Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/22607
DOI URL: http://dx.doi.org/10.21474/IJAR01/22607

RESEARCH ARTICLE

RECALIBRATING THE DEPRESSED BRAIN THROUGH TRANSCRANIAL MAGNETIC STIMULATION AND NEURO BIOFEEDBACK FOR PATIENTS WITH DEPRESSIVE DISORDERS

Shristi Tyagi[1] and Neha Sharma[2]

1. Student of Gautam Buddha University Bachelor of Science Applied Psychology (Hons.).
2. Assistant professor Department of Psychology and Mental Health School of Humanities and Social Sciences.

Manuscript Info

Manuscript History
Received: 08 November 2025
Final Accepted: 10 December 2025
Published: January 2026

Key words:-
Transcranial Magnetic Stimulation, Neurofeedback, major depression,emotional equilibrium.

Abstract

Brain stimulation techniques are the new cutting-edge tools in the ever-changing landscape of neuroscience and psychiatry, heralding the beginning of an arguably new age in therapeutic innovation. These techniques transcend pharmacological modalities,offering sophisticated , non-invasive alternatives for recalibrating the neural circuits to restore cognitive and emotional equilibrium. To open this neurotechnological modality are Transcranial Magnetic Stimulation (TMS) and Neurofeed back-two approaches that are independent of one another yet together aid in redefining the landscape of mental health care. Both having technological as well as therapeutic features combined synergistically. Relevant literature was collected from various database including both online and offline sources namely Google Scholar, Web of Sciences, Psych INFO, PubMed, National Library of Medicine, book related to Transcranial Magnetic Stimulation and quantitative EEG and Neurofee dback journal,journal of Neuro Engineering and Rehabilitation, review included significant relevant researches to the of research from both national and global were included in the review of literature. It was observed that TMS is a promising treatment as compared to neuro biofeedback as TMS offers immediate effective results within 2-3 sessions in a short duration as compared to neurofeedback which require more sessions. TMS is a more potential treatment for treatment resistant depression whereas neurofeedback is more effective for spectrum of depressive disorders, anxiety and mood regulation. So, TMS holds a stronger ground as comparison to neuro feedback for patients suffering from major depression and in future more therapeutic models can be adapted as per the choice of the therapist.

Introduction:-

Depression is the common cold of mental illness and as per data population of over 280 million is suffering from depressive illness (World Health Organization, 2023). Many psychotherapeutic techniques like cognitive

Corresponding Author:-Shristi Tyagi
Address:-Student of Gautam Buddha University Bachelor of Science Applied Psychology (Hons.).

behaviourtherapy and found to be effective for treating depressive illness but they are comparatively time taking so new advanced therapeutic techniques are being explored and treatments based on neurobiological basis of depression is being used widely now a days (Gkintoni, Nikolaou & Vassilopoulos, 2025). In order to address this, biopsychology is used and is prominently contributing to the development and advancement of these techniques. It may be better understood as that neuroscience is a team effort and biopsychologist as a part of this team (Pearson Higher Education 2024).

A core area of biopsychological research and clinical application involves brain imaging, brain stimulating and neuromodulating methods, which allow researchers to study the structure and function of the brain in both healthy and clinical populations (Langguth et al. 2012). These methods are instrumental in developing and evaluating treatments like Transcranial Magnetic Stimulation (TMS) and neurofeedback (NBF) which are among mostly used treatment procedures in this area. From 1988 to 2017, approximately 17,492 peer-reviewed articles on TMS were published worldwide, reflecting growing scientific interest in this technology (McLean 2019). Similarly, the neurofeedback research grew mainly over the last two decades starting with a bibliometric analysis database indicating that the first neurofeedback related publication appeared in 1989 (Wider et al., in 2024). National Library of Medicine reported 3,626 articles from 1989 to 2023 Wider, Mutang et al 2024). Brain Imaging methods- There are some methods which record electrical currents or magnetic fields as a measure of activity in the brain areas just underneath the skull.

