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Immediate Effect of whirlpool Bath on Autonomic Functions in Healthy Volunteers

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Abstract:
Background and Objectives: *The Whirlpool bath, one of the hydrotherapeutic treatment modality is commonly used by Naturopathy physicians as a treatment. Though whirlpool bath therapy has been used extensively in a clinical scenario for both rejuvenation as well as therapy. But their effect on autonomic activity is not studied. Hence, this study aims at understanding the physiological changes of Whirlpool bath in healthy volunteers.*
Methodology: *A total of 30 healthy volunteers were randomly selected and are recruited from the residential SDM College of Naturopathy and Yogic Sciences. On the Day-1 the volunteers were given with whirlpool bath and on the Day-2 the same volunteers was made to stand in upright position inside the whirlpool bath tub for ten minutes. Each group was assessed for blood pressure, autonomic variables (HRV & Heart rate) and respiratory variables (respiration rate) before and immediately after the intervention.*
Results: *Present study shows, significant increase in HRV [MeanRR ($p \leq 0.0001$*), RMSSD ($p \leq 0.0096$*), NN50 ($p \leq 0.0456$*), Pnn50 ($p \leq 0.0054$*)] and also increase in SBP ($p \leq 0.0001$*), DBP ($p \leq 0.0001$*) and HF ($p \leq 0.1276$) after intervention period. It also shows statistically significant decrease in Heart rate ($p \leq 0.0001$), body temperature ($p \leq 0.0001$) and pulse ($p \leq 0.05$) after intervention period. There were no significant changes in PR ($p \leq 0.9530$) and RR ($p \leq 0.7654$) after intervention period*
Conclusion: *The present study suggests that there was a statistically significant relationship between ANS activity manifested by heart rate variability and water temperature. Whirlpool bath enhances parasympathetic activity which can be a tool to calm down the mind, stress, anxiety, insomnia & rejuvenation.*
Keywords*: Autonomic Nervous System Heart Rate Variability, Hydrotherapy, whirlpool bath*.

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I. Introduction

Hydrotherapy is one of the oldest known therapies which can be defined as the use of water, in any forms, for the maintenance of health or for the treatment of diseases.[1]Hydrotherapeutic effects of hot bath, which is achieved by heat and hydrostatic pressure, includes increasing perspiration and metabolism, emotional suppression, fever, alleviating muscle tension, and pain.[2]Bath, well known technique of hydrotherapy, may be full or partial immersion of the body in water of various temperatures.[3] Many studies on the physiological effects of immersion bath, which include blood pressure, body temperature, intraocular pressure, regulation of autonomic nerve system and sleep, have been performed.[4] Mechanical effects are produced by the impact of water acting on the body surface in the form of sprays, underwater massages, frictions, immersions, whirlpools, etc. Chemical effects are produced when water is taken by mouth or used to irrigate large colon. Thermal effects are the most commonly used therapeutically.[5]Warm water immersion in physically trained men with tetraplegia shown reduction in heart rate, plasma noradrenalin concentration and expanded plasma volume levels.[6]Acute thermo neutral water immersion can prompt increase in arterial compliance.[7]A study by Using whirl pool for the lower extremity places the extremity in a dependent position. This has been shown to increase venous hypertension and vascular congestion of that limb, both of which physiologically decrease the efficiency of wound healing, especially in those patients with venous insufficiency.[8,9] Though whirlpool bath treatment has been used extensively in clinical scenario both for rejuvenation as well as therapy, its underlying mechanisms are less understood. The effect of whirlpool bath over the autonomic nervous system can be measured by heart rate variability. The measurement of heart rate variability (HRV) is clinical routine in most autonomic labs. In contrast to these cardio-vagal investigations, it is much more complicated to get quantitative information about

sympathetic nervous system function.[10.] Hence this study aims to evaluate the immediate effect of whirlpool bath on autonomic functions at temperature: 34°-37°C.

II. Materials And Methods

The study adopts is Self as a Control Trial. This particular study has been conducted upon healthy human subjects who gave their consent for being included in this study. The subjects were selected and registered for study from S.D.M college of Naturopathy and yogic sciences, Dakshina Kannada, Karnataka (India). 30 Subjects(15 male and 15 female volunteers with age group varies from 18 to 25 years and Body Mass Index (BMI) varies from 18-25 kg/m^2) were randomly selected and are recuited. The institutional ethical committee approval was obtained for conducting the study. On the Day-1 the volunteers underwent with whirlpool bath and on the Day-2 the same volunteers was made to stand in upright position inside the whirlpool bath tub for ten minutes. All the subjects were assessed before and after the treatment. The inclusion Criteria are the healthy students who are studying BNYS in SDMCNYS, UJIRE between 18 to 25 years, including 15 males and 15females and Body Mass Index (BMI) varies from 18-25 kg/m^2) who have given written informed consent. The Exclusion criteria are subject having any health disorders (in order to determine the health status of the subjects, in all cases a routine case history was taken and a routine clinical examination was conducted), who were taking medication which could influence autonomic function e.g., phenylpropanolamine as a common cold remedy[11], females during Menstrual **Cycle**[12] and who are consuming alcohol and nicotine except caffeine. There were no dropouts during the study.

