

Effects of Partial Immersion Bath on the Physiological Parameters of Elderly Men

K. Rhee, W. W. Jeong., and K. J. Chun

Abstract— Regulatory response of cardiovascular and nervous system is changed by aging, and the changes of hemodynamic parameters produced by bathing in hot water would be different for the elderly and healthy young persons. The purpose of this study is to investigate the changes of cardiovascular parameters during partial immersion bath for young and elderly men. Blood pressure, heart rate, internal body temperature and peripheral blood volume were measured before, during and after 3/4 and knee immersion bath. Blood pressure was decreased during immersion bath while heart rate, body temperature and peripheral blood volume were increased. The changes were more significant in the young men group compared to the elderly men group. Recovery of physiological parameters back to the baseline values after immersion bath was also faster in the young men group. The changes of measured parameters during knee immersion bath were negligible in the elder men group.

I. INTRODUCTION

HYDROTHERAPEUTIC effects of bathing, which is achieved by heat and hydrostatic pressure, includes increasing perspiration and metabolism, alleviating muscle tension, fever and pain, and emotional suppression [1]. Various studies on the physiological effects of immersion bath, which include body temperature, blood pressure, intraocular pressure, regulation of autonomic nerve system and sleep, have been performed [2,3]. Approximately 10% of the cases of sudden death occurred during bath, and about 10% were from drowning followed by cardiovascular disease in Japan [4]. Regulatory response of cardiovascular and nervous system is changed by aging, and the changes of physiological parameters during immersion bath would be affected by the bath temperature and immersion body part [5,6,7]. We would like to investigate the changes of cardiovascular parameters—blood pressure, heart rate, internal body temperature and peripheral blood volume—during partial immersion bath for young and elderly men.

II. METHODS

The study subjects were 7 elderly men (mean age 75.0 years) and 9 young men (mean age 26.6 years). Immersion body level was up to knees (knee immersion) and upper thoracic ribs (3/4 immersion). The bathroom temperature

was kept above 24°C. During knee immersion bath, upper body was covered with a blanket. After a rest of more than 15 min, the subjects were immersed in hot water (temperature 42°C and 44°C), and rested for 15 min (young men) and 10 min (elderly men) in the seated position. Changes in blood pressure and heart rate were monitored with an automatic digital sphygmomanometer (Model T4, OMRON Co, Japan). Prior to the experiment, the reliability of the automatic digital sphygmomanometer was confirmed by correlating measured blood pressure with blood pressure measured with a mercury-based sphygmomanometer. Internal body temperature was measured at the ear drum by a thermometer (Net-100, Hubydic Co, Korea). Peripheral blood volume was measured at the finger tip by the photoplethysmography (PPG) system developed in our laboratory. The output voltage signal in PPG showed a good positive correlation to the blood volume in the finger tip.

III. RESULTS

Systolic and diastolic blood pressure (Psys and Pdia, respectively) before, during and after immersion bath are shown in Fig. 1. Blood pressures were decreased during 3/4 immersion bath (temperature 42°C) and increased to the baseline (prior to immersion) value in 10 min after completion of immersion bath. Diastolic pressure which affected the mean blood pressure significantly, varied more compared to the systolic pressure. Blood pressure changes were more significant in the young men group comparing to the elderly men group. Blood pressure changes in 3/4 immersion bath at 44°C were more significant in the elderly men group compared to those at 42°C. Blood pressure recovery to the baseline was very slow for the elderly men group. During knee immersion bath, blood pressure changes were similar for the young men group, but negligible changes were observed in the elderly men group.

Heart rate (HR) was measured before, during and after immersion bath (Fig. 2). Heart rate increased during 3/4 immersion bath and decreased to the baseline at 42°C in the young men group, but heart rate changes were negligible in the elderly men group. During 3/4 immersion bath at 44°C, heart rate changes in the elderly men group were similar to those in the young men group, but the changes were less significant.

Internal body temperature before, during and after immersion bath are shown in Fig. 3. Body temperature increased during 3/4 immersion bath at 42°C in the young men group. It was decreased but maintained higher than the baseline value after the completion of immersion bath in the young men group, but body temperature changes were less significant in the elderly men group at 42°C and 44°C.

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Peripheral blood volume (BV) was measured using a PPG system, and output voltage of PPG positively correlated to the blood volume. Peripheral blood volume increased during 3/4 immersion bath at 42°C in the young men group, but peripheral blood volume changes were negligible in the elderly men group at 42°C. Some increase of peripheral blood volume was observed in the elderly men group at 44°C, but it was not significant. Increased peripheral blood volume was maintained in 10 min after completion of immersion bath (Fig. 4).

