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Exploring Transcranial Magnetic Stimulation as an Adjunctive Treatment for Trichotillomania

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ABSTRACT

Trichotillomania (TTM) is a disorder characterized by the irresistible urge to pull out one's hair, which can lead to significant mental and physical consequences. TTM is classified as a body-focused repetitive behavior and shares similarities with obsessive-compulsive disorder (OCD), which can present challenges with implementing effective and long-lasting treatment. This paper aims to investigate transcranial magnetic stimulation (TMS), a non-invasive technique that stimulates certain parts of the brain. It is often used to treat individuals with trichotillomania to reduce hair-pulling behaviors. The paper will first provide an overview of trichotillomania and its association with OCD, followed by a review of TMS and its implementation as a treatment method for patients diagnosed with OCD and OCD-related behaviors such as TTM. The paper will then examine the efficacy of TMS in managing trichotillomania and conclude by analyzing the gaps in current research, putting forward potential directions for future studies. This essential investigation intends to highlight a possible treatment option for TTM, hoping to advance the scientific and clinical understanding of trichotillomania.

INTRODUCTION

Trichotillomania (TTM) is considered a type of obsessive-compulsive disorder (OCD) in which individuals pull out their hair from different regions of their body (Grant & Chamberlain, 2021). Hair-pulling frequently begins when an individual is young (usually adolescent ages), although it can start at any age (Ricketts et al., 2019). Depending on the intensity of symptoms, TTM can present with moderate social disability, such as decreased physical and mental engagement in one's social life, alongside hair loss, leading to discomfort and reduced self-esteem (Grant & Chamberlain, 2021). Often, patients diagnosed with TTM also have mental health conditions such as depression and anxiety (U.S. Department of Health and Human Services, 2023).

TTM is a frequently underrecognized neuropsychiatric condition (Weidt et al., 2017). Some patients remain undiagnosed due to a lack of knowledge of TTM diagnostic criteria and not knowing exactly where to seek professional treatment (Weidt et al., 2017). However, approximately 65 percent or more of patients who are diagnosed with TTM do not seek treatment for this disorder (Grant & Chamberlain, 2021). Feelings of shame or embarrassment have been reported as barriers to care (Weidt et al., 2017).

Addressing trichotillomania early on can be helpful, as early intervention is reported to have a more substantial effect (Harrison & Franklin, 2012). Delayed diagnosis may cause long-term complications, such as permanent hair loss or hair-pulling continuing into adulthood (Harrison & Franklin, 2012). Current gaps in TTM treatment and the need for early intervention underscore the need to identify effective therapies to support individuals with TTM.

This paper aims to explore one potential treatment method for trichotillomania: Transcranial Magnetic Stimulation (TMS). This paper will first describe the underlying neurological pathology of TTM and the overlaps between TTM and other neuropsychiatric disorders, providing context for its presentation and underlying factors. Then, a discussion of TMS and its potential utility in treating TTM, along with a comparison to other relevant treatment models, will be elaborated on. Ultimately, the paper will review the effectiveness of TMS in managing trichotillomania and outline directions for future research on this treatment option.

METHODS

This study investigates the use of transcranial magnetic stimulation (TMS) as an adjuvant treatment for trichotillomania using a narrative literature review methodology. Using keyword combinations like trichotillomania, transcranial magnetic stimulation, OCD-related disorders, and neuromodulation, targeted searches of databases like PubMed, Google Scholar, and PsycINFO were used to find peer-reviewed studies. Randomized controlled trials, meta-analyses, systematic reviews, and clinically significant case series published within the previous 20 years were given priority. To summarize the available data and pinpoint areas in need of further investigation, a selection of studies were examined for methodological quality, treatment protocols, results, and limitations.

OVERVIEW OF TTM

Five clinical characteristics are commonly observed in individuals with TTM: recurrent hair-pulling behaviors; a feeling of tension when attempting to resist pulling or immediately before pulling; a sense of relief after the hair is pulled; symptoms that are not better explained by another mental disorder or medical condition; and significant negative impacts on an individual's social functioning (Schreiber et al., 2011). TTM typically presents in patients as nonscarring alopecia, characterized by patchy hair loss with short hairs (Melo et al., 2021).

Two different types of hair-pulling have been described in patients diagnosed with TTM: automatic and focused pulling (Melo et al., 2021). Automatic pulling occurs when an individual is not fully aware of their actions; this response typically arises from stressful events or emotional triggers (Melo et al., 2021). Focused pulling occurs while one is aware of their actions; individuals may pull hairs that feel "different" from the others (Melo et al., 2021).