Other techniques are:-

- Electroencephalography (EEG) records electrical brain activity by the use of electrodes placed on the scalp (Biasiucci, Franceschiello, Murray 2019)
- Functional neuroimaging - this procedure includes a range of methods that study how the brain is functioning normally, to correlate an alteration in activity within a given region with certain performances of a task, experiences, or behaviours. (Raichle & Min tun, 2006).
- Positron emission tomography (PET) -The method involves using radiotracers to quantify different metabolic processes within the body, reflecting metabolic activity, blood flow, and chemical composition. (Kapoor, Heston, Kasi 2019).

Neuromodulation and Brain Stimulation Techniques -Neuromodulation is a form of therapy in which neurophysiological signals are initiated or influenced with the intention of achieving therapeutic effects by altering the function and performance of the nervous system (Liu, Qian 2021). Neuromodulation can be carried out through a variety of means, including non-invasive modalities such as (TMS), (tDCS), and transcranial ultrasound stimulation (TUS), as well as invasive modalities such as deep brain stimulation (DBS), spinal cord stimulation (SCS), and VNS (Davidson, Bhattacharya et al 2024).

Brain stimulation methods are one of the categories of the neuromodulation therapies designed to alter neural activity to manage different neurological and psychiatric conditions (Conde, Bermudez, Rey, Khan 2022). Non-Invasive Neuromodulation (NINM) methods alter neural activity from outside the body without the need for surgery (Tyler, Sanguinetti, Fini, Hool 2017). These techniques modulate brain function by means of magnetic or electrical stimulation which are listed below:Non-invasive Brain Stimulation Methods to regulate the brain's excitability areTranscranial magnetic stimulation (TMS) employed to produce neural activity by creating a time-varying electric field in the brain, which will cause action potentials to be triggered in cortical neurons, By means of alternating currents, Transcranial Alternating Current Stimulation (tACS) alters the brain activity by enhancing synaptic plasticity and neural oscillations (Elyamany, Leicht, Herrmann, Mulert 2020), Low electrical currents used in Transcranial Direct Current Stimulus (tDCS) either increase or decrease brain activity (Giordano, Bikson et al., 2017).

Invasion of the Brain Methods include directly stimulating brain structures with electrodes that are surgically inserted (Kubben 2024) includeDeep Brain Stimulation (DBS) is a neurosurgical procedure that involves the implantation of electrodes at specific targets within the brain and the delivery of constant or intermittent electricity from an implanted battery source (Lozano et al., 2019), Vagus nerve stimulation (VNS) is a form of neuromodulation that utilizes a pulse generator within the chest of a patient and runs lead wires up to an electrode cuff wrapped around the cervical bundle of the left vagus nerve (Thompson et al., 2022).

Current research is focused to review the literature related to TMS and neurobiofeedback and comparing their effectiveness in treating major depressive disorder. Transcranial Magnetic Stimulation (TMS) is a non-surgical method of stimulating the cells of the nervous system in the brain, particularly psychiatric illnesses such as MDD (George & Post 2011). It was invented by Dr. Anthony Barker in 1985 at the University of Sheffield, UK and initially was meant to map motor cortex excitability (Noohi, Amirsalari 2016). Pharmacological and animal research has shown that rTMS affects the neural mechanisms of synaptic plasticity, such as gene and protein expression changes affecting the N-methyl-D-aspartate (NMDA) receptor function, which is a key component of long-term potentiation (LTP) and long-term depression (LTD) (Uzair et al., 2023). The stimulus induced magnetically by rTMS also impacts the direction of neural fibers within the area of the cortex that is targeted. Its effects are mainly on the axons in the superficial cortical gyri and the adjacent white matter, and its effectiveness is dependent on the geometry of the axon, myelination, location, and physiological condition. Moreover, The Food and Drug Administration (FDA) agency of the United States approved rTMS as a treatment for major depression in 2008 for patients who resist medication. It was definite that rTMShad anti-depressive effects with well tolerated and only minor adverse effects have been reported (Peng, Zhou 2018).

