IMMEDIATE EFFECT OF COLD SPINAL BATH ON AUTONOMIC AND RESPIRATORY VARIABLES IN HYPERTENSIVES

Geetha B. Shetty¹, Prashanth Shetty² and Balakrishna Shetty³

¹Professor & HOD, Department of Acupuncture, SDM College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.
²Principal, SDM College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.
³Assistant Professor & HOD, Department of Biochemistry, SDM College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.

*Corresponding Author: Geetha B. Shetty
Professor & HOD, Department of Acupuncture, SDM College of Naturopathy and Yogic Sciences, Ujire, Karnataka, India.

ABSTRACT

Background & Objectives: The cold spinal bath, one of the hydrotherapeutic treatment modality is commonly used by Naturopathy physicians as a treatment of choice in Hypertension. This study was done to assess the immediate effect of cold spinal bath on the autonomic and respiratory variables and thereby substantiate the clinical understanding of its effect on blood pressure. Methods: Sixty pre diagnosed patients of Hypertension belonging to both genders aged between 38 to 67 years (55.2±9.87) were recruited for the study and were assessed for blood pressure, autonomic variables (HRV & Heart rate) and respiratory variables (respiration rate) before and immediately after the intervention of cold spinal bath for 20 minutes. Results: Data was checked for normal distribution and analysed by using paired sample t test with SPSS (Version 20.0) package. There was a significant decrease in the blood pressure, heart rate, and LF/HF ratio and increase in the HF power, NN50 and pNN50 values after the cold spinal bath. Interpretation & Conclusion: Cold spinal bath reduces sympathetic tone and shifts sympathovagal balance towards vagal dominance and hence support the claim that cold spinal bath can be effectively used in lowering the blood pressure in Hypertension.

KEYWORDS: Hydrotherapy, cold spinal bath, Heart rate variability, Hypertension, Naturopathy.

INTRODUCTION

Hypertension or high blood pressure is a chronic medical condition in which the systemic arterial blood pressure is elevated.³¹ High blood pressure is a major risk factor for stroke, myocardial infarction, heart failure and arterial aneurysm, and is a leading cause of chronic kidney failure and better control can lead to prevention of 300,000 of the 1.5 million annual deaths from cardiovascular diseases in India.³² Essential hypertension is the most prevalent disorder, nearly one billion people or ~26% of the adult population have hypertension worldwide. It is common in both developed (333 million) and undeveloped (639 million) countries.³³ The prevalence of hypertension is increasing rapidly among Indian urban populations.³⁴

Large clinical trials in hypertensive patients showed a small reduction in blood pressure could reduce the risk of heart failure, stroke, and myocardial infarction markedly.³⁵ Although there are numerous therapies or protocols for treatment of hypertension none of them form a complete solution. The first line of treatment for hypertension is preventive lifestyle changes such as, the dietary changes, physical exercise, and weight loss, which have all been shown to significantly reduce blood pressure in people with hypertension.³⁶ If hypertension is high enough to justify immediate use of medications, lifestyle changes are still recommended in conjunction with medication.³⁷ But large segments of the hypertensive population are either untreated or inadequately treated because of the high cost for these treatments and also due to the side effects of the drugs on the body. To overcome this, non-pharmacological alternate therapies like hydrotherapy can be efficiently employed. Hydrotherapy is one of the ancient known therapies, where water is used in any forms, for the maintenance of health or the treatment of diseases.³⁸ Baths are one of the ways in which water is applied to human body for therapeutic use. Baths may be full or partial immersions of the body in water of various temperatures.³⁹ The temperature for cold treatments is 64-75°F, for hot 98-104°F and neutral 92-95°F.⁴⁰

Spinal bath is a local, non-pressurized hydraulic measure in which the pre-spinal and para-spinal area is immersed...
in water of required temperature for a specific duration to get desired effects. Dr. Pudukottai Laxman Sharma, a renowned naturopath of the country, invented the spinal bath. The clinical experience of using cold spinal bath in Hypertensive’s has shown reduction in blood pressure without any adverse effects. But physiological changes and efficacy of cold spinal bath in hypertensive subjects have not been studied; hence a systematic study and analysis of its effects to prove or disprove these claims are essential.