The subjects were seated on a chair recording leads were connected to the four-channel polygraph equipment (BIOPAC, Montana, USA; model No: BSL 4.0 MP 36) and monitored on a closed circuit TV. Instructions were given to the subjects to remain relatively undisturbed during the session. In the Whirlpool bath, the client lies relaxed in a large tub of water. The whirlpool apparatus constructed with tub, and directly connected with the sources of neutral water. The water needed for the whirlpool bath was drawn from the tub and returned under pressure through the hose. An internal pump creates the high-pressure stream of water. The Jacuzzi LX600M whirlpool bath includes three hydro-air fittings powered by a circulating pump which provides hydro massage by mixing air with water and can be rotated through a 30^0 angle. Whirlpool bath also included a 60 minute timer, anti-vertex suction covers, [13] and hair and lint strainersSubjects were given WPB in the treatment section of the Naturopathy Hospital for a period of 10 minutes. Prior to the intervention, each subject was asked to enter the treatment ring in minimal clothing, and shower cap. During the intervention, the subject stands erect in the centre of the circular ringed equipment such that multiple small but powerful jet streams per cussed simultaneously on the various parts of the body. After the intervention, the subject was instructed to be dried with a towel and dressed before the post assessment.

Temperature: 34°-37°C,Statistical analysis was performed using SPSS version 21.0 for windows. Data were expressed as mean ± SD. Data were tested for variables. Repeated measures analysis of variance (ANOVA) followed by a post hoc analysis with Bonferroni adjustment for multiple comparisons between the mean values of both groups. Levels of significance were set to 0.05.

III. Results

Figure 1 Represents By Comparing between the whirlpool bath group(post) and Control group(post) in time domain (independent t test), shows significant increase in Mean RR($p \leq 0.0001$*), RMSSD($p \leq 0.0096$*), Pnn50($p \leq 0.0054$*), whereas, Decrease in Mean HR($p \leq 0.0001$*) which indicates parasympathetic in WPB group.

Figure 2; Represents In vital data(independent t test), there is increase in blood pressure i.e. SBP ($p \leq 0.0001$*), DBP ($p \leq 0.0001$*) and Temp ($p \leq 0.0001$*) and there is no significant changes in PR ($p \leq 0.7385$) and RR ($p \leq 0.8258$).

Figure 3; Represents In frequency dominance (independent t test), there is decrease but not significantly in LF ($p \leq 0.1940$), LF/HF ($p \leq 0.5249$) and increase but not significantly in HF ($p \leq 0.1940$) while comparing between the WPB group and Control group.

IV. Discussion

The main aim of the study was to evaluate the physiological effect of whirlpool bath with the design self as a control. The present study was conducted to evaluate the changes in the autonomic functions such as Heart rate, Heart rate variability, Respiratory rate, Body temperature and Blood pressure following whirlpool bath in normal healthy volunteers By inter group Time domain analysis of WPB shows significant increase in mean RR ($p \leq 0.0001$*), RMSSD ($p \leq 0.0003$*), NN50 ($p \leq 0.006$*), Pnn50 ($p \leq 0.0002$*) whereas, decrease in mean HR ($p \leq 0.0001$*) which indicates parasympathetic dominance after the intervention.

In frequency domain there is increase in HF ($p \leq 0.1276$) and decrease in LF ($p \leq 0.1276$) and LF/HF ($p \leq 0.1068$) in which changes took place but not significantly, indicating its parasympathetic dominance after the intervention.