As TMS is based on the electromagnetic induction principle, as stated in Fara-day's Law (Eldaief, Press, Leone 2013). One of the most commonly used non-invasive methods for stimulating neural activity within the human brain is TMS and it works by creating a changing magnetic field which is strongest in the most superficial layers of the cortex, especially in the crowns and lips of cortical gyri; it may also reach into the juxtacortical white matter. TMS seems to influence both excitatory and inhibitory axons, especially at terminal ends of the axons and at turns along the myelinated fibers. There is further excitation of local neural circuits and remote brain areas through cortico-cortical and cortico-subcortical connections.TMSand major depression are related as TMS is a form of treatment for major depression that uses magnetic pulses to stimulate underactive sections of the brain like the left dorsolateral prefrontal cortex (Rizvi & Khan, 2019). TMS is aimed at brain areas linked with mood control and enhances the functional connectivity between the DLPFC and limbic system, such as the subgenual anterior cingulate cortex, a region that is commonly hyperactive in MDD (Holma 2013).

Research indicates that TMS is as effective as antidepressants, with less side effect. For those patients who are poorly aided by medication, TMS is a reasonable option (Perera, Georg2016e). Response rates in responders to the induction course were examined at 3 months, 6 months or 12 months post-induction (Senova, Cotovio, Leone, Maia 2018). Treatment-resistant depression has response rates of 50–60% and remission rates of 30–40%, according to meta-analyses and large trials (Cuijpers, Karyotaki et al., 2021). Biofeedbackis a general technique that amplifies sensory feedback, allowing individuals to take charge of normally physiologic functions. It is achieved through electronic sensors or devices to detect these physiologic functions and giving immediate feedback in the form of visual, auditory, or tactile forms (Malik, Dua 2025). By monitoring these signals, people can learn to voluntarily control their body functions by way of relaxation techniques, breathing exercises, or cognitive methods (Schwartz & Andrasik, 2005).One of the greatest benefits of biofeedback is that it is non-invasive, being a safe, drug-free treatment formanyprevelant disorders (Vázquez,2025).

The only limitation ofbiofeedback whichpersists is that it needs repeated sessions so that it can be effective for adequate long-term benefits (Saidi, 2025). But technological advancements in the field of biofeedback are increasing day by day, making it more easily accessible and to provide affective results in patients suffering from neurological disorders (Bowman, 2021).NeuroBiofeedbackis a form of biofeedback known as neurofeedback uses brain wave measurements and feedback signal presentation to teach subjects how to self-regulate their brain activity (Marzbani, Marateb, Mansourian, 2016). Research also suggests that neurofeedback provides aid in depression by acting as an augmentation treatment, not only for depressive symptoms, but also for functional recovery, in patients with TRD (Lee et al., 2019).Neurofeedback has a big plus: it's safe and doesn't invade the body. But to get results that last, patients need many training sessions which can be very time consuming and are costly(Marzbani, Marateb, Mansour ian, 2016). Although neurofeedback has proven beneficial, further research across different populations is required to determine its overall efficacy (Marzbani, 2016).During a neurofeedback therapy session, sensors are put on the scalp in order to record brainwave activity (Baculi 2020).The data is shown on a monitor in the auditory/visual feedb ack (Marateb,2016). When a person is doing mental exercises or relaxation exercises, he/she gets feedback on his/he r brain activity, enabling that person to learn how to self-regulate and change his/her brainwaves into more preferable patterns (Thompson & Thompson, 2003).Depressionis a negative affective state, ranging from unhappiness and discontent to an extreme feeling of sadness, pessimism, and despondency, that interferes with daily life. (American Psychiatric Association, 2018).

It involves various types:-

- Clinical depression (major depressive disorder): mood disorder characterized by persistent sadness and other symptoms of a major depressive episode but without accompanying episodes of mania or hypomania or mixed episodes of depressive and manic or hypomanic symptoms(APA, 2023).