Although some individuals with TTM simply pull out their hair and discard it, others may ingest parts of the hair or the hair as a whole, a condition known as trichophagia (Woods & Houghton, 2014). Ingested hair may lead to a trichobezoar, a hairball in the proximal gastrointestinal tract. Developing a trichobezoar is extremely rare and mostly seen in young or adolescent females (Schlosser & Cosci, 2023). The ingested hair is not readily digested due to its smooth surface, resulting in its accumulation in the gastrointestinal tract over time (Schlosser & Cosci, 2023). If hair ingestion continues, hair may continue to accumulate between the mucosal folds of the stomach (Schlosser & Cosci, 2023).

The most common site of hair-pulling is the scalp, closely followed by the eyebrows and/or eyelashes (Grant, 2019). pubic hair has also been identified as a common site for individuals with TTM (Woods & Houghton, 2014). Although hair-pulling may be concentrated in a specific site, pulling from multiple different sites on the body is not uncommon (Grant, 2019).

In most cases, hands or fingers are used to pull out the hair; however, other devices, such as tweezers, can also be used (Pereyra & Abdolreza Saadabadi, 2023). The hair-pulling can be characterized as ritualistic, where individuals may run their hands through and only pull hairs that feel coarse or are short, and then play with or eat the hair. (Pereyra & Abdolreza Saadabadi, 2023).

The triggers for TTM vary, but stress and anxiety are commonly reported (Grant & Chamberlain, 2021). Other triggers include boredom, fatigue, or anger (Grant & Chamberlain, 2021).

NEUROBEHAVIORAL OVERLAP BETWEEN TTM AND OCD

Studies have suggested that repetitive hair-pulling in TTM resembles the compulsions observed in patients with OCD (Lochner et al., 2005). Both TTM and OCD patients describe their compulsive urges as recurrent and habitual (Lochner et al., 2005). It is important to note that, unlike OCD, where individuals experience an obsession coupled with a compulsion, TTM does not occur in response to obsessive thoughts; patients have an uncontrollable urge with an expected sense of gratification after hair is pulled out (Lochner et al., 2005). Both TTM and OCD patients report symptoms of anxiety, with a sense of relief following their compulsive behaviors (Grant & Chamberlain, 2016).

Trichotillomania is often misdiagnosed as OCD (Grant & Chamberlain, 2016). However, according to a 2017 paper exploring management approaches for TTM, rates of OCD tend to be higher in individuals with TTM, ranging from 13- 27%, while rates of TTM in individuals with OCD range from 4.9-6.9% (Grant & Chamberlain, 2016). TTM patients often report having other body-focused repetitive behaviors, such as skin picking or nail-biting, underscoring the importance of screening for other repetitive behaviors alongside hair-pulling when attempting to distinguish TTM from OCD (Grant & Chamberlain, 2016). Although distinct, TTM and OCD share hallmarks of repetitive compulsion, suggesting a common neurobiological pathway (Grant & Chamberlain, 2016). However, twin studies have shown genetic differences associated with trichotillomania and other OCD-related disorders (Mattheisen et al., 2021).

DEMOGRAPHICS OF TTM PATIENTS

Trichotillomania affects about 1%–2% of the 1697 people surveyed in the 2023 study who self-reported symptoms aligned with a diagnosis of trichotillomania (Mackay, 2023). Although there is limited epidemiological data for TTM, some studies suggest a female predominance among those with the condition, with an approximate female-to-male ratio of 4:1 (Thomson et al., 2022). The mean age of individuals diagnosed with TTM significantly differs between male (19.0 years) and female (14.8 years) populations($p = 0.020$) (Grant et al., 2020).

Adults

In adult populations, TTM primarily affects females, who are reported to deny their habit often (Melo et al., 2021). Studies, such as an internet-based survey of 1,697 individuals conducted from April 2005 to May 2005, suggest that TTM exhibits more prevalent symptoms in females; however, approximately 93.2% of the individuals surveyed were female, which may further contribute to the female predominance (Schreiber et al., 2011). In a 2021 study aiming to evaluate the overall symptoms of TTM, over 75% of adults with TTM developed symptoms following stressful events (Melo et al., 2021). Although extensive studies have yet to be conducted, numerous small studies have demonstrated a high prevalence of TTM among college students, ranging from 0.5 to 3.9% in this population. (Schreiber et al., 2011). Adults with TTM tend to report mild to moderate "functional disability" across their social, family, and work lives (Woods & Houghton, 2014).

