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Noninvasive neuromodulation in the prophylaxis and acute treatment of migraine: a systematic review

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Introduction

Migraine is a highly prevalent and disabling neurological disorder associated with substantial functional impairment and reduced quality of life. In this context, noninvasive neuromodulation has emerged as a promising therapeutic approach, with the potential to modulate pain-related neural pathways and improve migraine control.

Objective

To evaluate the impact of noninvasive neuromodulation techniques on the acute and prophylactic management of migraine.

Methods

This systematic review was conducted using the PubMed and LILACS databases. The PICO strategy was defined as follows: P (patients with migraine), I (noninvasive neuromodulation), C (placebo, no intervention, or conventional treatment), and O (therapeutic efficacy and safety). The following search strategy was applied: "Migraine Disorders" AND ("Noninvasive Brain Stimulation" OR "neuromodulation") AND ("efficacy" OR "treatment outcome"). Initially, 48 articles were identified. After applying the inclusion criteria of publication within the last five years, free full-text availability and English language, 20 studies were included in the analysis.

Results

The analyzed studies demonstrated favorable outcomes of noninvasive neuromodulation in both acute migraine treatment and prophylaxis. The main techniques evaluated included transcranial magnetic stimulation, vagus nerve stimulation, external trigeminal nerve stimulation, and remote electrical neuromodulation (REN). Recent meta-analyses showed superiority of these interventions over placebo in reducing monthly migraine frequency, pain intensity, and migraine-related disability, in addition to significant improvements in quality of life. Studies involving REN demonstrated sustained long-term therapeutic efficacy, with no evidence of tachyphylaxis after three years of follow-up. In observational studies, more than 70% of patients reported clinically relevant improvement after device use, including reduced need for acute relief medications and lower functional impact of migraine attacks. Clinical trials also demonstrated good adherence, tolerability, and a low incidence of adverse effects, even in special populations such as adolescents and pregnant women. Furthermore, some studies suggested potential reductions in healthcare costs and decreased need for additional pharmacological interventions, reinforcing the clinical applicability of these therapies.

Conclusion

Noninvasive neuromodulation demonstrated efficacy, safety, and good tolerability in migraine management, with benefits observed in both attack reduction and functional improvement. Therefore, these techniques represent promising therapeutic alternatives, particularly for patients with unsatisfactory response or limitations to conventional pharmacological treatment.

Keywords:
Neuromodulation
Migraine
Noninvasive brain stimulation

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