In vital data there is increase in blood pressure i.e. SBP ($p \leq 0.0001$*), DBP ($p \leq 0.0001$*), and decrease in Temp ($p \leq 0.0001$*) and there is no significant changes in PR ($p \leq 0.9530$) and RR ($p \leq 0.7654$).By Comparing between the whirlpool bath group(post) and Control group(post) in time domain, shows significant increase in Mean RR($p \leq 0.0001$*), RMSSD($p \leq 0.0096$*), Pnn50($p \leq 0.0054$*), whereas, Decrease in Mean HR($p \leq 0.0001$*) which indicates parasympathetic in WPB group. In vital data there is increase in blood pressure i.e. SBP ($p \leq 0.0001$*), DBP ($p \leq 0.0001$*) and Temp ($p \leq 0.0001$*) and there is no significant changes in PR ($p \leq 0.7385$) and RR ($p \leq 0.8258$).Frequency domain analysis was shown increased in LF component($p \leq 0.1940$), and LF/HF ratio ($p \leq 0.5249$) but not significantly whereas decrease in HF ($p \leq 0.1940$) component which may not be an indicative of sympathetic or parasympathetic activity which is stated by Malliani A ,julienc, Billman et al.**[14]**

There was also reduced in body temperature and there was no significant changes in Pulse rate and Respiratory rate by comparing between whirlpool bath group and control group. There was a significant increase in blood pressure, both SBP and DBP in healthy volunteers after the intervention of whirlpool bath. Cold causes peripheral vasoconstriction in action phase and later vasodilatation in reaction phase; so due to vasodilatation in reaction phase it improves blood circulation.**[15]**Comparing cold underwater massage group with neutral underwater massage there is significant increase in the mean RR ($p \leq 0.05$) and decrease in RMSSD ($p \leq 0.05$) and HR ($p \leq 0.001$) which indicates parasympathetic dominance, similar result was shown by Buchheit et al.,**[16,17,]**

There is a general understanding that the LF band of the HRV is an index of cardiac sympathetic activity.[18] Neither the LF band (<0.15Hz) nor HF band (>0.15Hz) is considered exclusive markers of sympathetic/parasympathetic tone respectively.[19]The HRV represents the integrated eng-organ response to the complex nonlinear interaction between the two divisions of the autonomic nervous system as well as other factors. This particularly applies to the relationship between the LF power was reduced by the selective cardiac parasympathectomy and was not totally removed when b-adrenoceptor blockade was combined with denervation. Also activities that were expected to increase sympathetic activity failed to increase the LF power and actually significantly reduced the LF power. The association between the HF power and cardiac parasympathetic activity is stronger. However the association is qualitative rather than quantitative. Hence the HRV provides a qualitative marker of cardiac parasympathetic regulation and changes in the LF power and the LF/HF ratio have to be viewed with caution.[20]

Another study by Renza Perini,Stefania Milesi et all; on heart rate variability in exercising humans: effect of water immersion suggesting The HF% decreased in similar ways in Water immersion and and Air to about half at 55%–60% $\dot{V}O_{2max}$ and then increased to reach 1.5 times the resting values at $\dot{V}O_{2max}$. The central frequency of HF increased linearly with oxygen uptake, showing a tendency to be higher in Water immersion than in Air at medium to high intensities. The VLF% remained unchanged. The lack of differences in the LF peak between Water immersion and Air during exercise would suggest that blood distribution had no effect on the readjustments in control mechanisms of arterial pressure.[21]A study by Renza Perini and Arsenio Veicsteinas on Heart rate variability and autonomic activity at rest and during exercise in various physiological conditions stated that; Modifications in autonomic activities induced by different physiological conditions, e.g. hypoxia exposure, training, and water immersion, have been found in HRV power spectra at rest. The changes in HF and LF powers and in LF/HF ratio observed during exercise have been shown not to reflect the decrease in vagal activity and the activation of sympathetic system occurring at increasing loads. HF peak was recognized in power spectra in the entire range of relative intensity, being responsible for the most part of HR variability at maximal load. LF power did not change during low intensity exercise and decreased to negligible values at medium–high intensity, where sympathetic activity was enhanced.**[22]**

Results of the present study suggest Whirlpool enhances parasympathetic activity and this can be a tool to calm down the mind, relax and rejuvenate. The main limitation of the study was that, it was not possible to record the assessments during the intervention to have a better understanding of the Physiology for comparison which is a limitation of the study

Directions for future research; Conducting study with large sample size,Skin conductance (GSR) could be included,Study can be conducted on general population. Other variables can be included i.e. Myogram, Gastrogram, EEG etc..Study can be conducted on Pain relief in amputations (phantom pain), After removal of plaster cast (fractures), Stiff joints.

V. Conclusion

To conclude, the immediate effect of whirlpool bath on autonomic variables showed that it helps in parasympathetic dominance, hence it can be applied effectively in treating stress, insomnia and anxiety, to overcome the effects of sympathetic dominance caused by stress, so whirlpool bath can be used as one of the complementary alternate treatment modality.

