Effect of Ice Massage to Head and Spine on Blood Pressure and Heart Rate Variability in Patients with Hypertension: a Pilot Study

Mooventhan A, MD (Naturopathy)[1], Sneha Bharti, BNYS[2], Nivethitha L, PhD (Yoga)[3], Manjunath NK, PhD (Yoga)[4]

[1]Department of Research, Government Yoga and Naturopathy Medical College, Chennai, [2]The School of Yoga and Naturopathic Medicine, Division of Yoga and Life Sciences, S-VYASA (Deemed to be University), Bengaluru, Karnataka, [3]Department of Nauropathy, Government Yoga and Naturopathy Medical College, Chennai, [4]Division of Yoga and Life sciences, S-VYASA (Deemed to be University), Bengaluru, Karnataka, India

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Background: Ice massage is one of the common hydrotherapeutic procedures. The current study is first of its kind, conducted to evaluate the effect of ice massage to head and spine on blood pressure and heart rate variability in patients with hypertension.

Materials and Methods: Fifteen hypertensive subjects with the mean ± standard deviation (SD) age of 48.87 ± 11.17 yrs were recruited and underwent only one session of ice massage to head and spine for 20 min. Blood pressure and heart rate variability were assessed before and immediately after the intervention.

Results: Results of this study showed a significant reduction in systolic blood pressure (p = <.001), diastolic blood pressure (p < .001) and heart rate (p = .012), and a significant increase in R-R Interval (the intervals between adjacent R waves in the electro cardiogram) (p = .001) in the post-test assessments compared to its respective pre-test assessments.

Conclusion: Results suggest that 20 min of ice massage to head and spine may reduce blood pressure and heart rate in patients with hypertension. However, there is no evidence that this provides any significant clinical impact for the patient.

KEYWORDS: blood pressure; heart rate variability; ice application; hydrotherapy; naturopathy

INTRODUCTION

Hypertension is a major risk factor for cause of cardiovascular diseases (CVDs). It was defined as systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg, or current use of anti-hypertensive medication.[1] Hypertension is a major contributor to cardiovascular morbidity and mortality worldwide and in India.[2] In 2000, around two-thirds of hypertensive patients (639 million) were living in the developing countries, and this is expected to increase to three-quarters (1.15 billion) by 2025.[3] The prevalence of hypertension in Indian adults is 29.8% (urban areas 33.8%, rural areas 27.6%). In India, the levels of control of blood pressure are low, at 20% in urban and 11% in rural population.[2] Risk of cardiovascular death increases twofold if blood pressure (BP) rises to 135/85, fourfold if BP rises to 155/95, and eightfold at 175/105.[2,4] A majority of patients need more than one agent for control of blood pressure. Combination therapy in single pill is encouraged for better compliance.[2]

In hydrotherapy, various forms of water, such as ice, water, and steam/hot air, is used internally or externally for the promotion of health[5,6] or the treatment of various diseases.[7] Many naturopathic hospitals in India uses ice massage to head and spine (IMHS) to lower the blood pressure in hypertensive individuals. IMHS is simple, easy and cost-effective procedure, and a study that compared three types of cold simulation tasks (ice application to hands, forehead, and face) and their effects on cardiovascular adjustments (such as application of ice other than hand including forehead and face) reduce BP and heart rate (HR).[8] Likewise, IMHS has been shown

to produce a significant reduction in SBP, DBP, and (HR),[5] along with a significant improvement in heart rate variability (HRV) towards vagal dominance in healthy individuals.[6] Thus, we hypothesis that it might be useful in reducing BP in patients with hypertension. However, to the best of our knowledge there is no known study reported the effect of IMHS in patients with hypertension. This study was conducted to evaluate the effect of IMHS on BP and HRV in patients with hypertension.

METHODS

Study Design

Since the participants were recruited from a holistic health centre, it would be difficult to have a control group; thus, a single group pre-test and post-test study design was adopted for this pilot study. Fifteen hypertensive participants were recruited and advised to undergo only one session of IMHS for 20 min to find whether or not any changes occurred immediately after 20 min of IMHS. Pre-test and post-test assessments were taken before and immediately after the intervention, and analyses were done to find the difference between the pre-test and post-test assessments.

Participants

Fifteen hypertensive participants (6 males, 9 females) who were on regular anti-hypertensive medication with the mean ± SD age of 48.87 ± 11.17 years were recruited from a holistic health centre in South India, based on the following inclusion and exclusion criteria. Both male and female participants with the age range of 30–70 yrs, history of primary hypertension either on or not on regular medication, and willing to participate in the study were included in the study. Participants with the history of secondary hypertension, hypertensive complications like coronary heart disease and stroke, mental illness, and those who had participated in IMHS in the previous week were excluded from the study. The study was approved by the institutional ethics committee and written informed consent was obtained from all the participants.