Children

Among pediatric patients, TTM is found to predominantly affect female children who are between the ages of 9 and 13, with these children often reported to be in denial of their habit (Melo et al., 2021). Feelings of shame, low self-esteem, and consistent effort to actively conceal hair loss were reported among this population (Woods & Houghton, 2014). Although alopecia is prevalent in pediatric cases of TTM, pediatric cases reported without alopecia also exist. In such cases, patients had low hair density and a negative pull test (a diagnostic process that assesses the general well-being of hair follicles and looks for diseases that contribute to increased hair loss. However, a hair-pulling test usually yields a negative result when trichotillomania is present. To distinguish trichotillomania from other hair loss conditions, this is an essential diagnostic hint. With adolescents, behavioral approaches are crucial to treating TTM alongside pharmacotherapy, as they allow for increased "clinical benefits" (Melo et al., 2021).

In pediatric populations, parents of patients with TTM are strongly advised against using forms of negative feedback and punishment for pulling out the hairs, as they may not yield the desired results (Melo et al., 2021). Indeed, in this population, TTM is often found to spontaneously resolve, with parental education and support being crucial to managing TTM symptoms in children (Melo et al., 2021).

WHAT IS TMS?

Transcranial Magnetic Stimulation (TMS) is a non-invasive, painless, and safe treatment method that stimulates the brain and is used to treat neurological and psychiatric disorders (Saini et al., 2018). It utilizes electromagnetic induction; an electric current flows through a primary coil, creating a magnetic field which induces a secondary electric field in nearby neural tissue and ultimately stimulates neurons (Chervyakov et al., 2015). The technique of TMS was first developed by Barker and his colleagues in 1985 (Barker et al.). Shortly after, researchers developed possible ways to deliver multiple different pulses in short time frames, which came to be known as repetitive TMS (rTMS) (Somani and Kar, 2019). TMS generates relatively small electrical currents that are targeted towards specific cortical regions, ultimately inducing changes in gene expression, neurotransmitters, and synaptic plasticity (Chervyakov et al., 2015). It has diagnostic, prognostic, and therapeutic uses in neurology, serving as an effective treatment method for stroke, depression, migraines, and OCD-related disorders (Chervyakov et al., 2015; Kobayashi & Pascual-Leone, 2003). TMS-induced electromagnetic fields operate at different levels in the brain because these effects determine the multitude of therapeutic benefits produced by this method (Chervyakov et al., 2015). Different brain regions, disease states, or even genetic backgrounds may truly bias the system toward different mechanisms, producing visible contradictory results that are based on context.

While synaptic plasticity is commonly invoked to explain changes that are induced by TMS, definitive evidence for this mechanism in humans remains rather lacking, and alternative or complementary processes, such as altered membrane excitability, may contribute in a sustainable manner (Noh., 2025). TMS also encompasses a multitude of distinct stimulation paradigms, each one serving different purposes, in an investigational manner.

TMS AS A TREATMENT METHOD–TYPES OF TMS

Single-pulse, paired-pulse, and repetitive TMS are different types of modern TMS techniques for brain mapping and evaluating cortical excitability and neuronal inhibition (Rossini & Rossi, 2007). rTMS is being investigated as a potential intervention method for various psychiatric and physical disorders in a therapeutic manner (Somani and Kar). Two major variations of rTMS are used in clinical practice: High-frequency rTMS and Low-frequency rTMS. High-frequency rTMS is believed to have an active effect on the cerebral cortex, and low-frequency rTMS is thought to have inhibitory effects (Somani and Kar). Understanding the overall function of the brain, plasticity, and the effects of medications on neuropsychiatric disorders is simplified through the use of TMS. A recently introduced modality of rTMS is theta burst stimulation (TBS); larger amounts of stimulation are delivered to certain regions of the brain in shorter amounts of time (Somani and Kar). TBS represents a specialized form of rTMS protocol that closely mimics endogenous neural oscillations by delivering 50Hz bursts of triplet pulses repeated at 5Hz (Jannati et al., 2022). A standard session of rTMS may take approximately 30 minutes, whereas TBS sessions can take only three minutes and, based on the latest research, are in no way inferior to high-frequency rTMS when used in patients with psychiatric and physical disorders (Blumberger et al., 2018). Low-frequency rTMS (which is less than 1Hz) typically decreases cortical excitability, while high-frequency rTMS (which is greater than 5Hz) increases cortical excitability significantly (Chervyakov et al., 2015). Alongside other methods, such as magnetic resonance imaging (MRI), TMS enables researchers to effectively test brain-behavior relationships, particularly when applied to non-motor areas (brain regions outside the primary motor cortex that are directly involved in initiating and controlling movement) (Rossini & Rossi, 2007).