DSM-5-TR diagnostic criteria for a major depressive episode:-

A) Five (or more) of the following symptoms have been present during the same two-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.

1) Depressed mood most of the day, nearly every day, as indicated by either subjective report (eg, feels sad, empty, hopeless) or observations made by others.
2) Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day.
3) Significant weight loss when not dieting or weight gain.
4) Insomnia or hypersomnia nearly every day.
5) Psychomotor agitation or retardation nearly every day.
6) Fatigue or loss of energy nearly every day.
7) Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day.
8) Diminished ability to think or concentrate, or indecisiveness, nearly every day.
9) Recurrent thoughts of death, recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.

B) The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

C) The episode is not attributable to the direct physiological effects of a substance or to another medical condition.

D) The occurrence of the major depressive episode is not better explained by schizoaffective disorder, schizophrenia, schizophreniform disorder, delusional disorder, or other specified and unspecified schizophrenia spectrum and other psychotic disorders.

E) There has never been a manic or hypomanic episode.

The diagnostic criteria for MDD according to ICD-11 Mortality and Morbidity Statistics (MMS):-

1. The presentation is characterized by mood symptoms that share primary clinical features with other depressive disorders.
2. The symptoms do not fulfil the diagnostic requirements for any other disorder in the depressive disorders grouping.
3. The symptoms are not better accounted for by another mental, behavioural or neurodevelopmental disorder.

Other types of depressive disorders are:-

- Persistent depressive disorder (PDD): This condition is marked by a depressed mood lasting most of the day, for more days than not, over at least 2 years in adults or 1 year in children and adolescents (DSM-5, 2013)
- Disruptive mood dysregulation disorder (DMDD): DMDD causes chronic, intense irritability and frequent anger outbursts in children. Symptoms usually begin by the age of 10 (National Institute of Mental Health, 2024).
- Premenstrual dysphoric disorder (PMDD): With PMDD, an individual has premenstrual syndrome (PMS) symptoms along with mood symptoms, such as extreme irritability, anxiety or depression. (National Library of Medicine, 2023).

Treatment Resistant Depression–as depression is a negative affective state, ranging from unhappiness and discontent to an extreme feeling of sadness, pessimism, and despondency, that interferes with daily life. (American Psychiatric Association, 2018). It can be caused due to imbalance in parts of the brain that manage mood, thoughts, hormone levels, family history (Nestler, Barrot, DiLeone, Eisch, Gold &Monteggia, 2002). Major depressive disorder (MDD) is the more severe form of depression (Aadi, 2023). Treatment-resistant depression is major depressive disorder in which an affected person does not respond adequately to at least two different antidepressant medications at an adequate dose and for an adequate duration (Gaynes 2020). TRD affects approximately 30% of individuals diagnosed with major depressive disorder (MDD), making it a significant clinical challenge (McIntyre et al., 2023). The exact cause of TRD is not fully understood, but it is believed to involve a combination of genetic, neurobiological, and environmental factors (Draganov, 2020).

The most frequently implemented TRD treatments involve several combinations of treatments with antidepressants, with mood stabilizers, or with atypical antipsychotics (Shelton 2006). It has been shown that TMS combined with psychotherapy may be used to treat depression (Wang, Luo, Schülke, Geng, Sahakian & Wang 2021). Neurofeedback, a completely non-invasive method in which patients become trained to control their brain activity, has revealed promising treatment in reducing depressive symptoms in TRD (Chaudhary, 2025). Neuro-biofeedback helps in Major DepressionthroughElectroencephalographic (EEG) biofeedback that has been studied to assess the depressive symptoms as it targets the brainwave abnormalities which are commonly observed in MDD, such as increase in the alpha asymmetry in the frontal cortex (Hammond, 2005).Biofeedback techniques that focus on reducing the muscle tension in various areas and regulate physiological arousal have been found to develop and the enhance the validity of psychotherapy and medication for depression (Siepmann et al., 2008). However, its efficacy largely depends on patient adherence and continued practice, as improvements in depressive symptoms are more profound if long term training is implemented in its practice (Botella, 2021).