Intervention: Ice Massage to Head and Spine (IMHS)

Participants were asked to lie on a massage table in prone position. Ice (1°C–2°C) was filled in a rubber bag (ice bag). Then, ice bag was applied to each participant's head (3–5 s each on the crown, back, right and left sides) followed by spine (3–5 s in the cervical, 6–10 s in the thoracic, and 3–5 s each in the lumbar and sacral regions) by continuous displacements. The same procedure was repeated for a period of 20 min.[5,6] The intervention was provided by one of the investigators.

Assessments

Blood Pressure (BP)

Participants were asked to take 5 min of rest in supine position. In sitting position, SBP and DBP were measured just before starting of intervention (pre-test) and immediately after the 20 min of IMHS by auscultatory method[9] based on the Korotkoff sounds heard by keeping the bell of stethoscope over the left brachial artery and inflating blood pressure cuff with the use of a sphygmomanometer (diamond BPMR-120 Mercurial BP Delux, Pune, India).

Heart Rate (HR) and Heart Rate Variability (HRV)

HR and HRV were assessed before and immediately after IMHS through electrocardiogram (ECG), using a four-channel polygraph (Polyrite D, Recorders and Medicare Systems PTV Ltd., Haryana, India).To record the ECG, the Ag/AgCl pre-gelled electrodes were placed according to the standard limb lead-II configuration. Data were acquired at the sampling rate of 1024 Hz.[10]

Data Extraction

Time domain and frequency domain analysis of the HRV was done using Kubios HRV analysis software version 2.2 (Biomedical Signal Analysis Group, Department of Physics, University of Kuopio, Finland).[11] The following time domain HRV variables were studied:[6,10] 1) the mean of the intervals between adjacent QRS complexes or the instantaneous HR (R-R Intervals); 2) standard deviation of normal-to-normal R-R Intervals (SDNN); 3) HR; 4) the square root of the mean of the sum of the squares of differences between adjacent normal-to-normal (NN) intervals (RMSSD); 5) the number of interval differences of successive NN intervals >50 ms (NN50); and 6) the proportion derived by dividing NN50 by the

total number of NN intervals (pNN50) and the frequency domain HRV variables such as low-frequency (LF) band (0.04–0.15 Hz), and high-frequency (HF) band (0.15–0.4 Hz) with LF/HF ratio.

Data Analysis

Data were checked for normality using Shapiro-Wilk test. Statistical analysis was performed using Student's paired-samples *t*-test (for normally distributed data) and Wilcoxon signed-rank test (for not normally distributed data) with the use of SPSS, Version 16.0 (IBM SPSS Statistics, Armonk, NY). A *p* value <.05 was considered significant.

RESULTS

The demographic details of the study group are provided in Table 1. Results of this study showed a significant reduction in SBP, DBP, and HR and a significant increase in R–R Intervals in the post-test assessments compared to their respective pre-test assessments. But, no such significant difference was observed in rest of the time domain (i.e., SDNN, RMSSD, NN50, and pNN50) and frequency domain (i.e., LF, HF, and LF/HF ratio) variables (Table 2). Participants were comfortable, and none of the subjects reported any adverse effects during the study period.

DISCUSSION

Parameters such as SBP, DBP are known as the best predictors of CVDs risks.[10] Results of this study showed a significant reduction in SBP and DBP after 20 min of IMHS. It suggests that 20 min of IMHS might help to reduce BP in patients with hypertension. The reduction in BP might

TABLE 1. Demographic Variables of the Study Group (*N* = 15)

Parameter	*Study Group (N = 15)*
Age (yrs)	48.87±11.17
Gender	Female (*n* = 9), Male (*n* = 6)
Height (m)	1.58±0.10
Weight (kg)	67.90±11.16
Body Mass Index (kg/m^2)	27.10±4.46

TABLE 2. Pre-Test and Post-Test Assessments of the Study Group (*N* = 15)

Parameters	*Baseline*[a]	*Post-Test*[a]	*t/z Value*	*p Value*
SBP (mmHg)[b]	154.27±18.58	142.80±16.42	13.671	<0.001[c]
DBP (mmHg)[b]	93.60±11.06	84.40±10.72	6.818	<0.001[c]
RRI (ms)[b]	754.01±112.75	803.48±108.08	-4.295	0.001[c]
SDNN [d]	38.63±32.50	38.52±27.39	-1.475	0.140
HR (b/min)[b]	81.58±12.21	76.89±11.10	2.893	0.012[c]
RMSSD[d]	34.95±36.02	34.94±34.89	-0.909	0.363
NN50 (count)[d]	15.40±35.90	19.93±42.66	-1.364	0.173
pNN50 (%)[d]	4.33±10.61	5.79±12.89	-1.398	0.162
LF (n.u)[b]	54.75±25.05	55.77±23.02	-0.145	0.887
HF (n.u)[b]	45.89±25.32	43.32±22.58	0.365	0.720
LF/HF (ms^2)[d]	2.90±4.04	2.22±2.22	-0.625	0.532