TMS encompasses different paradigms of stimulation, each one serving a different purpose (Jannati et al., 2022). Single pulse TMS delivers isolated pulses that are separated by intervals and is primarily used to assess cortical excitability through motor-evoked potentials (MEPs) (Jannati et al., 2022). Paired-pulse TMS employs two consecutive pulses to provoke intracortical inhibitory and facilitatory circuits, with protocols such as short-interval intracortical inhibition (SICI) using 1-5 ms interstimulus intervals and intracortical facilitation (ICF) using 7-20 ms intervals (Blumberger et al., 2018). rTMS delivered a multitude of connective pulses at frequencies ranging from 0.5-20 Hz over durations from 30-40 minutes (Jannati et al., 2022). TBS protocols typically involve 600-1800 total pulses sent to the brain and come in two different primary forms: intermittent TBS (iTBS), which generally facilitates cortical excitability, and continuous TBS (cTBS), which tends to suppress and decrease cortical excitability (Jannati et al., 2022). The temporal patterning of TBS is generally designed towards more efficient induction of plasticity-like charges compared to conventional rTMS (Jannati et al., 2022).

TMS is used to treat various psychiatric disorders, but is primarily used to treat depression (Pridmore & Pridmore, 2018). It is particularly effective for depression, classified as treatment-resistant, with FDA-approved TMS devices currently available (George, 2013). Deep TMS, using H-coils, can initiate and modulate cortical excitability up to 6 cm deep, which can affect deeper neural circuits (Bersani et al., 2013). Ongoing research focuses on optimizing current treatment parameters for TMS and exploring its potential applications for other psychiatric conditions (George, 2013b; Bersani et al., 2013). Refer to Table 1 for a simplified explanation of the different types of TMS and their stimulation patterns, parameters, and application methods.

Table 1: Different Types of TMS and Their Stimulation Patterns, Typical Parameters, and Primary Application Methods

TMS type	Stimulation Pattern	Typical Parameters	Primary Application

Single-Pulse	Isolated Pulses	Variable intensity	Cortical excitability assessment via MEPs
Paired-Pulse	Two consecutive pulses	ISI: 1-5ms (SICI), 7-20 ms (ICF)	Intracortical inhibition and facilitation
Repetitive (rTMS)	Continuous pulse trains	0.5-20 Hz, 25-40 min duration	Sustained cortical modulation
Theta-burst (TBS)	Triplet bursts at 5Hz	50 Hz bursts, 600-1800 total pulses	Efficient plasticity induction

Technical refinements have significantly enhanced TMS precision and interpretability. Neuronavigation using structural MRI improves the spatial precision of TMS delivery, allowing specific targeting of accurate cortical regions (Jannati et al., 2022). The combination of TMS with electroencephalography (TMS-EEG) enables the accurate measurement of cortical reactivity through different regions of the brain rather than solely relying on certain motor outputs (Jannati et al., 2022). TMS-EEG can assess excitability, connectivity, and oscillatory dynamics across both motor and non-motor regions in the brain (Chung et al., 2015). This critical integration required dedicated TMS-compatible EEG amplifiers to manage artifact rejection (Ziemann et al., 2015). Pharmaco-TMS approaches to combine aspects of TMS with pharmacological interventions to characterize neurotransmitter systems and their roles in plasticity, using both TMS-EMG and TMS EEG measurements (Ziemann et al., 2015). Significant additional multimodal combinations include TMS with functional MRI for targeting and understanding network effects in the brain, and TMS with PET/SPECT imaging for studying various neurotransmitter pathways (Ziemann et al., 2015).

HOW IS TMS USED TO TREAT OCD AND OCD-RELATED DISORDERS

rTMS is a noninvasive neurostimulation technique that provides a rather novel “third way” of addressing OCD symptoms via electrical stimulation in a localized manner, distinct from pharmacotherapy and psychotherapy treatment approaches (A. Lusicic et al., 2018). This technique works by modulating multiple levels of neural activity present at the cortical level, which prolongs and repetitive application that leads to changes in brain excitability, outlasting the stimulation period (G. Saba et al., 2015).

