Comparative Analysis of Clinical and Biochemical Profile of Exertional Heat Related Illness Among Cadets in a Military Training Centre in South India: A Single Centre Experience

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Abstract

Background: Heat-related illnesses includes a range of manifestation starting from minor illness like heat rashes/heat cramps to more complicated illness like heat exhaustion and the most severe heat stroke. Often derangements in biochemical parameters including metabolic acidosis, respiratory alkalosis, electrolytes, transaminitis and renal dysfunction are noticed in patients with heat stroke. Objective: The present study was an attempt to compare the clinical and changes in biochemical parameters in exertional heat exhaustion and heat stroke patients among cadets from a military training centre admitted to an Armed forces hospital in South India.

Material and Methods: The present study was carried out as a cross sectional comparative study among patients with heat exhaustion (n=30) and heat stroke (n=30) in a tertiary level Armed forces hospital located in Chennai. Simple random sampling technique was used to select study participants. Clinical and biochemical parameters of the study participants were examined. Statistical analysis: Means and proportions were calculated for continuous and categorical variables respectively. Difference in proportions were tested using chi square test and a p value <0.05 was considered statistically significant.

Results: On examination most the patients had tachycardia, blood pressure and respiratory rate in normal ranges. Most of the patients were found having elevated liver enzymes (>90%). Hyponatremia was the most common electrolyte abnormality. Other abnormal biochemical parameters noted were hypokalemia and deranged renal parameters. Higher proportion of patients with heat stroke were found to have tachycardia, transaminitis and abnormal electrolyte and biochemical parameters as compared to those with heat exhaustion.

Conclusion: Tachycardia, transaminitis and hyponatremia was widely observed in patients with heat related illness and these changes occur at higher rates in patients in heat stroke as compared to heat exhaustion.

Introduction

Heat stress, a condition that results from the effects of various factors involving environment, metabolic rate, and clothing.¹Heat-related illnesses includes a range of manifestation starting from minor illness like heat rashes/heat cramps to more complicated illness like heat exhaustion and the most severe heat stroke.² Heat stroke is manifests by neuropsychiatric impairment and a high core body temperature usually more than 40.5°C (105°F).³ Heat stroke occurs when the thermoregulatory system becomes compromised due to excessive heat production (ie, metabolic heat production from the working muscles) or inhibited heat loss (ie, decreased sweating response, decreased ability to evaporate sweat) or both. The temperature in India is projected to increase continuously in the next decades and by the end of this century globally mean temperatures are forecasted to increase by 5.5°C.³ Future climate change is expected to cause substantial increases in heat-related mortality.³ Historically in the Armed Forces, ‘Exertional Heat Hyperpyrexia’, was described in the past as ‘Classic Fatigue Syndrome’ by the British troops from the days of the Crimean War and Indian Mutiny.⁷ Although this illness is presumably occurs in hot and humid weather, it can present itself with extreme physical exertion in the absence of extreme environmental conditions also. The first sign of heat stroke is often CNS dysfunction (eg, collapse, aggressiveness, irritability, confusion, seizures, altered consciousness)⁴ and can even progress to a systemic inflammatory response and multi-organ system failure unless early diagnosis and management is ensured. The risks of morbidity and mortality increases with increasing time for which an individual’s body temperature remains above the threshold (>40.5°C [105°F]) and are significantly reduced if body temperature is lowered.⁴ Often derangements in biochemical parameters including metabolic acidosis, respiratory alkalosis, electrolytes, transaminitis and kidney dysfunction are noticed in patients with heat stroke.⁹¹⁰ There are very few studies comparing the biochemical parameters in patients with exertional heat exhaustion and heat stroke. The present study was an attempt to compare the changes in biochemical parameters in exertional heat exhaustion and heat stroke among the cadets from a military training centre admitted to an Armed forces hospital in South India.

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Material and Methods

The present study was carried out as a cross-sectional comparative study among the cadets admitted to Armed forces hospital with features suggestive of heat stroke and heat exhaustion. Operational definition of heat stroke in the present study was central nervous system dysfunction and extreme hyperthermia (more than 40.5°C), after exertion and exposure to environmental heat and the definition of heat exhaustion considered was elevated core temperature (less than 40.5°C) without any CNS dysfunction after exertion and exposure to heat.

The study was undertaken in a tertiary level Armed Forces hospital located in Chennai during the period from March 2018 to June in 2019. The temperature and humidity levels of this region during the study period varies from 34.3 to 36.9°C and 62 to 70% respectively. Simple random sampling technique was used to select study participants from all the patients admitted to this hospital. The minimum required sample size was calculated to be 30 in each group using the software epi-info. After the onset of symptoms, the patients were taken to the emergency resuscitation room and vitals were recorded by a medical officer, after emergency resuscitation measures, they were immediately transferred to ICU.

