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The impact of cold mud pack on abdomen and eyes on the autonomic control of heart rate

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***Abstract*---**Mud therapy is a system of naturopathic medicine where treatment is given using various forms of mud. Hence, the present study aims to evaluate the physiological effects of simultaneous application cold mud pack over the abdomen and eyes by determining the cardiovascular and autonomic parameters of the study participants. 30 healthy volunteers were recruited for the study. All volunteers were subjected to two sessions of treadmill run up to 10 minutes and subsequently to supine rest. Their first session was considered under control trial, during which they were given a dry abdomen and an eye pack after the treadmill run for 20 minutes. With a gap of 15 days in between, in the experimental trial, they were given a cold mud packs to the abdomen and eyes during the supine rest after the treadmill run. HRV Assessments were done during the intervention and their BP and pulse were recorded immediately after the intervention. All HRV parameters in the time domain and HF in frequency domain remain increased during the mud pack trial. Whereas LF of frequency domain, LF/HF ratio, HR, and PR during the mud pack trial were found to decrease. Blood Pressure (SBP), Diastolic Blood Pressure (DBP) also got reduced. Simultaneous application of cold mud packs to the abdomen and eyes enhances the parasympathetic activity and could have a role in maintaining cardiac tone and preventing various cardiovascular ailments.

***Keywords*---**cold mud pack, heart rate variability, autonomic nervous system, India, adults.

Introduction

Naturopathy is a rational and evidence-based system of medicine imparting treatment to natural elements based on the theories of vitality, toxaemia, and the self-healing capacity of the body and the principles of healthy living. Indian Naturopathy includes Yoga along with some ancient Indian concepts like – 'Panchabhuta based understanding of health and disease.[1] Among these five elements, the earth is an integral component of the human body and has a specific effect on health and disease. Naturopathy uses each one of these elements as a therapeutic modality because of their properties to treat diseases. In naturopathy, mud is one of the core therapeutic components as an element of earth. Mud is a mixture of inorganic and organic matter with water, which has undergone geological and biological processes under the influence of various physicochemical factors. Mud therapy can be defined as the application of processed mud either directly or indirectly in the form of packs to elicit therapeutic benefits. The mud acts by diluting and absorbing the toxic substances of the body and ultimately eliminating them from the body.[2] Naturopathy physicians prescribe mud therapy as one of the eliminative therapies. Mud therapy is a very simple and cost-effective treatment procedure. Mud packs and mud baths are the two main and popular forms of mud therapy.

Mud pack is used to treat conditions like fever, diarrhea, pile, dysentery, constipation, anxiety, conjunctivitis, headache, allergy, and errors of refraction in the eyes.[3] The chemical analysis of the mud has revealed that mud contains hydrophilic organic compounds like humic acid, fulmic acid, and ulmic acid. It also contains organic substances like fatty acids. Because of these properties and components of mud, it is having many therapeutic characters like improved membrane electrical conductance, absorption, and hyperthermia, and activate hydropoietic glands and hormones in the body. However, the composition and compounds of the mud and its properties change according to the area of availability. Worldwide, mud bath is taken for relaxation and luxurious purposes.[4] In many conditions like chronic inflammation, sprains, mud shows a greater effect than other modalities because it can retain moisture and coolness for a longer duration when compared to water.[5] Simultaneous application of mud packs to the abdomen and eyes is one of the most popular and important treatment modalities in the Naturopathy hospitals.

The beneficial results are brought about because the cool moisture in and under the pack relaxes the pores of the skin, draws the blood to the surface, relieves inner congestion, pain, and promotes heat, radiation and elimination of morbid matter. Although mud pack have been used extensively for various conditions, the actual mechanism of how a mud bath works remains unclear. The aim of the study is to examine the influence of simultaneous application of cold mud pack on the abdomen and eyes on the cardiac autonomic regulation. The objectives of the study are to study the influence of simultaneous application of cold mud pack on abdomen and eyes on cardiovascular function such as blood pressure and pulse rate and to study the effect of simultaneous application of cold mud pack on abdomen and eyes on autonomic functions such as heart rate variability changes among healthy volunteers.