Researches related to Transcranial Magnetic Stimulation and Major Depressive Disorder:-

The meta-analysis conducted by Deng, Li, and Zhang (2023) was to investigate the influence of TMS on brain function in depressed patients. In a study that used Activation Likelihood Estimation (ALE), authors compared neuroimaging data from five studies out of those identified through a systematic literature search until January 5, 2022. The results showed that in specific regions of the brain TMS alters the activity of brain. These results showed that TMS is responsible for consistent changes in the activity of the brain and can act as a potential treatment for depression. Roth, Hanlon, Pell, Zibman, Harmelech, Muir, MacMillan et al., (2022)to evaluate how accelerated TMS designed to shorten treatment duration and speed up response as compared to standard FDA-approved protocols. The study examined existing research involving patients with MDD undergoing accelerated TMS, though the exact population size varied across studies. They highlighted the need to determine which parameters were most effective and safe using tools like neuronavigation, EEG, MRI, and e-field modeling. Although accelerated TMS showed promise in delivering faster symptom relief, the review concludes that more rigorous clinical trials are essential to establish optimal protocols, safety, and long-term effectiveness.

The research conducted by Somani, Kar (2019) aimed at testing the effectiveness of rTMS neuromodulation in patients having depression and not responding to standard antidepressant treatments or psychotherapy. Examination of findings indicated that the increase in evidence for efficacy of rTMS has grown, and with use in TRD has been approved by the US Food and Drug Administration for major depressive disorder. Janicak and Dokucu (2015),proposed a systematic review of the development and how the clinical application of transcranial magnetic stimulation (TMS) is used as a treatment for major depression, especially in cases where conventional therapies had proven ineffective.The review evaluated efficacy, safety, and tolerability by analyzing data from controlled and pragmatic clinical trials regarding the use of TMS. The outcome revealed TMS to be a promising neuromodulation technique that offered a safer and better-tolerated option for patients with treatment resistant depression, bridging a huge gap in the management of depression by alleviating symptoms and their related complications.

Researches related to Depressive disorder and Neuro biofeedback:-

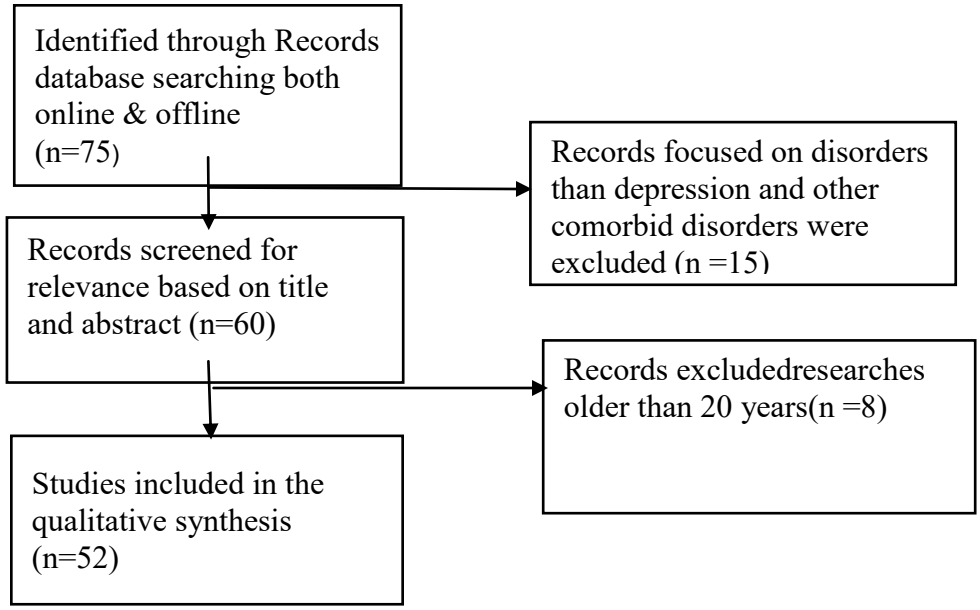
Conroy, Holtzheimer (2021) were interested in reviewing the evolution and application of neuromodulation paradigms for the management of depression from a neural circuit perspective. The review focused mainly on patients with major depressive disorders and addressed treatment-resistant forms of depression. (TMS), (DBS), and other neurostimulation therapies constituted the neuromodulation discussed in the work. In this overview, the authors provide the background and current status of neuromodulation for treating psychiatric illness with a specific focus on such approaches to treating depression, given that this has been the principal indication for the techniques historically.Lee, Lee, Seo, Koo, Kim, Cheon (2019) conducted an open-label pilot study to evaluate the effects of neurofeedback as augmentation treatment for depressive symptoms and functional recovery in TRD. TRD patients aged 20 years to 60 years, n=24, were assigned into a neurofeedback group (n=12) and a medication-only group (n=12) for the study. Neurofeedback group participants received 12-24 sessions within 12 weeks. Measures of key outcome assessments for depressive symptoms and functional recovery were considered by HAM-D, BDI, CGI-S EQ-5D-5L, and Sheehan Disability Scale (SDS), along with evaluation of brain-derived neurotrophic factor (BDNF) levels. Significant improvement was observed in the neurofeedback group, which showed greater response rate of 58.3% and remission rates which were 50% as compared to the medication-only group, indicating that there is significant potential and efficacy in neurofeedback as a treatment in TRD cases.