Appropriate history from the medical assistant who provided medical cover to the training event, was obtained and physical examination was carried out simultaneously. Patients were given active cooling measures, fluid resuscitation, electrolyte replacement and other supportive measures. Biochemical parameters including electrolytes, liver enzymes, renal function parameters, haemogram and INR were evaluated for all the study patients in the same lab using the same equipment throughout the study period. Institute ethical committee approval was obtained before the study was begun and informed written consent was obtained from all the patients before including them in the study. Statistical analysis: Data entry was done using MS Excel 2013 and data analysis was performed using SPSS version 22.0. Means and proportions were calculated for continuous and categorical variables respectively. Difference in proportions were tested using chi square test and a p value <0.05 was considered statistically significant.

**Results**

On examination most the patients had tachycardia, blood pressure and respiratory rate in normal ranges. Anaemia was observed in 58% of the patients. Most of the patients were found having transaminitis (>90%). Hyponatremia was the most common electrolyte abnormality that is observed.
in 75% of the patients. Other biochemical parameter disturbances noted were hypokalemia (20%), elevated blood urea nitrogen (75%), elevated serum creatinine (45%), elevated serum uric acid (40%) and elevated INR (43.3%) (Table 1).

Higher proportion of patients with heat stroke were found to have transaminitis and abnormal electrolyte/biochemical parameters as compared to those with heat exhaustion. Also, this association was found to be statistically significant (p value <0.05). Leukocytosis and INR was also found to be significantly high among patients with heat stroke as compared to that of heat exhaustion group of patients (p value <0.05) (Table 2).

Discussion

Heatstroke is the most severe form of heat-related disorders that include mild heat intolerance, heat exhaustion and heat stress. The present study was an attempt to compare the changes in biochemical parameters in exertional heat exhaustion and heat stroke among cadets in military training centre, admitted to an Armed forces hospital in South India. Even after extensive literature search, it was noted that available published material on comparative analysis of biochemical profile for patients with exertional heat related illnesses among young cadets are minimal. Some of the important known biochemical changes observed in patients with heatstroke are elevated urea, creatinine, cardiac and skeletal muscle enzymes, myoglobin and troponin. Elevated liver enzymes, renal parameters, derangements in serum electrolytes were noted in a study among 78 patients with exertion heat stroke in Agra, North India.9 These abnormalities were commonly noted in the present study participants also.

In a study among 106 miners it was observed that Urea and creatinine were significantly increased patients with heat cramps as compared to those without (p<0.001). However, the study did not report any significant difference in serum sodium levels (p=0.384).11 Comparable to the above study results the present study also noted that statistically significant higher urea and creatinine values were noted among patients with severe heat related illness, whereas serum sodium levels did not differ significantly. An ecological study in Australia, correlated increased hospital admissions due to renal disease and acute renal failure during heat wave periods,12 this indirectly confers with the out study observation of renal parameter abnormalities in patients with heat illnesses. The miners study reported a significant increase in liver enzymes among the patients with heat cramps,13 which is similar to the present study a significant proportion of patients with heat related illness had raised liver enzymes, however, no significant association was observed between elevated liver enzymes and the severity of the disease. The abnormalities in liver enzyme levels could be explained by activation of inflammasome in the liver (high-mobility group box 1 (HMGB1) dependent) which is exhibited by byraised capase-1 activity, followed by IL-1β activation and hepatocyte pyroptosis.13 A significant increase in all liver enzymes was demonstrated in unacclimatized as compared to acclimatized patients who reported with exertional heat stress.14 These findings further strengthen the results of the present study. In a retrospective cohort study among 66 patients with heat stress carried out between 2003 and 2014, the common electrolyte disturbances were hypokalemia (71.2 %), hypophosphatemia (59.1 %), hypernatremia (53.0 %), hypercalcemia (51.5 %), and hypomagnesemia (34.9 %).15 The observed proportions in the above study were in comparable ranges with that of the findings noted in the present study. Absence of control group to clearly delineate the heat stroke illness patients with abnormal biochemical profile remained one of the important limitation of the present study. The study population mainly comprised of young cadets who are healthy with out any co morbidities, as compared to that of general population, thereby limiting the generalization of the present study findings. However, it is also assumed that biochemical variations noted in such healthy subjects will also be expected, in similar proportions or higher, in other subjects with different demography considering the pathophysiology of the disease.

Conclusion

This study is unique in the sense that only very few studies mentioned in literature comparing the effects of heat exhaustion and heat stroke particularly among exertional heat related illness which are different from effects of classical non exertional heat stroke in the elderly. Tachycardia, transaminis and hyponatremia was widely observed in patients with heat related illness and these changes occur at higher rates in patients in heat stroke as compared to heat exhaustion. These abnormalities should be suspected and corrected in all patients with heat related illnesses. Prompt identification of patients with heat exhaustion and immediate resuscitation including cooling measures, intravenous fluids and correction of electrolyte abnormalities are required to prevent further progression to devastating heat stroke.

References