Materials and Methods

Study design

Non Randomized single arm clinical study.

Place of study

The study was carried out at the Government Yoga and Naturopathy Medical College, Chennai, Tamil Nadu.

Sample size

30 adult healthy volunteers. The inclusion criteria were participants aged between 19 to 25 years and those willing to provide written informed consent to participate in the study. All cases who had no previous exposure to the mud packs and those who were under nourished or obese were excluded from the study. A trained physician had provided the fitness certificate to all participants based on their history taking and clinical assessment at the start of the study.

Intervention

Before HRV data recording, all participants were instructed to maintain their normal sleep pattern, not to consume any beverages with caffeine or alcohol before the evaluation. This test was conducted only when they were on an empty stomach in the morning or in the evening after 3 hours of lunch. Participants were encouraged to void urine before commencing recording.

Preparation of Mud packs

Brown coloured virgin mud was collected from 3 feet below the ground level. The collected mud was freed from impurities, composts, or pebbles. The mud was finely sieved. It was stored under direct sunlight. Sufficient quantity of cold water was added to the mud to make it a pasty like substance. The pasty like mud was applied up to one inch thickness in the middle of a flannel of wet muslin cloth of suitable rectangular size and wrapped on all sides and kept ready in a tray. All study participants were subjected to an exercise protocol consisting of a walk–run on a motorized treadmill for a maximum duration of 10 minutes or until the subject achieves 50% of the maximum heart rate achievable, to ensure sympathetic dominances. The initial speed set was 2 km/hour, which was gradually increased by half a kilometer for every 30 seconds. The maximum speed of the treadmill run was up to 10 km/hour towards the end of the run. The run was followed by 20 min of recovery in the supine position, with a mud pack on the abdomen and eyes placed over the pelvis below the umbilical region of the abdomen in such a way that the entire mud pack is in contact with the skin and over the closed eyes. The transition from exercise cessation to treatment commencement was 2 - 3 min.

Their first session was considered as control during which they were given a dry abdomen and eye pack after the treadmill run. With a gap of 15 days in between,

in the second session, they were given a cold mud packs to the abdomen and eyes during the supine rest after the treadmill run. All subjects were assessed for HRV during the intervention for 20 minutes. And their BP and pulse were recorded immediately after the intervention. Two dry flannels of cloth, similar to the size of mud packs was applied over the abdomen and eyes simultaneously for 20 minutes during the control trial. The temperature of the dry pack was tuned to room temperature. After this, the mud pack intervention was carried out.

Outcome measures

In the present study, the autonomic variables measured were the heart rate and heart rate variability (HRV), blood pressure, and pulse rate. The HRV spectrum is believed to be a useful indicator of cardiac sympathetic activity (reflected by low frequency [LF] band power values) and parasympathetic activity (reflected by high frequency [HF] band power values).Heart rate variability spectrum (HRV) and audacity, a sound recording software that is freely available, was used in the study for recording and displaying the real‐ time ECG recording. It acts as an A/D converter, and an advantage of using the computer's sound card as an A/D converter is that it eliminates the additional requirement of an external microprocessor. Sound editing software can display the real‐ time signals with time and amplitude analysis solutions. A simple ECG analog amplifier was used to acquire the ECG signals. Digitalization of the analog signals was done using the sound card of a computer (laptop). Display of the data recording was done using Audacity sound editing software (version 1.2.2) in wave format. This software has many offline editing options which were used for obtaining the RR interval in a simple manner. Electrical noise (50) Hz in the digital data was filtered using a low pass filter. R waves were identified using beat‐ to‐ beat finder tool in the Audacity software by fixing the amplitude as 60 Hz, and if the amplitude of the waves were low, it could be increased to a desired amplitude by using the amplify option. Later, R peak, which was identified by the beat finder, was converted into real‐ time RR interval data by exporting the label option in the software, which was then stored in the notepad format. The RR intervals saved in the notepad format were then fed into the Kubios HRV-software (version 2.2, Bio signal Analysis and Medical Imaging Group, Department of Applied Physics, University of Eastern Finland, Kuopio, Finland) to process for HRV analysis.[6] The blood pressure was recorded with a digital sphygmomanometer over the left brachial artery and pulse rates were recorded towards the end of the intervention.