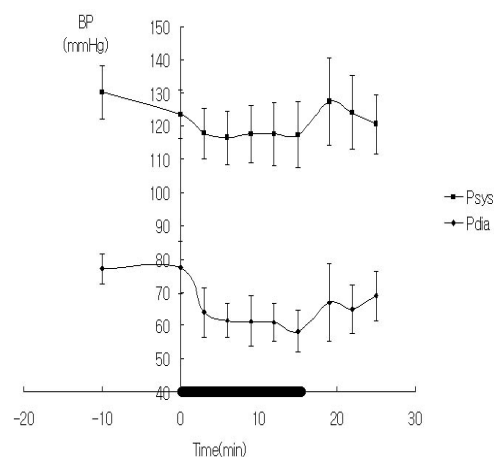
The changes of blood pressure, heart rate, internal body temperature and peripheral blood flow during knee immersion bath at 44°C were similar to those during 3/4 immersion bath, but in less extent in the young men group. No significant changes of physiological parameters were observed in the elderly men group during knee immersion bath.

IV. CONCLUSION

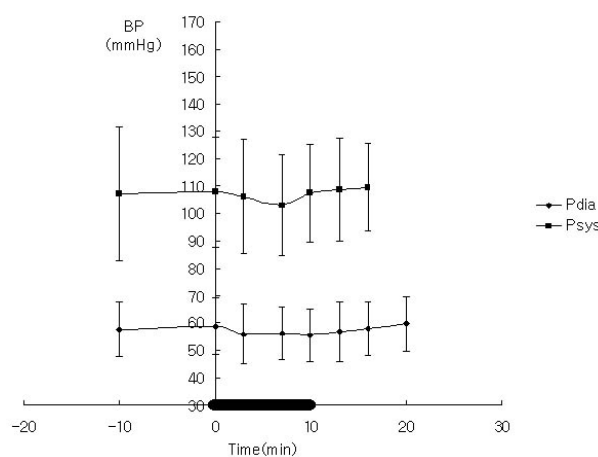
Blood pressure was decreased during immersion bath while heart rate, body temperature and peripheral blood volume were increased. The changes were more significant in the young men group compared to the elderly group. All the physiological parameters recovered their baseline (prior to immersion) values after immersion bath, and recovery of physiological parameters back to the baseline values after immersion was faster in the young men group. The changes of physiological parameters during knee immersion bath at 44°C showed similar trends to those during 3/4 immersion bath, but in less extent in the young men group. But the changes of measured parameters during knee immersion bath were negligible in the elderly men group. The present study implies that it is difficult for the elderly to maintain homeostasis during hot immersion bath, which would be caused by decreased response of autonomic nervous system to the heat stress.

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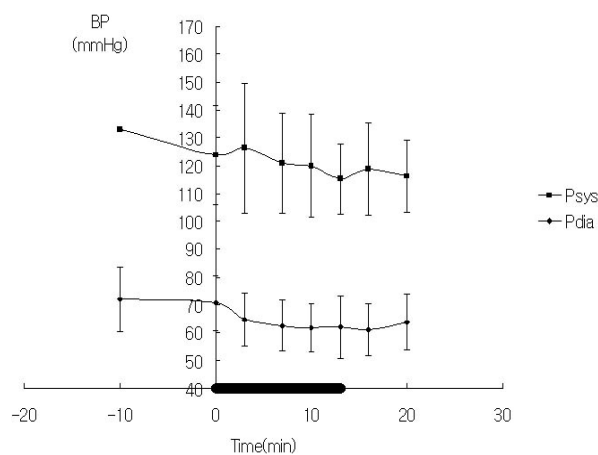
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(a) 3/4 immersion bath at 42°C (young group)

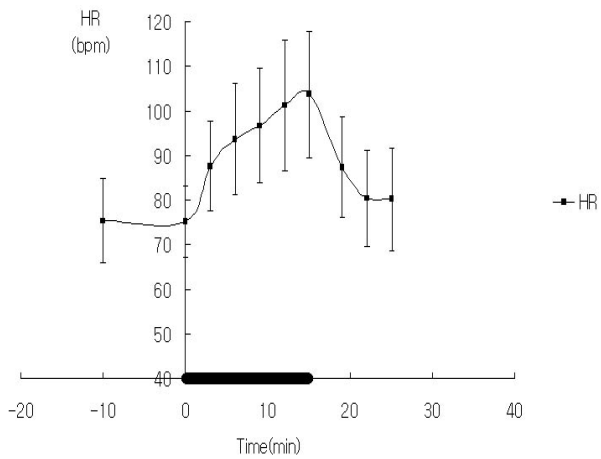


(b) 3/4 immersion bath at 42°C (elderly group)

