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Combined Effect of Cold Compress on Forehead and Alpha Binaural Beats in the Treatment of Migraine

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Abstract

Background: Migraine is a common neurological disorder characterised by recurrent moderate-to-severe headache attacks accompanied by nausea, photophobia, and functional limitation. Cold compress over the forehead may reduce pain through local cooling and sensory modulation, while alpha-frequency (8–12 Hz) binaural beats may promote relaxation and reduce arousal.

Objectives: To evaluate the combined effect of cold compress on the forehead and alpha binaural beats on migraine disability, pain intensity, photophobia, and mood-related symptoms.

Materials and Methods: A single-group pre–post interventional study was conducted on 10 participants (2 male, 8 female) aged 19–24 years with migraine without aura. The intervention consisted of a cold compress applied over the forehead for 15 minutes followed by alpha binaural beats (8–12 Hz) for 20 minutes, administered once daily for 10 days. Outcomes were assessed using the Migraine Disability Assessment Scale (MIDAS), Short-Form McGill Pain Questionnaire (SF-MPQ), Utah Photophobia Symptom Impact Scale-12 (UPSIS-12), and Patient Health Questionnaire-9 (PHQ-9) before and after the intervention. Data were analysed using paired t-tests.

Results: Significant improvements were observed across all outcome measures. Mean MIDAS score decreased from 16.80 ± 2.22 to 11.60 ± 2.22 ($p < 0.001$); SF-MPQ from 9.71 ± 0.76 to 1.14 ± 0.19 ($p < 0.001$); UPSIS-12 from 31.50 ± 5.54 to 21.00 ± 2.40 ($p < 0.001$); and PHQ-9 from 17.10 ± 1.91 to 4.50 ± 1.27 ($p < 0.001$).

Conclusion: The combined intervention of cold compress on the forehead and alpha binaural beats significantly reduced migraine disability, pain intensity, photophobia, and mood-related symptoms. This simple, safe, and non-invasive protocol may serve as an effective supportive naturopathic therapy for migraine management. Larger controlled trials are warranted.

Keywords: *Migraine; cold compress; alpha binaural beats; MIDAS; SF-MPQ; UPSIS; PHQ-9; naturopathy*

1. Introduction

Migraine is a primary headache disorder characterised by recurrent attacks of moderate-to-severe headache, often unilateral and pulsating, accompanied by nausea, vomiting, photophobia, phonophobia, and aggravation by routine physical activity [1]. It is a neurological condition that affects sensory processing, pain modulation, autonomic function, and daily performance [2]. The global burden is high because the disorder predominantly affects individuals during their most productive educational and working years, leading to missed classes or work, reduced concentration, and impaired quality of life [3].

Current understanding frames migraine as a disorder of cortical excitability, brainstem and hypothalamic networks, trigeminovascular activation, and altered pain processing [4]. Attacks may progress through premonitory, aura (in some individuals), headache, and postdrome phases [5]. Because the condition involves both peripheral pain mechanisms and central sensory and arousal pathways, multimodal non-pharmacological approaches that simultaneously address local discomfort and central relaxation are theoretically attractive.

Cold compress therapy involves application of a cold pack or cloth over a selected body region for a fixed duration. In migraine, forehead cooling may provide relief through local temperature reduction, decreased superficial nerve conduction velocity, mild analgesic effect, and sensory counter-stimulation [6,27]. It is low-cost, non-invasive, and easily supervised.

Alpha binaural beats are auditory stimuli created when two tones of slightly different frequency are presented separately to each ear through stereo headphones; the listener perceives a third rhythmic beat corresponding to the frequency difference. Alpha-range stimulation (8–12 Hz) is associated with relaxed wakefulness and has been explored as a passive relaxation aid that may reduce arousal and improve pain coping [7,8].

The combined use of cold compress and alpha binaural beats addresses two complementary dimensions of the migraine experience: local head discomfort and sensory pain modulation on the one hand, and central arousal reduction and relaxation on the other. The present study evaluated whether a standardized 10-day protocol of forehead cold compress followed by alpha binaural beats produces measurable improvements in migraine disability, pain quality, photophobia, and mood-related symptoms.