Statistical analysis

R statistical software version 3.1.1 was used for the analysis. After testing the normality of the data with Kolmogorov–Smirnov test, independent samples t-test, and Chi-square for baseline characteristics and analysis of variance tests for outcome variables were used in the statistical analysis. P-value < 0.05 was considered as statistically significant.

Ethical considerations

The study was approved by the Ethics Committee of Government Yoga and Naturopathy Medical College (Letter number- RES/IEC-GYNMC/2017/018;

Dated- 30-03-2017). All participants were explained in detail about the study and their rights to participate voluntarily along with confidential storage of their data. They were allowed to ask questions for further clarification at any given point of time during the study period. A written informed consent was obtained from the participants before the start of the study.

Results

The final analysis was done on 20 cases who completed the study. There were 10 drop outs. In time domain parameters, 20 mins of mud pack showed a significant increase in RR interval ($p \leq 0.05$), SDNN ($p \leq 0.03$), RMSSD ($p \leq 0.05$), NN50 ($p \leq 0.04$) and pNN50 ($p \leq 0.01$). HR also showed a significant reduction immediately after the mud pack among the healthy volunteers (Table 01).

Table 1
Effect of Mud Pack on Time Domain Parameters of HRV in healthy volunteers

Time Domain Parameters	Without Mud pack	With Mud pack	p value
HR (ms)	78.23±7.34	70.73±9.89	0.04
RR (ms)	804.16±281.43	892.75±141.07	0.05
SDNN (ms)	63.13±7.91	71.6±9.04	0.03
RMSSD (ms)	46.86±6.09	60.83±9.13	0.05
NN50 (count)	79.64±10.47	90.6±18.3	0.04
pNN50 (%)	21.11±3.22	32.02±3.05	0.01
Total Power (ms)	4572±860	6325±780	0.03

[HR=Heart rate, RR=Respiratory rate, PR=Pulse rate, RMSSD=the square root of the mean squared difference between adjacent N-N intervals, NN50=Consecutive normal sinus (NN) intervals exceeding 50 ms, pNN50=the fraction of consecutive NN].

In frequency parameters, 20 min of simultaneous application of mud pack over the abdomen and eyes shows a significant reduction in low frequency parameters ($p \leq 0.04$) and a significant increase in high frequency parameters expressed in the normalized units ($p \leq 0.05$). LF/HF also showed a significant reduction after mud pack intervention (Table 02).

Table 2
Effect of Mud Pack on Frequency Domain Parameters of short-term HRV in healthy volunteers

Frequency Parameters	Without mud pack	With mud pack	p- value
LF (n.u)	52.32±4.15	41.53±4.77	0.04
HF (n.u)	47.14±3.74	56.4±5.77	0.05
LF/HF ratio	1.35±0.26	1.09±0.6	0.04

[LF=Low frequency Power, HF=High frequency power, LF/HF=Low frequency/High frequency ratio].

The effect of mud pack on blood pressure variables and found a significant decrease in systolic blood pressure from 128.06±8.92 to 109.49±10.95 mmHg ($p \leq$

0.05) and changes noticed in diastolic blood pressure from 84.11±9.89 to 68.58±6.18 ($p \leq 0.01$) which is also significant. It also showed that pulse rate changes after mud pack application. It reduced significantly from 78.34±7.92 to 65.06±8.14 bpm ($p \leq 0.05$) (Table 03).