Multiple meta-analyses demonstrate significant therapeutic benefits for rTMS as a possible treatment method for TTM. A 2016 meta-analysis consisting of 15 randomized controlled trials (n-483) found TMS significantly superior compared to other stimulation with a moderate effect size (Hedges g=0.45, 95% CI: 0.2-0.71) (A. Trevizol et al., 2016). A large 2017 meta-analysis of 20 studies (n=791) reported an even more substantial large effect size (g=0.71, 95% CI: 0.55-0.87) (Dongdong Zhou et al., 2017). However, an earlier 2003 Cochrane review concluded that there was insufficient data to draw an accurate and definitive conclusion about the overall efficacy (J. L. Rodriguez-Martin et al., 2003). Refer to Table 2 for different brain targets of TMS and the effectiveness of the treatment in those areas.

Table 2: Brain Targets of TMS and Effectiveness

Brain Targets	**Effectiveness**
Supplementary Motor Area (SMA)	Shows significant improvement over sham treatment (g=0.56) and is considered one of the most promising targets (Dongdong Zhou et al., 2017)(N. Jaafari et al., 2012).
Dorsolateral Prefrontal Cortex (DLPFC)	Effective across multiple different configurations -left SLFPC (g=0.47), bilateral DLPFC (g=0.65), and right DLFPC showing the strongest effect (g=0.93) (Dongdong Zhou et al., 2017).
Orbitofrontal Cortex (OFC)	This shows promising results, but with more variable results present (g=0.56, not reaching statistical significance in some analyses)(Dongdong Zhou et al., 2017) (N. Jaafari et al., 2012).
Anterior Cingulate Cortex (ACC)	This specific area is targeted through deep TMS (dTMS) with encouraging but variable results (A. Lusicic et al., 2019) (S. Kar et al., 2023)

Both low-frequency (g=0.73) and high-frequency (g=0.70) stimulation protocols show significant benefits over sham treatment, which so specific differences between both frequencies (Dongdong Zhou et al., 2017). Also, threshold-intensity stimulation appears to be significantly more effective than subthreshold approaches (Dongdong Zhou et al., 2017).

Despite promising results, several challenges remain. High heterogeneity across studies ($I^2 = 43\%$ in one meta-analysis) indicates that there is significant variability in both treatment protocols and outcomes (A. Trevisol et al., 2016) (S. Kar et al., 2023). Researchers also emphasize the need to better quantify the clinical role of TMS, noting that several factors, like the context of stimulation, certain neural principles supporting network effects, and even neuroanatomical heterogeneity, are often overlooked in certain applications of the treatment, clinically (L. Cocchi et al., 2018).

TMS AND TTM

The most common treatment for TTM is cognitive behavioral therapy, particularly habit reversal training, which is effective, but relapse is common among patients (Franklin et al., 2011). Some pharmacological treatments, such as N-acetylcysteine and memantine, have also shown significant potential as initial therapy methods (Nina Dominguez et al., 2024a). However, TMS targeting the supplementary motor area and dorsolateral prefrontal cortex in TTM patients has yielded symptom improvement with minimal side effects (Kar et al., 2025; Efruz Pirdoğan Aydın et al., 2020). A 2025 paper assessing the role of TMS in treating TTM among 22 patients reported a substantial improvement in the overall severity of patients' symptoms (Kar et al., 2025a). Further, a 2020 case series exploring alternate methods for treating TTM, such as TMS, demonstrated substantial benefits for patients (Efruz Pirdoğan Aydın et al., 2020). The case series, which included five female patients aged 19-26 who were diagnosed with TTM, demonstrated that low-frequency repetitive Transcranial magnetic stimulation (rTMS) over the bilateral supplementary motor area (SMA) resulted in significant symptom improvement for three patients (Efruz Pirdoğan Aydın et al., 2020). Partial improvement was observed in one of the two patients who did not show significant improvement, and no benefit was observed in the remaining patient. The sample size of this study is considered relatively small, with a lack of controls for the experiment, limiting. The generalizability of the study to populations other than young females. Nonetheless, these results suggest that rTMS may be a promising treatment for female patients diagnosed with TTM (Efruz Pirdoğan Aydın et al., 2020).

A 2014 paper reviewing current and emerging treatment methods for compulsive and impulsive disorders discussed both noninvasive neuromodulation techniques (such as TMS) and pharmacological treatments (Pallanti & Hollander, 2013). The authors of the paper reported that certain compulsive disorders—including OCD, TTM, and skin picking disorder—share neurobiological characteristics, which makes them potential candidates for similar treatment options (Pallanti & Hollander, 2013). Repetitive TMS was one such treatment option for obsessive and impulsive disorders, reducing symptom severity (Pallanti & Hollander, 2013). Much of the evidence included in this paper was considered preliminary, however, as it was drawn from small case studies and non-controlled trials (Pallanti & Hollander, 2013).