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Figure: 1 Comparing Vital Data Of Wpb Post With Ctl Post
(independent t test)

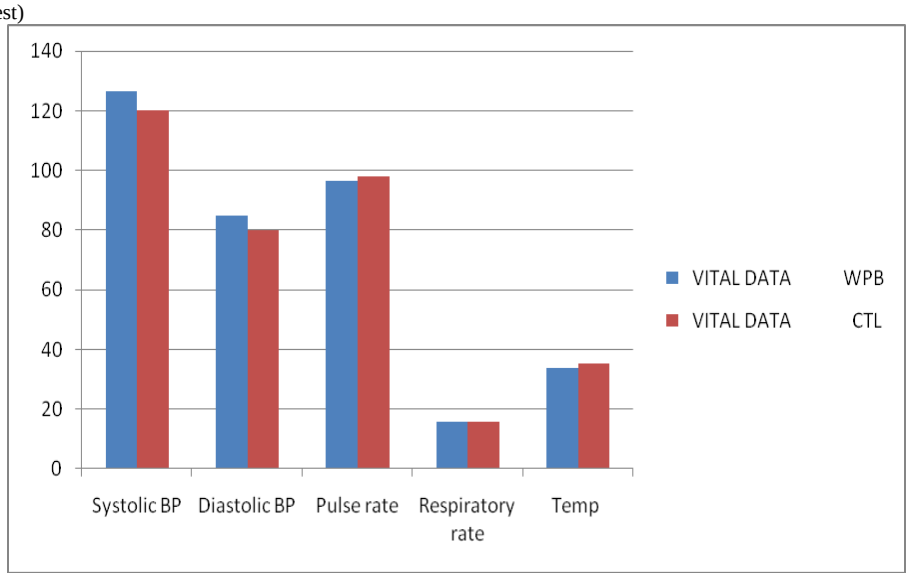

Figure: 2 Comparing Time Domain Of Wpb Post With Ctl Post (Independent T Test)

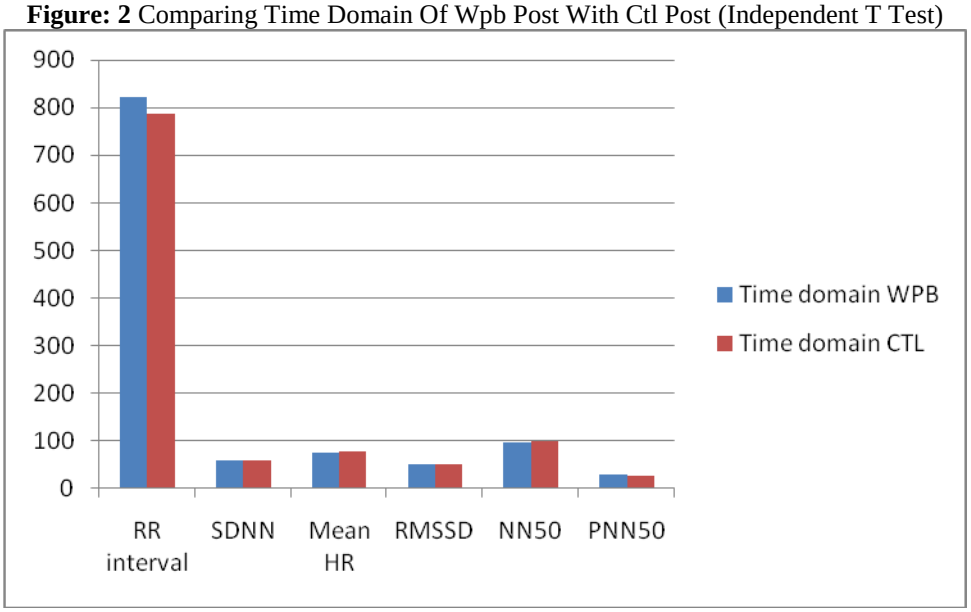

Figure: 3 Comparing Frequency Domain Of Wpb Post With Ctl Post (Independent T Test)

