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Regulation of Respiratory Rate, Body Temperature, Pulse Rate and Lung Functions Effect by Neutral Immersion Bath

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ABSTRACT: To assess the effect of Neutral Immersion Bath on circulatory and thermogenic changes. Neutral Immersion Bath (*NIB*) is a hydrotherapeutic procedure involving immersion of an individual in water (*Temp: 92 – 97degree Fahrenheit*) upto manubrium sterni (*head out immersion*) in supine position It is unclear whether this bath has any circulatory or thermic reactions on human body. There are no reported studies of NIB on Respiration Rate (*RR*), Body Temperature (*BT*), Pulse Rate (*PR*), and Peak Expiratory Flow Rate (*PEFR*). This is a prospective longitudinal randomized study. 20 healthy male volunteers (*age range 18 to 35 years*) were randomly selected from the 60 male subjects enrolled for wellness program from the inpatient department of Smt. Jammuna Devi SDM Yoga and Nature Cure Hospital, Ambala. All the 20 subjects were assessed for the following parameters. Respiratory Rate – Close observation of the chest wall and abdominal wall movements; Body Temperature – Infra red ear thermometer (*Braun & Co, UK*); Pulse Rate – palpation method; Peak, Expiratory Flow Rate – standard PEFR apparatus. The above mentioned parameters were recorded before the treatment and 60 minutes thereafter (*during and post treatment*) for every 5 minutes. All the 20 subjects were subjected to 20 minutes of Neutral Immersion Bath at the temperature range of 92 – 97^0 F, where the subject was made to lie in the Immersion Bath tub immersing the body in supine position upto the neck region exposing only the head and maintaining the same surrounding conditions for all the volunteers. Pulse rate was insignificantly varying during the bath (*first 20 mins*), however after the bath it significantly dropped (*P<0.005*) and remained stable at that level. PEFR showed a significant decrease at the 5th minute of immersion compared to the baseline (*P< 0.05*). The results showed that the post treatment effect is sedative as indicated by the reduction thus support the idea that Neutral Immersion Bath does not induce any significant circulatory or thermic reactions in human body. This is a first study to explore into the concept, hence it is desirable to develop more extensive studies on larger samples to understand and apply the same in clinical use.

INTRODUCTION

In another study (Choukroun ML *et al*, 1983) pulmonary capillary blood volume (Qc) was determined for 7 subjects in the standing posture and immersed up to the sterna manubrium at three water temperatures: 34 degrees C +/- 0.5 degrees C, thermally neutral bath; 25 degrees C +/- 0.5 degrees C, cold bath; and 40 degrees C +/- 0.5 degrees C, hot bath. The QC was calculated from the lung transfer factor Delco measured while breathing two gas mixtures (21.1% O_2 and 90.0% O_2) during breath holding. Control experiments in a dry air environment show that QC values for standing posture decrease compared to the sitting values, owing to a redistribution of the intra-thoracic blood volume to lower body parts as a result of gravity. Immersion at 34 degrees C in an upright position produces a significant increase in QC (P less than 0.01). This is a result of the hydrostatic counter pressure: blood shifts from the periphery to the intra-thoracic regions.

Immersion at 25 degrees C increases QC compared to the values obtained at 34 degrees C, but the difference is not significant. The contribution of vasoconstriction to blood volume shift in cold water is probably less important than that of hydrostatic counter pressure. During immersion at 40 degrees C, the rise in QC is very significant (P less than 0.05). This may be explained by an increase in cardiac output and central blood volume when skin temperature is raised at 40 degrees C.

Further to differentiate between the effect of cold and hydrostatic pressure on hormone and cardiovascular functions of man, a group of young men was examined during 1-h head-out immersions in water of different temperatures (32 degrees C, 20 degrees C and 14 degrees C) (Srámek P et al 2000). Immersion in water at 32 degrees C did not change rectal temperature and metabolic rate, but lowered heart rate (by 15%) and systolic and diastolic blood pressures (by 11 %, or 12%, respectively), compared to controls at ambient air temperature. Plasma rennin activity, plasma cortisol and aldosterone concentrations were also lowered (by 46%, 34%, and 17%, respectively), while diuresis was increased by 107%.

