using a model of the brain that was based on an imaging database that used functional magnetic resonance imaging (fMRI) that showed some success with predicting targets for TMS treatments (Raij et al., 2023). Raij et al. suggest the possibility of using this model of the core neuronal networks associated with depression to form a more general pattern of TMS treatments for depression. The model showed validity when it was compared to a model of healthy brains and showed a noticeable difference in activity (Raij et al., 2023). This model also demonstrated the variability between participants' brains and the biological factors in the treatment of their depression (Raij et al., 2023). It is important to consider that each individual brain functions in similar ways, but not the same. Meaning biological factors of depression can present themselves differently in each participant.

Another form of TMS treatment involves a deeper stimulation of the prefrontal cortex. This treatment, deep TMS, consists of a broad stimulation at a greater depth that affects a larger area of gray matter and has shown strong antidepressant effects (Shanok et al., 2023). It is

thought that this is accomplished by reducing slow wave activation in the prefrontal cortex while also facilitating the production of neurotransmitters that help reduce depressive symptoms such as norepinephrine and serotonin (Shanok et al., 2023). Neurotransmitters are chemical messengers in the brain that are associated with conveying specific information. They are thought to influence our behaviors and emotions by signaling what parts of the brain need to be active and what behaviors are required to facilitate necessary bodily functions. As well as activating neurotransmitters, deep TMS is thought to effectively reduce depressive symptoms through stimulation of reward and emotion pathways in the brain (Shanok et al., 2023). iTBS is another form of TMS that uses intermittent theta burst stimulation to activate parts of the brain that are usually found to be underactive in participants presenting depressive symptoms (Bulteau et al., 2022). A study at Stanford University attempted to establish a high dose iTBS treatment that employed neuroimaging targeting techniques that they called Stanford Neuromodulation Therapy (SNT). SNT was found to effectively reduce severe depressive symptoms among participants (Cole et al., 2021). There are many different forms of TMS that function in different ways, but they are ultimately the same kind of treatment.

TMS is a noninvasive form of neuromodulation, which is a way to alter nerve cell functioning, specifically in the brain (Schulze et al., 2018). It has very few reported side effects, with the most common being a headache or scalp irritation that typically resolve within a few weeks at the latest (Shanok et al., 2023). Researchers call for TMS treatment to be more widely available to participants who present depressive symptoms as it is an effective, noninvasive treatment with very few negative consequences (Bouaziz et al., 2023). Additionally, researchers call for more research to be done on the possibilities of TMS treatment, as there are many different ways to accomplish this treatment.

Is Transcranial Magnetic Stimulation An Effective Treatment For Depression?

Research shows that TMS treatment is correlated with a reduction in depressive symptoms. Razafsha et al. (2023) describe a correlation between a reduction of depressive symptoms and a number of TMS sessions. The standard TMS procedure lasts for 36 sessions spread out over the course of six weeks. As participants increase their number of sessions, their depressive symptoms show more significant improvement on a clinical scale of measurement (Razafsha et al., 2023). In addition to this, a different study done by Hutton et al. (2023) showed that participants who had undergone less TMS sessions showed less significant reduction of depressive symptoms when compared to participants that had more treatment sessions Hutton et al. (2023) also state that TMS showed no signs of becoming less effective as treatment was prolonged. Rates of remission, as well as rates of response showed a tendency to increase over time without reaching a high point (Hutton et al., 2023). This implies the possibility of extended or indefinite treatment to further improve cases of depression that require more care. In addition to improving with the number of sessions, it was also found that TMS treatment can be done effectively in less time if the participant undergoes up to ten sessions in one day (Gogulski et al., 2023). Additionally, researchers found that participants that underwent TMS treatment twice a day showed improvement in half as much time as those who underwent treatment once daily, even when the amount of treatment stayed the same (Schulze et al. 2018). This leads to the possibility of more rapid improvement of severe cases of depression through an increased dose and frequency of TMS treatment.

When compared to other treatments for treatment resistant depression, TMS was shown to be more effective overall. These findings were based on both clinician and participant ratings (Sackheim et al., 2020). Sackheim et al. (2020) found that the comparisons favored TMS

strongly and suggested that it could be used as a first line treatment for depression. TMS can also be effective in treating treatment resistant depression when comorbidities are present (Bouaziz et al., 2023). This could potentially be a treatment for depression that does not interfere with other mental illnesses in ways that other treatments, such as medication, may interfere. However, Razafsha et al. (2023) found a possible limitation in that non-responders to TMS treatment in their study presented more comorbidities than those that did respond to the treatment. In other words, there was a correlation between participants who did not respond to TMS treatment and participants who had multiple mental illnesses. More research should be conducted on the possibility of TMS treatment in clinical populations presenting comorbidities. The iTBS branch of TMS treatment has shown effectiveness in treating depression as well as the stabilization of symptoms once the treatment course was concluded (Bulteau et al., 2022). In addition to iTBS, a follow up conducted on participants of the SNT trial at Stanford University showed significant reduction of severe depressive symptoms (Cole et al., 2021).

Conclusion

The literature states that TMS is an effective treatment for depression, especially in cases that are resistant to traditional medication. Participants of TMS show statistically significant improvement of depressive symptoms. TMS also carries a lower risk profile with minimal side effects compared to many traditional antidepressants with the most commonly reported side effects of TMS being scalp irritation and headaches, though most of these symptoms are shown to subside within a few weeks (Shanok et al., 2023). In addition to a low risk profile, TMS has not been shown to interfere with daily life, with research suggesting that TMS becomes more effective the more it is applied.

Researchers are looking to find ways to make TMS even more effective than it already is.

The literature suggests that using TMS alongside brain imaging techniques may increase the effectiveness of this treatment. Many researchers question why TMS is used as a last line treatment of depression when it has a significant rate of success. More research is required on TMS being used alongside other treatments of depression. Additionally, there is a lack of research on the use of TMS for depression that is not treatment resistant. TMS is often not prescribed unless a participant is presenting a resistance to the traditional course of treatment.

While many researchers agree that TMS effectively reduces symptoms of depression, more research is required on if it can be more effective. TMS can be used in many different ways, however most clinicians only use the basic, surface level functions of the machines (Gogulski et al., 2023). Future research should be undertaken to examine the possibilities of TMS treatment including pairing it with imaging technology, trying different functions of the TMS machines, and higher frequency of treatment sessions. These parameters may lead to future breakthroughs in the field of depression treatment.

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