A 2023 case report discussing the treatment of a patient with TTM using repeated sessions of TMS references studies that used low-frequency rTMS targeting the pre-SMA, and resulted in reduced symptom severity (Alizadehgoradel et al., 2024)... The au decreased symptoms both during and after rTMS treatments, suggesting that rTMS may help reduce and alleviate compulsive hair-pulling behaviors (Alizadehgoradel et al., 2024).

CHARACTERISTICS OF INCLUDED STUDIES

There are two specifically relevant publications examining TMS for trichotillomania treatment. One was a primary case series of five patients (E. Aydın et al., 2020), and the other was a systematic review synthesizing four studies that totaled 22 patients (S. K. Kar et al., 2025).

The patient population in the case series consisted exclusively of females ranging from the ages of 19 to 26 (E. Aydın et al., 2020). The baseline severity of TTM, measured by the MGH Hair Pulling Scale, ranged from 15/38 to 28/28 (E. Aydın et al., 2020). All patients who participated had significant psychiatric comorbidities, including various disorders such as ADHD, major depression, generalized anxiety disorder, onychophagia, bipolar disorder type 2, OCD, alcohol abuse, and even specific types of phobia (E. Aydın et al., 2020). Previous treatment with variable effectiveness included methylphenidate, escitalopram, fluoxetine, and behavioral therapy (E. Aydın et al., 2020).

TMS PROTOCOL CHARACTERISTICS & TREATMENT EFFICACY

The case series positioned the coil over the pre-SMA at 15% of the distance between nasion and union anterior to the vertex using the International 10-20 system (E. Aydın et al., 2020). The systematic review identified heterogeneity in both TMS type and target regions across included studies, with treatments targeting SMA, pre-SMA, and left dorsolateral prefrontal cortex (S. K. Kar et al., 2025). Neither source provided complete technical parameters, including frequency, intensity, number of pulses per session, or sessions per week (E. Aydın et al., 2020).

The case series demonstrates that approximately three of five patients achieved substantial benefit within the 3-week period of treatment (E. Aydın et al., 2020). The case series demonstrated that three of five patients achieved substantial benefit within the 3-week treatment period (E. Aydın et al., 2020). One patient achieved complete remission with MGH-HP scores declining from 19/28 to 0/28, while two others showed 70-75% reductions in symptom severity (E. Aydın et al., 2020). A fourth patient experienced partial symptom reduction of 33%, and one patient showed no improvement with a mild increase in disease severity (E. Aydın et al., 2020). The systematic review reported improvement in the majority of patients but did not quantify response rates or provide specific outcome data (S. K. Kar et al., 2025).

Given the current evidence, TMS appears to provide patients with short-term symptom reduction in some patients with trichotillomania when delivered as an adjunct treatment to other therapies or prevention measures, with little to no safety concerns. However, this response is not universal; durability in most presented cases is limited, and the absence of controlled trials prevents separation of specific TMS effects from non-specific treatment effects. Patients who have fewer psychiatric comorbidities are more likely to respond positively to the treatment, though this hypothesis requires systematic testing. The small sample sizes across the two major studies observed, along with the lack of controlled methodology, mean that these findings should be considered hypothesis-generating rather than practice-informing.

AGE CONSIDERATIONS IN TMS FOR TTM PATIENTS

The effects of TMS can vary across age groups due to age-related physiological differences (Bhandari et al., 2016). Some studies show that age negatively correlates with TMS-induced electric field peaks in brain tissue, indicating weaker electric fields and potentially less effective treatment in older adults (Bhandari et al., 2016).

A 2016 meta-analysis investigating the effects of aging on motor cortex neurophysiology (using TMS) suggests that various TMS studies show age-related changes in cortical excitability, including an increased resting motor threshold (Bhandari et al., 2016). The threshold is the lowest level of TMS that can make the motor cortex respond when the muscles are not moving Bhandari et al., 2016). As people age, this threshold increases, suggesting that the brain's excitability changes with age, potentially influencing the design of TMS protocols tailored to different age groups (Bhandari et al., 2016).

Further, as TMS-induced electric fields tend to vary across an individual’s lifespan, their wider cortical spread in children warrants significant safety considerations (Alawi et al., 2023). The evidence base for TMS as a possible treatment method for TTM shows significantly encouraging but preliminary efficacy signals that are tempered by significant methodological limitations.