Immersion at 20 degrees C induced a similar decrease in plasma renin activity, heart rate and systolic and diastolic blood pressures as immersion at thermo neutrality, in spite of lowered rectal temperature and an increased metabolic rate by 93%. Plasma cortisol concentrations tended to decrease, while plasma aldosterone concentration was unchanged.

Diuresis was increased by 89%. No significant differences in changes in dieresis, plasma rennin activity and aldosterone concentration compared to subjects immersed to 32 degrees C were observed. Cold water immersion (14 degrees C) lowered rectal temperature and increased metabolic rate (by 350%), heart rate and systolic and diastolic blood pressure (by 5%, 7%, and 8%, respectively). Plasma noradrenalin and dopamine concentrations were increased by 530% and by 250% respectively, while dieresis increased by 163% (more than at 32 degrees C). Plasma aldosterone concentrations increased by 23%. Plasma rennin activity was reduced as during immersion in water at the highest temperature. Cortisol concentrations tended to decrease. Plasma adrenaline concentrations remained unchanged. Changes in plasma rennin activity were not related to changes in aldosterone concentrations. Immersion in water of different temperatures did not increase blood concentrations of cortisol. There was no correlation between changes in rectal temperature and changes in hormone production. Our data supported the hypothesis that physiological changes induced by water immersion are mediated by hum oral control mechanisms, while responses induced by cold are mainly due to increased activity of the sympathetic nervous system.

Lung function test performed (Burki NK. 1976 ;) during immersion in water to the neck resulted in a small but significant fall in VC, FEV 1.0/FVC and TLC, and a rise in DLCO, but flow/volume curves and 'closing volume' were unchanged. Peripheral venous occlusion during immersion only significantly increased VC and DLCO; pulmonary compliance and flow/volume curves did not alter significantly. It is concluded that peripheral venous occlusion produces these effects by altering intra-thoracic blood volume. Water immersion reduces TLC, mainly from the hydrostatic pressure, and VC is reduced from both the hydrostatic pressure and the increase in intra-thoracic blood volume consequent on immersion. The increase in DLCO is due, almost entirely, to the increase in intra-thoracic blood volume.

Respiratory gas exchange was investigated (Choukroun & Varene 1990 ;) in human subjects immersed up to the shoulders in water at different temperatures (Tw = 25, 34, and 40 degrees C). Cardiac output (QC) and pulmonary tissue volume (Vti) were measured by a re-breathing technique with the inert gas Freon 22, and O_2 consumption (VO_2) was determined by the closed-circuit technique. Arterial blood gases (PaO_2, $PaCO_2$) were analyzed by a micro-method and alveolar gas (PAO_2) was analyzed during quiet breathing with a mass spectrometer. The findings were as follows. 1) Immersion in a cold bath had no significant effect on Qc compared with the value measured at Tw = 34 degrees C, whereas immersion in a hot bath led to a considerable increase in Qc. Vti was not affected by immersion at any of the temperatures tested. 2)

A large rise in metabolic rate VO_2 was only observed at Tw = 25 degrees C (P less than 0.001). 3) Arterial blood gases were not significantly affected by immersion, whatever the water temperature. 4) O_2 transport during immersion is affected by two main factors: hydrostatic pressure and temperature. Above neutral temperature, O_2 transport is improved because of the marked increase in QC resulting from the combined actions of hydrostatic counter pressure and body heating. Below neutral temperature, O_2 transport is altered; an increase in O_2 extraction of the tissue is even calculated. Although the above discussed studies have examined the effect of NIB on circulatory and respiratory functions there are no studies which has simultaneous looked at heart rate, respiratory rate, body temperature and lung functions before, during and after the NIB in normal male volunteers.

MATERIALS AND METHODS

Twenty male healthy subjects between the age group 18 to 35 years were selected for the study by convenient sampling from Smt.Jammuna Devi Snatan Dharma Mandir (Yoga and Nature Cure Hospital,) Ambala.Each of these subjects undergone a general health check up to rule out any disease or abnormality. A signed informed consent was obtained from each of the subjects involved in the study.

Design: Each of the 20 subjects would undergo a neutral immersion bath under the same environmental conditions. Self remains the control and no separate control would be made. A baseline recording was done before immersion of the individual in water. Following the baseline, recordings were made at every 5^{th} minute till the 80^{th} minute.