The objective of Zotev, Yuan, Misaki, Phillips, Young, Feldner, and Bodurka's (2016) study was to investigate the relationship between BOLD activity of the amygdala and frontal EEG asymmetry during (rtfMRI-nf) training with MDD patients. Twenty-four patients MDD were involved in this study, with thirteen in the experimental group actually receiving real-time fMRI neurofeedback targeting the left amygdala during a happy emotion induction task, whereas eleven in a control group received sham feedback. The tools used were EEG-fMRI combined recordings and depression severity ratings. The present study showed that rtfMRI-nf applied to the amygdala enhanced EEG and BOLD signal, potentially improving emotion regulation in MDD patients.

Methods:-

PRISMA research design was used to analyse researches in systematic review. This study aimed to explore and compare the therapeutic effectiveness of two non-invasive brain-based interventions Neuro Biofeedback and Transcranial Magnetic Stimulation (TMS) in treating individuals diagnosed with depressive disorders. The methods were carried out in accordance with the relevant guidelines and regulations and has been approved in the meeting of the departmental research committee which looks into the ethical aspects of the research. It focused on the measures how well each method reduces depressive symptoms, overall satisfaction with each treatment. By comparing these two techniques, the study seeks to provide insights that could guide clinicians in choosing the most effective, personalized treatment for depression.For the primary research, terms related to transcranial magnetic stimulation (TMS) and neurofeedback were combined with keywords associated with depression to identify relevant studies. Relevant literature was collected from various database including both online and offline sources. For online following data resources were referred namely Google Scholar, Web of Sciences, Psych INFO, PubMed, National Library of Medicine, book on Transcranial Magnetic Stimulation, book of Transcranial Magnetic Stimulation (Neuromethods, 89), Introduction to Quantitative EEG and Neurofeedbackjournal, journal of Neuro Engineering and Rehabilitation, review included 52relevant researches to the of research from both national and global were included in the review of literature of India as well as other countries which were analysed further.