[a]All values are in mean ± SD
[b]Student's paired samples *t*-test
[c]*p* value < .05
[d]Wilcoxon signed ranks test
SBP = systolic blood pressure; DBP = diastolic blood pressure; RRI = the intervals between adjacent QRS complexes or the instantaneous heart rate; SDNN = standard deviation of RR interval; HR = heart rate; RMSSD = the square root of the mean of the sum of the squares of differences between adjacent NN intervals; NN50 = the number of interval differences of successive NN intervals greater than 50 ms; pNN50 = proportion derived by dividing NN50 by the total number of NN intervals; LF = low frequency; HF = high frequency; LF/HF ratio = ratio of low frequency to high frequency.

be mediated through the significant reduction in HR. BP is the byproduct of cardiac output and peripheral resistance, while cardiac output is the byproduct of HR and stroke volume, and thus HR forms one of the determinants of BP.[5]

HR is influenced by physical, cognitive, and emotional activities. Physiological oscillations that lead to variable beat-to-beat fluctuations in HR are known as HRV. Hence, HR and HRV are the most sensitive, and easily accessible, indicators of parasympathetic and sympathetic activity and autonomic regulation.[6,12] Results of this study showed a significant increase in R-R Intervals and a subsequent significant reduction in HR. The reduction in HR might attribute to the significant increase in R-R Intervals. The literature suggests that the R-R Intervals (a time domain measure of the HRV) is one of the stronger predictors of vagal modulation.[6] Thus, increase in R-R Intervals immediately after 20 min of IMHS suggests that 20 min of IMHS might reduce HR and improve HRV towards parasympathetic dominance. However, results of this study showed no significant changes in time domain variables such as SDNN, RMSSD, NN50, and pNN50, and the frequency domain variable like HF spectrum of HRV, all of which are also considered as the predictors of parasympathetic activity.[6] According to a previous study results, the application of ice to forehead and face has shown to reduce BP and HR.[8] Similarly, in another study, IMHS has shown to significantly reduce BP and HR[4] and improve HRV in healthy volunteers.[6] These studies suggest that the increase in R-R Intervals and the subsequent reduction in HR in the current study might not attribute to parasympathetic activity but might attribute to sympathetic withdrawal. The results of the present study are supported with the previous studies' findings.[5,6] IMHS is a simple, easy, and cost-effective method that produces reduction in BP and HR temporarily, immediately after the application, with no known adverse effects and, thus, IMHS is expected to improve cardiovascular function (reduce BP and HR) in patients with hypertension. However, we did not check how long the effect was sustained, which is limiting the scope of the usefulness of the study findings. Further studies are required to find the duration of BP lowering effect, as well as the long-term effects of IMHS in patients with hypertension, before implementing it in the clinical setting.

The strength of the study is that, to our knowledge, this is the first-ever study to evaluate the effect of IMHS on BP and HRV in patients with primary hypertension. None of the subjects reported any adverse events during the intervention. Limitations of the study are that since it is a pilot study, sample size calculation was not made and this study had a small sample size. A control group and assessment of other cardiovascular parameters, namely peripheral arterial resistance, continuous BP monitoring, and baroreceptor sensitivity and autonomic parameter like galvanic skin resistance and photo plethysmography, would have provided a better understanding of the state of the cardiovascular functions which are missing in this study. The present study assessed only the immediate effects of IMHS. Assessing its long-term effects and its underlying mechanisms could elevate this technique as a potential preventive and management therapy. Hence, further studies are required (randomized controlled trials) on a large sample size, with longer duration and advanced techniques, to evaluate its precise effects with underlying mechanisms.

CONCLUSION

Results suggest that 20 min of ice massage to head and spine may reduce blood pressure and heart rate in patients with hypertension. However, there is no evidence that this provides any significant clinical impact for the patient.

CONFLICT OF INTEREST NOTIFICATION

The authors declare there are no conflicts of interest.

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Corresponding author: Dr. Mooventhan A, MD (Naturopathy), Department of Research, Government Yoga and Naturopathy Medical College, Arumbakkam, Chennai-600106, Tamilnadu, India
E-mail: dr.mooventhan@gmail.com