FUTURE DIRECTIONS TO GO REGARDING TMS AS A TREATMENT METHOD FOR TTM

The most urgent need is conducting properly powered, double-blind, sham-controlled trials with 100-150 participants to establish whether TMS effects are genuine or placebo-driven. Current research and evidence lack the methodological structure and rigor needed for significant clinical implementations. Protocol standardization represents another immediate priority. Research must also systemically compare low-frequency versus high-frequency stimulation; this means that the researchers would need to target different regions of the brain (SMA, pre-SMA, DLPFC), and optimize the intensity and duration parameters. The current heterogeneity in approaches prevents the identification of effective protocols.

Since most patients relapse within 2-3 months, maintenance protocol development is essential for sustainable results. Future studies should investigate weekly or biweekly booster sessions along with extended initial treatment courses (ranging from 6-12 wrrks instead of three weeks), and combination approaches that incorporate behavioral intervention to sustain benefits. For home-based maintenance, using portable TMS devices could possibly revolutionize long-term care, allowing patients to receive ongoing treatments without visiting clinics too often.

When using Transcranial Magnetic Stimulation to treat OCD-related behaviors such as Trichotillomania, it is essential for future research to focus on improved precision, reduced noise, and enhanced patient comfort. Integration of symptoms with smartphone apps would significantly improve outcomes. Also, since Artificial Intelligence (AI) has become more prevalent in medical environments, using AI for predicting patient response to treatment and optimizing protocols based on the individual's represented characteristics would possibly excite future possibilities.

OTHER RELEVANT TREATMENT METHODS FOR TTM

Although TMS is an effective treatment method for Trichotillomania, other promising treatments are effective. Introducing other effective treatment methods helps contextualize the overall effectiveness of TMS on a larger scale. From this comparison, readers can gain a comprehensive understanding of other possible treatment methods for TTM.

1) Habit reversal training

Habit reversal training (HRT) is a promising and effective treatment method for TTM and other behavior-focused repetitive behaviors. Some studies have shown HRT to be an effective method for reducing hair-pulling behaviors in patients (Rahman et al., 2017; Shareh, 2017).

HRT involves the patient developing an awareness of pulling behaviors, implementing control over the stimulus, and adopting specific responses (Morris et al., 2013). Although HRT has demonstrated efficacy, researchers suggest that further investigation is needed to determine if this therapeutic method has long-term effects and whether it could be enhanced through the implementation of other psychotherapies, such as meditation (Morris H et al., 2013; Syed Minhaj Rahman et al., 2023).

2) Behavioral Therapies

Other promising therapeutic methods for TTM include cognitive–behavioral therapy (CBT) and dialectical behavioral therapy (DBT). Both CBT and DBT significantly reduce TTM symptoms immediately after treatment, with periods of relapse thereafter (Keijsers et al., 2016). DBT-enhanced CBT has been linked to significant improvement in the severity of TTM, along with emotion regulation capacity and symptoms of anxiety and depression (Keuthen et al., 2012).
Another type of therapy that has shown promise is Acceptance and Commitment Therapy (ACT), which has been effective in both adults and children, resulting in significant reductions in the severity of TTM symptoms (Lee et al., 2018). Using ACT along with HRT and stimulus control is considered to be a highly effective treatment method for TTM, particularly when the individual is not fully aware that they are pulling (Jones et al., 2018).

Another treatment approach for TTM is Comprehensive Behavioral Treatment, which provides individualized interventions for patients, particularly based on factors that maintain hair-pulling. This method is effective not only in reducing TTM symptoms but also in improving the overall quality of life (Falkenstein et al., 2015).

3) Pharmacological Treatments

Pharmacological treatments for TTM have shown mixed results in patients. In a 2007 study investigating the relative efficacy of habit-reversal therapy, SSRIs, and clomipramine in the treatment of trichotillomania, assessed through a systematic review of randomized controlled trials: in individuals diagnosed with trichotillomania who engaged in randomized, blinded clinical trials assessing habit-reversal therapy, SSRIs, or clomipramine treatments., clomipramine, as a tricyclic antidepressant used to treat obsessive-compulsive and related disorders, was found to be more effective than placebo, while selective serotonin reuptake inhibitors (SSRIs) did not show significant benefits (Bloch et al., 2007). N-acetylcysteine (NAC), an antioxidant and glutamate modulator that helps stop compulsive behaviors, and aripiprazole, an atypical antipsychotic used to treat psychiatric disorders such as schizophrenia and bipolar disorder, have emerged as promising interventions for TTM, with NAC proving to be particularly effective as an adjunctive therapy (Ghani et al., 2024). However, other reviews have shown inconsistent results regarding various psychopharmacological treatments for TTM, with no consistent recommendations (Jaspers, 1996).