There is also strong evidence that a large proportion of patients with hypertension have autonomic nervous system function abnormalities which are increased sympathetic activity and decreased parasympathetic tone. This was shown with consecutive sympathetic and parasympathetic blockade of the heart, and by the spectral analysis of the Heart rate variability (HRV). So the measurement of HRV can be used as a tool to assess the role of spinal bath on regulation of blood pressure. Hence, this study aims at understanding the effects of cold spinal bath on autonomic and respiratory variables in healthy volunteers and hypertensives and establishing strong evidence against the extent of efficacy of this treatment modality in the management of hypertension.

MATERIALS AND METHODS

Participants
Sixty pre diagnosed patients of hypertension belonging to both genders aged between 38 to 67 years (55.2±9.87) were recruited for the study from Yoga and Nature Cure Hospital, Karnataka. Exclusion criteria were subjects with cardiac disorders like coronary artery disease, pacemaker rhythm, primary valve disease, cardiac rehabilitation following bypass surgery, hypertensive patients with renal involvement, hypertensive with diabetes mellitus and female subjects during their menstrual cycle. Subjects were explained in detail about the procedures involved in assessments as well as intervention. A signed informed consent was taken from each subject. The project was approved by the Institutional Ethics Committee.

Design of the study
This is a single group pre – post interventional study. The study designed to assess the immediate effect of cold spinal bath on Autonomic and respiratory variables in subjects with primary hypertension. Subjects were assessed before and immediately after a cold spinal bath.

Assessments
The subjects are assessed for the blood pressure, autonomic and respiratory variables as per the standard operating procedures before and after the intervention of cold spinal bath. Before the assessment the subjects were made to sit in a dimly lit, sound attenuated cabin and relax. Blood pressure was recorded before and after the cold spinal bath by using a standard mercury sphygmomanometer, auscultating over the right brachial artery. The systolic pressure was noted as the first clear tapping sound (korotkoff sounds) and diastolic pressure was noted as the reading at which the korotkoff sounds appeared muffled.

ECG was recorded using a four channel polygraph (MP 45 Biopac Student Lab, BIOPAC System Inc, U.S.A. The Ag/AgCl pre-gelled electrodes (Tyco Healthcare, Germany) were placed as per the Limb Lead II configuration for recording ECG. Data were acquired at the sampling rate of 1024 Hz and were analysed offline. Noise free data were included for analysis. Respiration was recorded using a volumetric pressure transducer fixed around the trunk at the level of the lower costal margin as the subject sits erect. Care is taken to adjust the strap such that full inhalation is not restricted. Breath rate is calculated in cycles per minute (cpm) by counting the breath cycles in 60 second epochs, continuously.

Intervention
Cold spinal bath was given in tubs specially made for the purpose. Spinal bath tubs are made up of fibre material and are water proof and non-allergic. The spinal bath tub, from Indian Fibre Company, Bangalore, Karnataka was used in the study. The dimensions of the spinal bath tub was 3’x21/2’ and the height is 10 inches. Tub helps to maintain the constant water temperature. The water level in the tub was an inch and a half to two inches. The temperature of the water in the spinal bath was 18-24°C (64-75°F). Water temperature was measured by using a digital thermometer. The subject’s lies down in a spinal bath tub with minimum dress, with the head on the side that is most slanted, his buttocks at the opposite side end and his feet outside and adjusts himself to the water of the tub such that water should touch the entire length of the spine, from the nape of the neck to the lowest portion of the spine. Intervention was given for 20 minutes.

Data Extraction
From the digitized ECG data, the R waves are detected to obtain a point event series of successive R-R intervals, from which the beat to beat heart rate series was computed. The data recorded was visually inspected offline and only noise free data was included for analysis.