PRISMA analysis of the literature review



Neuro feedback researches	Transcranial Magnetic Stimulatio researches	Other related researches
N=24	N=28	N=3

Discussion:-

Present study focused to compare the effectiveness of neuro biofeedback and transcranial magnetic stimulation (TMS) as therapeutic interventions among patients with depressive disorders. To achieve this aim three objectives were formulated and interpreted by using relevant review of literature. These objectives are discussed one by one as follows: Objective one stated the effect of transcranial magnetic stimulation (TMS) on depressive disorders and studied the therapeutic outcomes of (TMS) in individuals diagnosed with depressive disorders. The study explored how TMS, a non-invasive neuromodulation technique that uses magnetic fields to stimulate nerve cells in the brain, impacted various aspects of depression and overall symptom reduction. The goal was to assess both short-term and long-term effects of TMS, evaluate patient response rates, and determine the safety and potential side effects of this intervention. This objective can be supported and discussed by Roth, Hanlon, Pell, Zibman, Harmelech, Muir, MacMillan et al (2022) in their study which evaluated the real-world safety, efficacy, and durability of various accelerated Deep Transcranial Magnetic Stimulation (TMS) protocols for treating major depressive disorder (MDD). This objective is consistent with prior researches, such as conducted by Janicak and Dokucuin 2015 which of critically reviewed the development and clinical application of transcranial magnetic stimulation (TMS) as a treatment for major depression, particularly in cases where standard therapies were insufficient and found that TMS is a promising neuromodulation technique that offers a safer and better alternative for patients with treatment-resistant depression, helping to address a significant gap in depression management by reducing symptoms and related complications.

Objective two stated the effect of neurofeedback therapy on depressive disorders and focused on analysing the therapeutic impact of neurofeedback, to teach self-regulation of brain function, in individuals suffering from depressive disorders. It also evaluated the degree to which neurofeedback training helped patients develop long term coping contributing to overall mental health improvement as neurofeedback is a method that assists subjects to control their brain waves consciously. Above objective is supported through an open-label pilot study conducted by Lee , Lee , Seo , Koo , Kim , Cheon (2019) where findings showed significant improvements in the neurofeedback group, with higher response (58.3%) and remission rates (50%) compared to the medication-only group, suggesting neurofeedback's effectiveness in TRD. This objective can be further understood by study of Zotev, Yuan, Misaki, Phillips, Young, Feldner, Bodurka (2016) where findings showed a significant positive correlation between changes in frontal EEG asymmetry and depression severity, as well as between EEG asymmetry and amygdala BOLD laterality. The study demonstrated that rtfMRI-nf targeting the amygdala positively influenced both EEG and BOLD signals, suggesting its potential to improve emotion regulation in MDD patients.Objective three stated the effectiveness of neurofeedback and transcranial magnetic stimulation (TMS) as therapeutic interventions in patients with depressive disorders. This objective aimed to perform a comparation between the two non-invasive brain stimulation techniques neurofeedback and TMS in the treatment of depressive disorders. The researches showed that TMS is a more effective treatment of major depression with less side effects. A 2012 study published in the Journal of Clinical Psychiatry conducted by Carpenter, Janicak, Aaronson, Boyadjis, Brock, Cook, Dunner found that 58% of patients with treatment-resistant depression showed improvement after TMS treatment, with 37% achieving full remission. Neuro feedback is more effective in a broad spectrum of depressive disorders, anxiety and mood disorders.

Conclusion:-

The aim of the present study was to recalibrate the depressed brain through neurofeedback and transcranial magnetic stimulation for depressive disorders. In order to achieve these three objectives were devised through some researches after interpretation from review of literature and analysed by Prisma method. Objective one explored the effect of transcranial magnetic stimulation (TMS) on depressive disorders and its efficacy as a therapeutic treatment for patients with these conditions. The objective is supported by the research by Roth, Hanlon, Pell, Zibman, Harmelech, Muir, MacMillan et al. (2022), which evaluated real-world safety, efficacy, and long-term effectiveness of different accelerated deep TMS regimens in the management of MDD. Objective two examined the effect of neurofeedback therapy on depressive disorders, with a focus on evaluating its therapeutic potential in helping individuals learn to self-regulate brain function to alleviate symptoms of depression. This objective is supported by Zotev et al. (2016), whose study found that amygdala-targeted rtfMRI neurofeedback improved both EEG and BOLD signals, indicating its potential to enhance emotion regulation in individuals with MDD.Objective three addressed the efficacy of neurofeedback and transcranial magnetic stimulation (TMS) as therapeutic interventions in the treatment of patients with depressive disorders. To this end, a 2012 study by Carpenter, Janicak, Aaronson, Boyadjis, Brock, Cook, and Dunner, appearing in the Journal of Clinical Psychiatry, stated that the