Table 3
Effect of Mud Pack on resting cardiovascular parameters in healthy volunteers

Cardiovascular parameters	Without mud pack	With mud pack	p- value
PR (bpm)	78.34±7.92	65.06±8.14	0.05
SBP (mmHg)	128.06±8.92	109.49±10.9 5	0.01
DBP (mmHg)	84.11±9.89	68.58±6.18	0.05

Discussion

To our best knowledge, this is the first detailed study in an Indian set-up to demonstrate the positive effect of mud pack application on cardiovascular parameters. The results strongly indicate that immediately after the mud pack intervention there occurs parasympathetic domination. The frequency domain parameters of short term HRV also indicate that the improvement in the sympatho-vagal balance. These changes strongly reflected that immediately after mud pack intervention, parasympathetic domination was produced among the subjects. The increase in arterial pressure stimulates afferent baroreceptor discharge, causing reflex inhibition of efferent sympathetic outflow to the blood vessels and heart and activation of parasympathetic outflow to the heart. The resultant decreases in vascular resistance, stroke volume, and heart rate will reduce arterial pressure back to baseline. Decreases in arterial pressure have the opposite effect, evoking reflex increases in peripheral resistance, stroke volume, and heart rate to restore arterial pressure.[7] A Study conducted to find the effect of hot and cold foods on signals of heart rate variability and nail fold microcirculation of healthy young humans found that the capillary red blood cell (RBC) velocity in nail fold microcirculation of subjects with hot constitution accelerated significantly after taking hot-attribute aged ginger tea, which might be the result of elevated vagal activity leading to arteriole dilation in these subjects. In contrast, in subjects with cold constitution, capillary RBC velocity decelerated significantly and skin temperature decreased markedly after taking cold-attribute coconut water, which might have been induced by sympathetic nerve activation causing the arteriole to be constricted.[8] Due to the paucity of literature, a direct comparison with previous published studies cannot be done. Nevertheless, the present study showed that the cold mud pack application over the abdomen and eyes may have a significant impact on the overall short-term HRV range and cardiovascular parameters. A Japanese study reported that among sleeping men, if the temperature is low, then predominant cardiac parasympathetic activity is being observed in the form of a slight rise in heart rate.[9] In the present study, among the participants, it were found that immediately after the cold mud pack application over the abdomen and eyes, the resting cardiovascular parameters, i.e., pulse rate, systolic blood pressure and diastolic blood pressure were significantly reduced compared to that of the values obtained while in supine rest with a dry pack over the same areas. In the time domain parameters of HRV, HR

has shown a significant reduction, RR interval, SDNN, RMSSD, NN50, and pNN50 have shown a significant improvement which indicates an activation of parasympathetic nervous system. Another Indian study reported that a statistically significant reduction ($p<0.01$) in mean values of Systolic BP, Diastolic BP, and HRV attained a statistically significant change ($p<0.01$) in mean score in the frequency domain except for very low-frequency power (VLF) and a significant difference found in the mean score of time-domain values ($p<0.01$) on application of a cold spinal mud pack.[10] Parasympathetic dominance was confirmed by frequency domain parameters of HRV with significant improvement in HF, total power and significant reduction in LF. LF/HF reduction indicates improved sympatho-vagal balance. The mechanism behind the parasympathetic dominance has to be explored. The current study result shows that local cold mud pack application were found to enhance the parasympathetic activity. Thus, Cold mud pack as a naturopathic approach could aid as an effective non-pharmacological technique for reducing stress and its related cardiovascular complications.

Conclusion

The present study showed that simultaneous application of cold mud pack on the abdomen and eyes enhances the parasympathetic activity and has a role in maintaining cardiac tone and preventing various cardiovascular ailments. The reduction of cardiovascular parameters after the application of mud pack intervention reflected the status of parasympathetic domination and reestablishment of sympatho- vagal balance. HRV parameters also showed affirmative changes in both Time and Frequency domain parameters and adding more strength to cardiovascular parameters immediately after the cold mud pack intervention.

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Conflicts of Interest

The authors declare that they have no conflicts of interest. All authors have no financial relation to the commercial identities mentioned in the paper that might lead to conflicts of interest.

Authors contributions

SD, MN and SK- conceived and designed the study, conducted research, provided research materials, and collected and organized data. SM analysed and interpreted data and also wrote initial and final draft of article, and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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