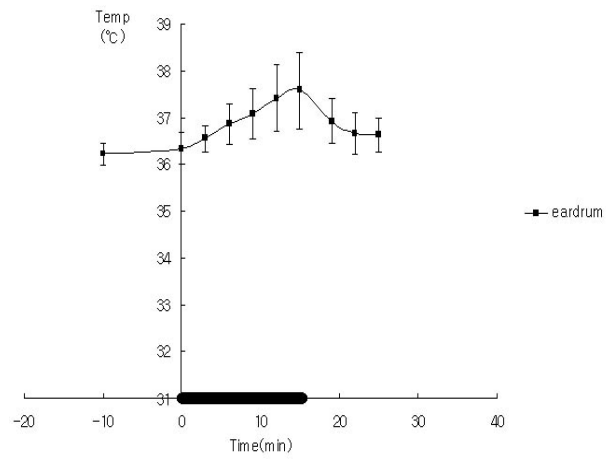


(c) 3/4 immersion bath at 44°C (elderly group)

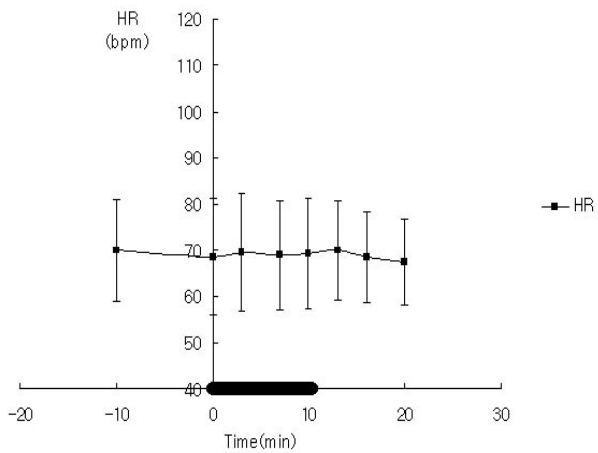
Fig. 1. Blood pressure (BP) changes before, during and after bath (Psys: systolic pressure, Pdia: diastolic pressure). Thick bar on the abscissa implies hot bath immersion. Horizontal bars on the data show standard deviations. Blood pressure decreases during bath, and maintained lower values after the bath for the young and elderly men groups. Blood pressure variation is more significant in the young men group.



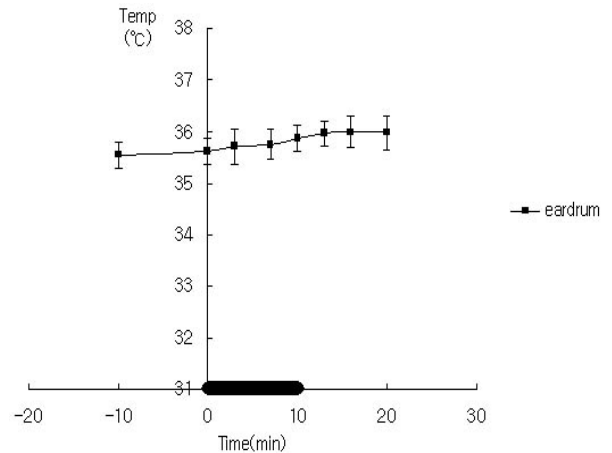
(a) 3/4 immersion bath at 42°C (young group)



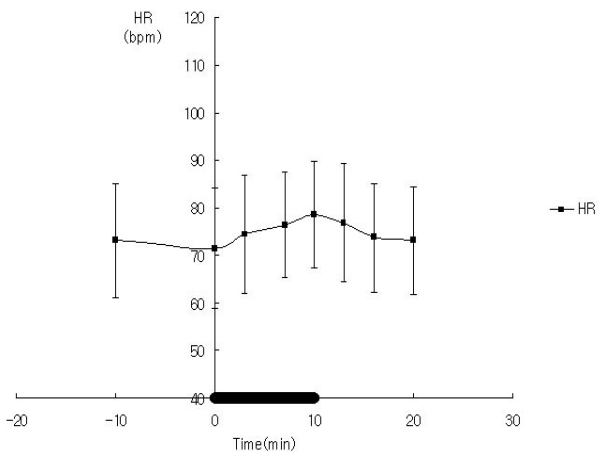
(a) 3/4 immersion bath at 42°C (young group)