i. Heart rate variability:
The HRV power spectrum was obtained using Fast Fourier Transform analysis. The energy in the HRV series of the following specific bands was studied viz. the very low frequency component (0.0-0.05 Hz), low frequency component (0.05-0.15 Hz), and high frequency component (0.15-0.50 Hz). The low frequency and high frequency values are expressed as normalized units. In addition to frequency domain analysis, time domain analysis was also done. The following components of time domain HRV were analyzed: (i) mean RR interval (the mean of the intervals
between adjacent QRS complexes or the instantaneous heart rate), (ii) NN50 (the number of interval differences of successive NN intervals greater than 50 ms), and (iii) pNN50 (the proportion derived by dividing NN50 by the total number of NN intervals). Fourier analysis of the R-R interval series was done using the HRV analysis software version 2.1 developed by the Biomedical Signal Analysis Group, University of Kuopio, Finland.

ii. Heart rate
The R waves from the electrocardiogram are detected, to obtain a point event series of successive R-R intervals, from which the beat to beat heart rate series are computed. The heart rate is obtained based on R-R inter-beat interval analysis. The heart rate in beats per minute (bpm) was obtained by continuously counting the QRS complexes in successive 60 second periods.

iii. Respiratory rate (RR)
Respiratory rate (in cycles per minute) was calculated by counting the breath cycles in 60 seconds epochs. The readings obtained from the 5 minute data was averaged.

Data Analysis
Statistical analysis was done using SPSS (Version 20.0) package. Data was checked for normal distribution and analysed by using paired sample t test. P values less than 0.001 were accepted as indicating significant differences between pre and post intervention data.

RESULTS
The data obtained following cold spinal bath were analysed for normal distribution and variance using Shapiro Wilk test. The pre–post data was analysed using paired sample t-test. Data of both autonomic and respiratory variables were found to be normally distributed with equal variance.

Heart rate and HRV
There was a significant decrease in the pre and post values of heart rate (p <0.01), and significant increase in the pre and post values of NN50 (p <0.01) and pNN50 (p <0.01) after the intervention in the Hypertensive’s. There was a significant decrease in the pre and post values of LF power (p <0.01), and significant increase in the pre and post values of HF power (p <0.01) and LF/HF (p <0.01) after the intervention in the Hypertensive’s.

Respiratory Rate
There was a significant decrease in the respiration rate (p <0.01) in hypertensive’s after the intervention compared to their pre values.

Table-1: Blood pressure, respiratory rate, and HRV values recorded before and after cold spinal bath in hypertensives (Values are group mean ± S.D).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre Mean ±SD</th>
<th>Post Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>55.17±9.83</td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>142.07±5.60</td>
<td>139.67±5.97*↓</td>
</tr>
<tr>
<td>DBP</td>
<td>92.8±4.6</td>
<td>91.27±4.65*↓</td>
</tr>
<tr>
<td>Hear Rate</td>
<td>72.96±12.62</td>
<td>69.22±11.37*↓</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>15.18±1.82</td>
<td>14.22±1.57*↓</td>
</tr>
<tr>
<td>Low frequency (LF)</td>
<td>53.98±17.35</td>
<td>46.53±17.82</td>
</tr>
<tr>
<td>High frequency (HF)</td>
<td>45.91±17.32</td>
<td>53.47±17.78*↑</td>
</tr>
<tr>
<td>LF/HF ratio</td>
<td>1.57±1.17</td>
<td>1.15±0.99**↓</td>
</tr>
<tr>
<td>NN50</td>
<td>31.00±5.62</td>
<td>45.12±4.84*↑</td>
</tr>
<tr>
<td>pNN50</td>
<td>9.98±11.62</td>
<td>14.03±14.53*↑</td>
</tr>
</tbody>
</table>

Paired sample t test comparing “Post” with “Pre” values: * p <0.05, ** p <0.01, *** p <0.001
(Note: ↑: increase; ↓: decrease)

DISCUSSION
The present study evaluated the immediate effects of a cold spinal bath in subjects with hypertension. There was a significant decrease in blood pressure, both SBP and DBP in hypertensives immediately after cold spinal bath. The significant reduction in heart rate observed is suggestive of parasympathetic dominance immediately after the intervention. This fact is further supported by the findings observed in the components of HRV. Perhaps, a reduction in LF component, LF/HF ratio and increase in HF component, are all suggestive of a shift in sympathovagal balance towards parasympathetic dominance. In addition, the changes observed in blood pressure provide a clear direction to the effects of spinal bath.