percentage of improvement in patients suffering from depression was 58% and the percentage of patients who were able to attain full remission was 37%. From this conclusion it can be observed that TMS is a promising treatment as compared to neuro biofeedback as TMS offers immediate effective results within few sessions in a short duration as compared to neurofeedback which require more repetitive sessions. TMS is a more potential treatment for treatment resistant depression whereas neurofeedback is more effective for spectrum of depressive disorders, anxiety and mood regulation. So, TMS holds a stronger ground as comparison to neuro feedback for patients suffering from major depression and in future more therapeutic models can be adapted as per the choice of the therapist.

Limitations and suggestions for further researches:-

1) More researches related to the topic can be explored and added with respect to the continuous advancements in the technology in this area like neuroscience and medical technology, the use of TMS protocols along with the dynamic advances in treating depressive disorders.

2) The underlying parameters such as treatment duration, cost-effectiveness can be further studied through the empirical research which will help in making TMS more effective and will help in further analysis and standardize techniques to determine their viability.

3) Investigating advanced statistical methods will enhance the reliability and validity of research findings.

4) TMS and neurofeedback represent a relatively unexplored area, with TMS emerging since the 1980s and neurofeedback since the late 1950s and '60s; more research is needed in order to build a strong evidence base for these non-invasive treatments.

References:-

1. Deng, Y., Li, W., Zhang, B. (2023). Functional activity in the effect of transcranial magnetic stimulation therapy for patients with depression: A meta-analysis. Journal of Personalized Medicine, 13(3), 405. https://doi.org/10.3390/jpm13030405
2. Harmelech, T., Pell, G. S., Roth, Y., Tendler, A., Zangen, A., &Zibman, S. (2022). Efficacy of deep TMS with the H1 coil for anxious depression. Journal of Clinical Medicine, 11(4), 1015. https://doi.org/10.3390/jcm11041015
3. Kar, S. K., & Somani, A. (2019). Efficacy of repetitive transcranial magnetic stimulation in treatment-resistant depression: The evidence thus far. General Psychiatry, 32(4), e100074. https://doi.org/10.1136/gpsych-2019-100074
4. Janicak, P. G., &Dokucu, M. E. (2015). Transcranial magnetic stimulation for the treatment of major depression. Neuropsychiatric Disease and Treatment, 1549–1560. https://doi.org/10.2147/NDT.S67477
5. Conroy, S. K., &Holtzheimer, P. E. (2021). Neuromodulation strategies for the treatment of depression. American Journal of Psychiatry, 178(12), 1082-1088.https://doi.org/10.1176/appi.ajp.2021.21101034
6. Cheon, E. J., Kim, H. G., Koo, B. H., Lee, G. W., Lee, Y. J., & Seo, W. S. (2019). Neurofeedback treatment on depressive symptoms and functional recovery in treatment-resistant patients with major depressive disorder: An open-label pilot study. Journal of Korean Medical Science, 34(42).https://doi.org/10.3346/jkms.2019.34.e287
7. Bodurka, J., Feldner, M. T., Misaki, M., Phillips, R., Young, K. D., Yuan, H., &Zotev, V. (2016). Correlation between amygdala BOLD activity and frontal EEG asymmetry during real-time fMRI neurofeedback training in patients with depression. NeuroImage: Clinical, 11, 224–238. https://doi.org/10.1016/j.nicl.2016.02.003
8. Lew, B. J., Tirrell, E., Fukuda, A. M., Murugan, N., Perez, C., Griffith, W., & Carpenter, L. L. (2025). Identifying patients with non-response for an extension of TMS treatments for depression: A retrospective analysis of clinical response conversion. Transcranial Magnetic Stimulation, 4, 100092. https://doi.org/10.1016/j.transm.2025.100092