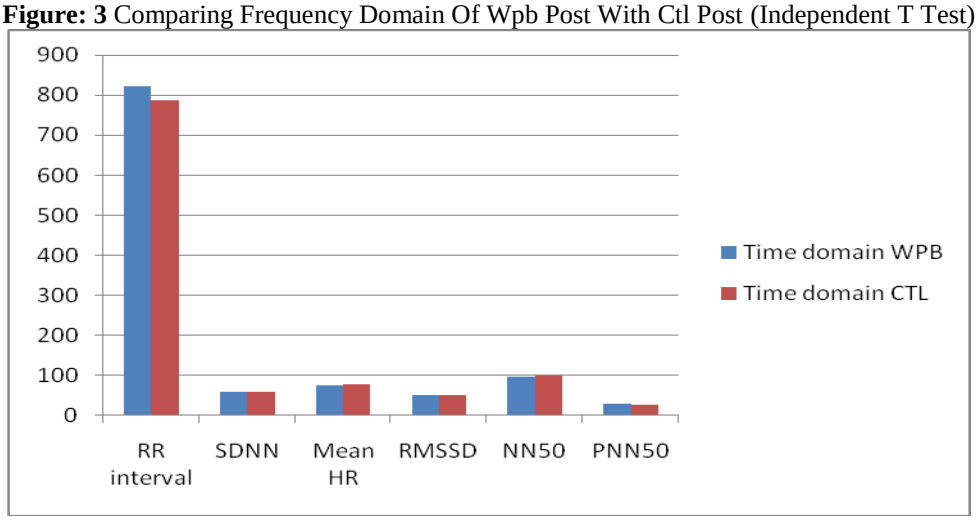

Figure 4 Flow chart of TRIAL PROFILE.

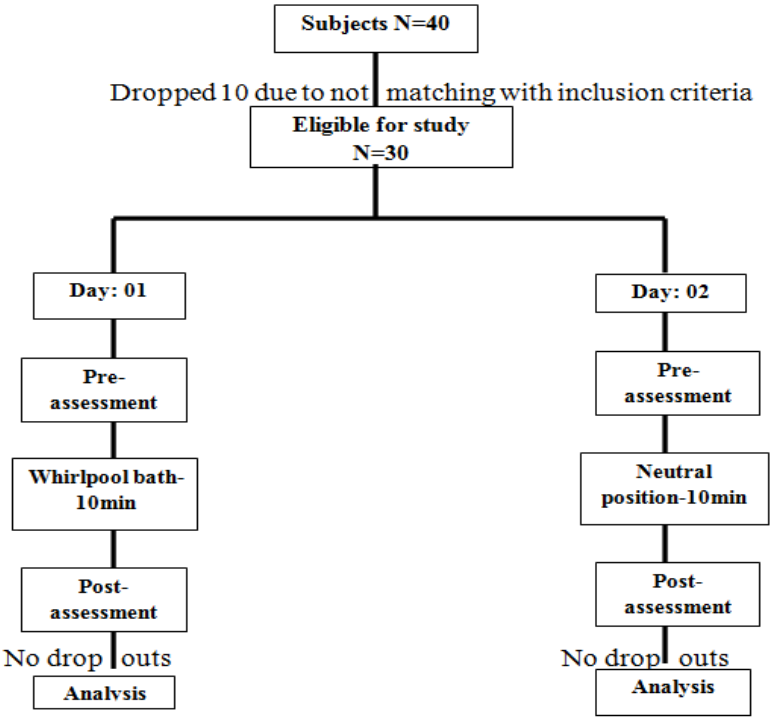

Table 1: Comparing the Changes in Blood Pressure, Pulse Rate and Respiratory variables Heart rate variability's in normal healthy volunteers immediately after WPB and immediately after CONTROL .Values are group mean ± S.D.

Variables	WPB POST MEAN SD	CTL POST MEAN SD	T TEST VALUE	P VALUE
Systolic BP	126.47±8.03	120.13±3.75	11.3397	0.0001*
Diastolic BP	85.00±5.19	80.00±2.46	7.7340	0.0001*
Pulse Rate	96.37±3.63	97.89±1.11	-0.3354	0.7385
Respiratory Rate	15.58±1.53	15.72±1.48	0.2210	0.8258
Temp	33.64±0.83	35.37±0.52	17.4986	0.0001*
RR Interval	821.66±109.63	786.69±100.87	4.7762	0.0001*
SDNN	57.97±19.85	58.14±22.52	-0.4594	0.6477
Mean HR	74.75±10.43	77.93±10.00	5.0299	0.0001*
RMSSD	51.33±22.78	51.21±25.10	2.6774	0.0096*
NN50	97.97±56.36	100.70±61.68	2.0429	0.0456*
PNN50	30.88±21.40	27.92±19.15	2.8935	0.0054*
VLF	36.08±17.63	32.96±14.31	2.6355	0.0108*
LF	51.44±19.34	48.71±18.27	-1.3141	0.1940
HF	48.56±19.34	51.29±18.27	1.3141	0.1940
LF/HF Ratio	1.55±1.48	1.41±1.60	-0.6398	0.5249

applied dependent t test

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