The changes in the autonomic variables found in the present study are comparable to the findings observed following an immersion bath. An earlier study by Miyamoto and his associates, [16] has illustrated the effects of water immersion as a simple and efficient method for increasing parasympathetic activity and lowering sympathetic tone at rest, as inferred from heart rate variability measures. The hydrostatic pressure created by the head-out water immersion condition shifts peripheral blood into the thoracic vasculature thereby increasing central blood volume, stroke volume, cardiac output, and HRV.

www.wjpmr.com 238
output and central venous pressure. This increase in central venous pressure is likely to stimulate arterial pressure and lower cardiopulmonary pressure. This process is known to augment parasympathetic activity and inhibit sympathetic activity, leading to a bradycardia and an increase in vagal-related HRV indices. [17]

One more mechanism, which could be speculative the hypotensive effect of cold spinal bath is the role of transient receptor potential cation channel subfamily M member 8 (TRPM8), transient receptor potential family. Application of cold water in the form of spinal bath may send the signal through the DRG neurons, specialized dorsal root ganglion (DRG) neurons in the trunk. The cell bodies of DRG neurons are adjacent to the spinal cord within the vertebral column and thereby activate TRPM8. TRPM8 activation antagonizes contractile action of sympathetic neurotransmitters [18] & thereby may bring hypotensive effect. Also cold induced activation of TRPM8 localized in the sarcoplasmic reticulum membrane can support Ca2+ release from the sarcoplasmic reticulum causing Ca2+ store depletion and which may lead to the inhibition of the vasoconstriction activity. [19]

Mourot and his associates also showed that moderately cold (26–27 °C) exposure had a greater effect on cardiac parasympathetic activity compared with a thermo neutral immersion temperature (35–36 °C). [19] This may be due to an arterial vasoconstriction that can induce greater increases in central blood volume or faster reductions in core temperature. The cold immersion stimulates the pressure-dependent baroreceptors and co-activation of cold receptors and thereby results in increase in vagal-related HRV indices. [19]

While the above mentioned mechanisms might support the results observed in the present study in general, the physiological changes documented following the exposure of skin to cold explain the underlying mechanisms in particular. When skin is exposed to cold, initially it causes vasoconstriction, followed by dilatation of the peripheral blood vessels as a secondary reaction. [20] Similarly, adrenaline and nor-adrenaline increases initially, but once the cold stimulus is withdrawn, the catecholamine response gets attenuated as well as the resting catecholamine levels decreases. [21] which could cause the reduction in blood pressure as seen in the present study immediately after cold spinal bath.

Since the physiological changes following a cold spinal bath are not documented so far, the present study made an attempt to understand the physiological effects of cold spinal bath in hypertensives. It can be speculated from the results of the present study that, changes are mediated not only through sympathetic-vagal changes, but also influenced by humoral factors. Further research is required to understand in detail and reproduce such physiological changes considering proper controls and regulating all confounding variables.

Limitations of the study
Despite the impressive results of cold spinal bath found in this study, cautious interpretation of study findings is warranted because of some limitations, such as Experimental design was without a control condition, autonomic variables were assessed before and immediately after the treatment, so it is not known whether the observed beneficial effect of cold spinal bath is sustained beyond the acute period.

Directions for future research
The same study with the control group and more number of subjects on normal volunteers and hypertensives can be focused to substantiate the effects of cold spinal bath for its therapeutic application. Cumulative effect of the intervention can also be studied to know the long term effect of it on hypertensives.

CONCLUSION
The present study shows that a cold spinal bath has a physiologically relaxing effect as demonstrated by a reduction in blood pressure, heart rate, LF component of HRV and an increase in the HF component of HRV, suggesting a shift in the sympatho-vagal balance towards vagal dominance. Hence, a cold spinal bath may be used as a simple non-invasive effective means of reducing blood pressure in hypertensives.

ABBREVIATIONS
DBP: Diastolic Blood pressure, HF: High frequency, HRV: Heart rate variability, LF: Low frequency, SBP: Systolic Blood pressure,

COMPETING INTERESTS
The authors declare that they have no competing interests.

ACKNOWLEDGEMENT
We would like to thank the SDM management & the Principal for providing all the facility for carrying out the above work.

REFERENCES