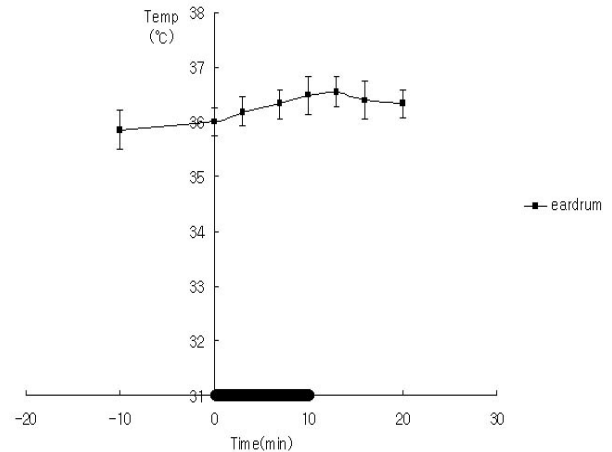
(b) 3/4 immersion bath at 42°C (elderly group)



(b) 3/4 immersion bath at 42°C (elderly group)



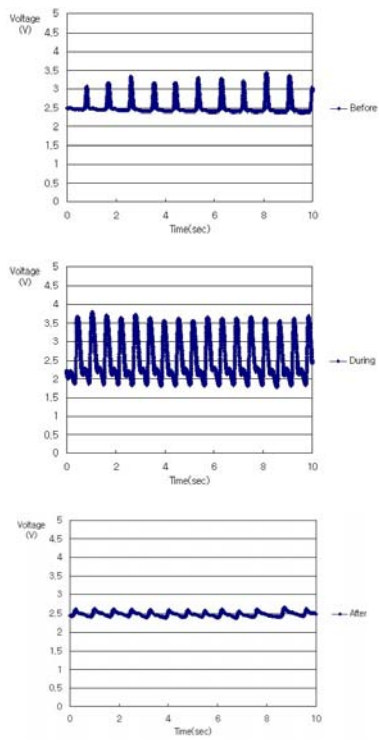
(c) 3/4 immersion bath at 44°C (elderly group)



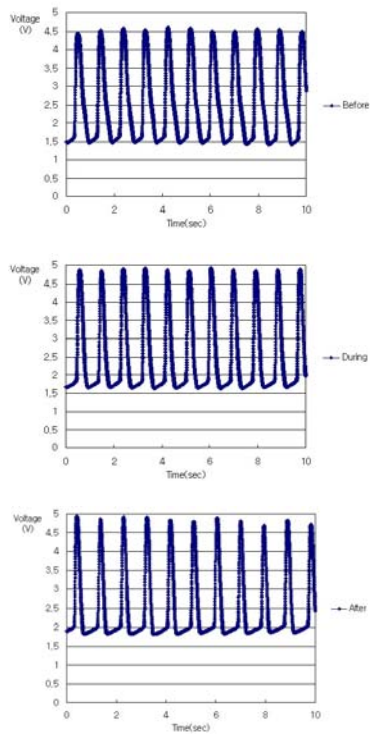
(c) 3/4 immersion bath at 44°C (elderly group)

Fig. 2. Heart rate (HR) changes before, during and after bath. Thick bar on the abscissa implies hot bath immersion. Horizontal bars on the data show standard deviations. Heart rate increases during bath, and decreases to the baseline value (before bath) after the bath for the young and elderly men groups. Heart rate variation is more significant in the young men group.

Fig. 3. Body (ear drum) temperature changes before, during and after bath. Thick bar on the abscissa implies hot bath immersion. Horizontal bars on the data show standard deviations. Body temperature increases during bath, and decreases after bath for the young and elderly men groups. But body temperature maintains higher than the baseline value (before bath) after the bath. Body temperature variation is more significant in the young men group.



(a) 3/4 immersion bath at 42°C (young group)



(b) 3/4 immersion bath at 44°C (elderly group)

Fig. 4. Peripheral blood volume (BV) changes before, during and after (10 min) bath. BV increases during bath, and decreases after the bath for the young men groups. BV variation is not significant in the elderly men group.