2. Aims and Objectives

Aim: To evaluate the combined effect of cold compress applied over the forehead and alpha-frequency binaural beats in the management of migraine.

Objectives:

1. To assess baseline severity and frequency of migraine attacks using the Migraine Disability Assessment Scale (MIDAS).

2. To evaluate the effect of the combined intervention on migraine pain using the Short-Form McGill Pain Questionnaire (SF-MPQ).
3. To assess change in photophobia impact using the Utah Photophobia Symptom Impact Scale-12 (UPSIS-12).
4. To evaluate change in mood-related burden using the Patient Health Questionnaire-9 (PHQ-9).

3. Review of Literature

Migraine is defined as a recurrent primary headache disorder with attacks typically lasting 4–72 hours when untreated, characterised by unilateral pulsating pain of moderate-to-severe intensity, aggravation by routine activity, and association with nausea, photophobia, or phonophobia [1,12]. Migraine without aura and migraine with aura are the major clinical subtypes [13]. The disorder contributes substantially to global disability, particularly among young adults [3,14].

Pathophysiologically, the trigeminovascular system plays a central role; activation of cranial nociceptive pathways transmits pain signals to brainstem and cortical areas [17]. Migraine is now understood as an integrated neurovascular and sensory-processing disorder rather than a purely vascular headache [18]. Photophobia is a frequent and disabling non-pain symptom that interferes with reading, screen use, and outdoor activity [20,21].

Cold therapy reduces nerve conduction velocity, elevates pain threshold, and produces temporary analgesia in cooled tissues [27]. Open-label and controlled studies have demonstrated pain relief with cold application in a proportion of migraine patients [6,28–30]. Systematic evidence supports short-term symptom reduction, although long-term preventive efficacy remains limited [30].

Binaural beats arise when two slightly different pure tones are presented dichotically; the brain perceives a beat at the frequency difference [7]. Meta-analytic evidence suggests that binaural beats can influence cognition, anxiety, and pain perception [8]. Alpha-range stimulation (8–12 Hz) is linked to relaxed wakefulness and has been explored as a supportive auditory intervention in migraine [10].

Validated outcome instruments selected for the present study include MIDAS (functional disability) [23], SF-MPQ (sensory and affective dimensions of pain) [24], UPSIS-12 (photophobia impact) [25], and PHQ-9 (mood-related symptom burden) [26]. Together these tools capture the multidimensional impact of migraine.

4. Materials and Methods

4.1 Study Design and Setting

A single-group, pre-test/post-test interventional study was conducted at Tapovana Medical College of Naturopathy and Yogic Sciences, Doddabathi, Davangere, Karnataka.

4.2 Participants

Ten participants (2 male, 8 female) aged 19–24 years with a clinical diagnosis of migraine without aura were enrolled. All completed the 10-day protocol with no dropouts.

Inclusion criteria:

- Age 19–24 years, either gender
- Clinical diagnosis of migraine (preferably without aura) consistent with ICHD-3 criteria
- Willingness to provide written informed consent and attend daily sessions
- No current acute severe attack requiring emergency care at enrolment

Exclusion criteria:

- Secondary headache disorders, recent head trauma, or intracranial pathology
- Skin conditions or cold hypersensitivity over the forehead
- Hearing impairment precluding use of stereo headphones
- Pregnancy, uncontrolled systemic illness, or concurrent experimental migraine therapy

4.3 Ethical Considerations

The study was conducted after institutional ethics committee approval. Written informed consent was obtained from all participants. Participation was voluntary and confidentiality of data was maintained.

4.4 Intervention

The intervention was administered once daily for 10 consecutive days in a quiet setting. Participants first received a cold compress applied over the forehead for 15 minutes (cold pack or cloth-wrapped ice, temperature monitored to avoid cold injury). Immediately thereafter, they listened to alpha-frequency (8–12 Hz) binaural beats through stereo headphones for 20 minutes at a comfortable volume while remaining seated or reclining. Sessions were supervised; any discomfort was recorded and the session stopped if necessary.

4.5 Outcome Measures

Migraine Disability Assessment Scale (MIDAS): Quantifies days of lost or reduced productivity due to headache over the preceding three months [23].