In a 2007 investigation, the relative effectiveness of habit-reversal therapy, clomipramine, and SSRIs in the treatment of trichotillomania among diagnosed individuals was found to be that HRT had outperformed both clomipramine and SSRIs in controlled trials (Bloch et al., 2007). Recent literature suggests that combining pharmacological treatments with other behavioral therapy methods might provide more comprehensive management of TTM (Ghani et al., 2024). Refer to Table 2 for a comparison of different treatment methods for TTM.

Table 3: Comparison of TMS vs. Other Treatments for TTM

Treatment Method	**Mechanism**	**Effectiveness**	**Limitations**	**Side effects/safety**	**Notes**
TMS (Transcranial Magnetic Stimulation)	Magnetic Brain Stimulation	Promising (⅗ improved)	Small Studies; early data	Minimal; Caution in kids	Best for restraint cases
HRT (Habit Reversal Training)	Behavioral replacement	Reduces symptoms	Some relapse shown	None noted	Standard first-line treatment
CBT / DBT	Thought and emotion regulation	Reduces symptoms	Some relapse shown	None noted	DBT adds emotional control
ACT (Acceptance & Commitment Therapy)	Acceptance and behavioral shift	Effective for all ages	Not stated	None noted	Best with HRT/ stimulus control
Comprehensive Behavioral	Personalized behavior plan	High success shown	Not stated	None noted	Improves the quality of life

Treatment (ComB)					
Pharmacological (e.g., NAC, Clomipramine, SSRIs, Aripiprazole)	Brain chemistry	Mixed; NAC is better than SSRIs	Rather inconsistent; works best alongside therapy	Varies	NAC is the most effective option

MECHANISMS OF RELAPSE

Research on relapse mechanisms and TMS interventions reveals the significant importance of therapeutic insights in general. For TTM, there are several predictors of relapse which include including post-treatment abstinence status, along with TTM severity during initial response (Falkenstein et al., 2014). TMS has proven to be a promising treatment to address concerns or relapse across disorders through certain mechanisms of neuroplasticity that influence both local and network levels of neural activity, potentially affecting overall behaviors that are related to craving and modes of relapse (Diana et al., 2017).

For certain major depressive disorders, “early relapse” TMS protocols using 5 sessions over three days at monthly intervals are significantly effective in moving patients through relapse/partial remission back towards remission, with about 79% achieving remission after treatment compared to only 30% before treatment (Pridmore et al., 2018; Pridmore & May, 2018). This approach is better conceptualized as relapse prevention rather than maintenance therapy.

CURRENT GAPS IN RESEARCH

Although TMS is a promising treatment method for TTM, its clinical application faces limitations, including complex application procedures, difficulty in obtaining high-quality signals, and an insufficient overall understanding of the neurobiological responses to TMS (Julkunen et al., 2022). Additionally, for TTM, there is a lack of FDA-approved treatments (Johnson & El-Alfy, 2016). Indeed, there are concerns regarding the effects of TMS in older patients with compromised brain pathology (Weiler et al., 2019). To close current gaps, randomized controlled trials with a larger sample size are needed to determine the most effective protocols for TMS in TTM management, ensuring proper safety.

CONCLUSION

Transcranial magnetic stimulation is a non-invasive therapeutic intervention being explored for reducing hair-pulling behavior in patients diagnosed with trichotillomania. This condition is classified as an OCD-related disorder due to the compulsive nature of symptoms. Although TMS has shown moderate promise in reducing TTM symptoms, significant gaps in research exist. Addressing these gaps is highly crucial for advancing treatment options for TTM and alleviating symptoms for individuals diagnosed with this disorder.

Although most of the current findings are encouraging, they are significantly limited by the small sample sizes and inconsistent methodologies of the studies. This makes it highly difficult to draw accurate and definitive conclusions about the long-term effects of TMS as a potential treatment method. This dramatically emphasizes the importance of conducting larger-scale, well-controlled clinical trials. Research advancing in this field holds much potential not only to prove to be a more effective, evidence-based treatment for TTM, but it also contributes to the broader overall research in impulse control and OCD related disorders. Ultimately, more research is needed to determine the overall long-term effectiveness of TMS on patients diagnosed with Trichotillomania. Future work must include multi-center randomized controlled trials to determine whether TMS should be incorporated into clinical guidelines for TTM.

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