These 80 minutes of study comprised 20 minutes of immersion in water and 60 minutes follow up period outside water on an adjacent bed. A signed informed consent was obtained from each of the subjects involved in the study.
Neutral Immersion Bath Baseline

- Followed by readings every five mins till the 80^{th} min
- Each of the subjects would undergo neutral immersion bath for 20 mins followed by an hour of follow up period.

Assessments: Assessments were made throughout the duration of the bath. First a baseline reading of pulse rate, respiratory rate, body temperature and PEFR was taken before the subject entered the bath. Following this reading, the subject was assessed at a regular interval of five minutes.

The parameters assessed were

- **Pulse rate** – Palpatory method, recorded manually at the radial artery.
- **Respiratory Rate –** Close observation of the chest wall and abdominal wall movements.
- **Body temperature** – Infrared ear thermometer (Braun & Co. UK).
- **PEFR –** Peak Flow Meter (Approved by Indian Standards Institute).

Intervention: Each of the individuals was subjected to Neutral Immersion bath (Temp – 35degree Celsius or 95 degree Fahrenheit) for 20 mins. The subjects were immersed in water of the mentioned temperature till their chest (manubrium sterni) for a period of 20 minutes and then the subjects were taken out of the tub, dried by towel and were made to lie down on a bed adjacent to the tub and were followed up for the same parameters being recorded at the same intervals for a period of sixty minutes. Following this the subjects were advised rest for an hour.

Data Extraction: Peak Expiratory Flow Rate was recorded by taking an average of three readings.

Data Analysis: Data analysis was done using Statistical Package for the Social Sciences (SPSS, Version 10.0). Repeated Measures ANOVA was used for analysis. Post- hoc tests for multiple comparisons were performed with Bonferroni adjustment.

RESULTS

Post- hoc tests for multiple comparisons were performed with Bonferroni adjustment. The pulse rate dropped significantly from the baseline till 20^{th} minute of immersion. It showed a further drop after the bath ($P < 0.05$) and remained stable till the 80^{th} minute. PEFR showed a significant drop at the 5^{th} minute of immersion compared to the baseline ($P < 0.05$), which further gradually raised till the 15^{th} min of immersion and further dropped down. The further drop in PEFR is not significant. Body Temperature and Respiration rate did not show any significant changes.

DISCUSSION

The present study on NIB before, during and after NIB showed the sustained decrease in pulse rate and PEFR during the NIB. The body temperature and respiratory rate showed no changes when compared to pre. Rate from the 20^{th} minute till the 80^{th} minute. This reduction can be attributed to the in consistent with the earlier studies (Sramek P et al2000,Burki NK. 1976 ;) this study shows the consistent reduction in the pulse thermo-regulatory effect triggered by the changes in surface temperature. This reduction endorses the autonomic relaxation induction by the neutral immersion. This effect has a specific therapeutic value in hypertension, cardiac diseases and anxiety disorders.
The reduction in the PEFR shows that there is a certain compromise in the respiratory function i.e., half way through the treatment. This can be explained through the thermogenic stress induced by the cold where the mild compensation in respiration is seen to overcome the thermogenic stress.
Although the present results are encouraging the results are of a limited value as the recording methods were qualitative. Further more rigorous studies on a larger sample with objective variables are needed to understand the physiology of NIB.

REFERENCES

Kellogg, JH. *Rational Hydrotherapy*; Part III; Tech: The Neutral bath. Michigan: Battle Creek, 1903.

Smith, D.E., Kaye, A.D., Mubarak, S.K., Kusnick, B.A., Anwar, M., Friedman, I.M., Nossaman, B.D. Cardiac Effects of Water Immersion in Healthy Volunteers. *Echocardiography* 1998; **15**(1): 35-42.

Choukroun, M.L., Guenard, H., Varene, P. Pulmonary capillary blood volume during immersion in water at different temperatures. *Undersea Biomed Res.* 1983; **10**(4): 331-42.

Srámek, P., Simecková, M., Janský, L., Savlíková, J., Vybíral S. Human physiological responses to immersion into water of different temperatures. *Eur J Appl Physiol.* 2000; **81**(5): 436-42.

Burki, N.K. Effects of immersion in water and changes in intrathoracic blood volume on lung function in man. *Clin Sci Mol Med.* 1976; **51**(3): 303-11.

Choukroun, M.L., Varene P. Adjustments in oxygen transport during head-out immersion in water at different temperatures. *J Appl Physiol.* 1990; **68**(4): 1475-80.