Short-Form McGill Pain Questionnaire (SF-MPQ): Assesses sensory and affective qualities of pain [24].

Utah Photophobia Symptom Impact Scale-12 (UPSIS-12): Measures the impact of light sensitivity on daily activities [25].

Patient Health Questionnaire-9 (PHQ-9): Brief measure of depressive symptom burden [26].

4.6 Statistical Analysis

Data were expressed as mean ± standard deviation. Pre- and post-intervention scores were compared using the paired Student's t-test. A p-value < 0.05 was considered statistically significant. Analyses were performed using SPSS.

5. Results

All 10 participants completed the 10-day intervention with no reported adverse events.

5.1 Demographic Profile

Table 1 summarises the demographic characteristics of the study participants.

Variable	Category	Frequency (n)	Percentage (%)
Age	19–24 years	10	100
Gender	Male	2	20
	Female	8	80
Migraine type	Without aura	10	100
Attack frequency	3–5 days/month	4	40
	>5 days/month	6	60

Table 1. Demographic profile of participants (n = 10)

5.2 Primary Outcomes

Table 2 presents the pre- and post-intervention scores for all outcome measures.

Outcome	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Diff.	p-value
MIDAS	16.80 ± 2.22	11.60 ± 2.22	5.20	<0.001
SF-MPQ	9.71 ± 0.76	1.14 ± 0.19	8.57	<0.001
UPSIS-12	31.50 ± 5.54	21.00 ± 2.40	10.50	<0.001
PHQ-9	17.10 ± 1.91	4.50 ± 1.27	12.60	<0.001

Table 2. Pre- and post-intervention outcome scores (n = 10)

All four outcome measures showed statistically highly significant reductions ($p < 0.001$). The largest absolute mean reduction was observed in PHQ-9 (12.60 points), followed by UPSIS-12 (10.50), SF-MPQ (8.57), and MIDAS (5.20).

5.3 Statistical Comparison

Table 3 summarises the paired t-test results.

Variable	Test	t-value	p-value / Result
MIDAS	Paired t-test	10.96	<0.001 (Highly significant)
SF-MPQ	Paired t-test	6.93	<0.001 (Highly significant)
UPSIS-12	Paired t-test	7.11	<0.001 (Highly

			significant)
PHQ-9	Paired t-test	18.27	<0.001 (Highly significant)

Table 3. Statistical comparison of pre- and post-intervention scores

6. Discussion

The present study demonstrated that a 10-day combined protocol of forehead cold compress followed by alpha binaural beats produced statistically highly significant improvements in migraine-related disability (MIDAS), pain intensity and quality (SF-MPQ), photophobia impact (UPSIS-12), and mood-related symptoms (PHQ-9).

These findings are consistent with prior evidence that local cooling can reduce migraine pain through decreased nerve conduction velocity, elevated pain threshold, and sensory counter-stimulation [6,27–30]. The additional auditory relaxation component aligns with reports that alpha-range binaural beats may reduce arousal and support pain coping [7,8,10]. The simultaneous targeting of peripheral pain mechanisms and central relaxation pathways offers a plausible explanation for the multidimensional improvements observed across disability, pain, photophobia, and mood domains.

The study has limitations. The sample size was small (n = 10), the design lacked a control or sham group, the intervention period was short, and all participants were young adults with migraine without aura, limiting generalizability. Outcomes relied on self-report instruments. Nevertheless, the consistency of improvement across four validated measures, the absence of adverse events, and the simplicity and low cost of the protocol support its potential value as a supportive naturopathic approach.

Future research should employ larger samples, randomized controlled designs (including sham cold or sham audio arms), longer follow-up, and objective measures where feasible to confirm efficacy and clarify mechanisms.

7. Conclusion

Within the limitations of this single-group pre–post study, the combined application of cold compress over the forehead and alpha binaural beats for 10 days significantly reduced migraine disability, pain intensity, photophobia, and mood-related symptoms. The intervention was safe, well tolerated, inexpensive, and easy to administer. These findings support its use as a complementary, non-pharmacological option in the supportive management of migraine. Larger controlled trials are recommended to confirm and extend these results.

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Conflict of Interest

The author declares that there is no conflict of interest.

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