CASE REPORT

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Acute Complication After Heat Stroke in a Half Marathon Healthy Participant: Literature Review

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ABSTRACT Heat stroke is a set of symptoms that include a severe rise of body temperature that is usually but not always higher than 40ºC. Clinically, it is characterized by central nervous system dysfunction such as ataxia, delirium or cramps, in conditions of exposure to hot weather or strenuous physical exertion. We presented a 46-year-old male athlete who collapsed during a half marathon after running 20 km and 640 m in 2 hours and 2 minutes. He was brought to the clinic in an unconscious state febrile 38.6ºC with fasciculations, convulsions, hypotensive, tachycardic. During hospitalization with rhabdomyolysis and hypoxic hepatitis. It is crucial to recognize the clinical symptoms and signs in the acute phase of heat stroke and in areas with temperate continental climate, to begin timely treatment, to reduce mortality. Complications of heat stroke need to be diagnosed, appropriate treatment provided, to improve the prognosis of these conditions.

Keywords: Heat stroke; half marathon; rhabdomyolysis; hypoxic hepatitis

Heat stroke is the most dangerous condition of diseases that progress from heat exhaustion, heat injury to heat stroke, in which the common finding is hyperthermia. Hyperthermia is associated with decreased cerebral blood flow, which may lead to presyncope signs or central nervous system (CNS) abnormalities.[1] Heat stroke is a set of symptoms that include a severe rise of body temperature that is usually but not always higher than 40℃. Clinically, it is characterized by CNS dysfunction such as ataxia, delirium or cramps, in conditions of exposure to hot weather or strenuous physical exertion.[2] There are 2 forms of heat stroke, classic and heat stroke on exertion. Classic heat stroke usually affects the elderly with chronic medical conditions, while heat stroke on exertion occurs in healthy individuals who exercise hard in hot or humid weather.[3]

The purpose of this paper was to analyze a case of heat stroke during a half marathon.

CASE REPORT

A 46-year-old male patient athlete during a half marathon after running 20 kilometer and 640 meters in 2 hours and 2 minutes, felt that he would collapse about 450 meters before the end of the race and sat down. His next memory is waking up after 5 hours in the intensive care unit at University Clinic of Toxicology. During ambulance transport with convulsive activity, for which it has been applied 3 times diazepam injection. Brought to the clinic in an unconscious state, febrile 38.6ºC, with fasciculation, convulsions, hypotensive 90/70 mmHg, tachycardia 170 beats per min, tachypnea, with a Glasgow coma score of 8. Cooling treatment was started.

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Figure 1 shows cadence and heart rate, and Figure 2 shows pace and the patient's heart rate during the race. Computed tomography of the brain was made with an orderly finding. Laboratory analysis have shown increased values of creatine kinase (CK), myoglobin, lactate dehydrogenase (LDH), high sensitive troponin I (hs-TnI), and pigmented urine in addition to rhabdomyolysis, with the maximum value creatine phosphokinase during hospitalization up to 86,301 U/L (Table 1). Timely aggressive fluid support was started. The second day with elevated aminotransferase levels, which reach a maximum on the fourth day, aspartate aminotransferase (AST) 2,059 U/L and alanine aminotransferase (ALT) 1,189 U/L and diarrhea in addition to hypoxic hepatitis and intestinal ischemia. Hepatic viral markers were negative and the patient denied the use of medication. In that direction, an ultrasound Doppler of the abdomen was performed: The liver, gallbladder, biliary trunk, pancreas, spleen and kidneys were with normal finding. Hepatic veins, portal vein as well as inferior vena cava are Doppler passable. The patient was placed on N-acetylcysteine 600 milligram three times daily. Our patient had elevated D-dimer values as a result of heat stroke and its complications, for which he was placed on low molecular weight heparin 1 mg/kg divided in two doses.

Due to thrombocytopenia, a peripheral smear was made and on 2 occasions hemostasis with an orderly finding. Thrombocytopenia was likely related to athletic stress.

The patient left the clinic on the ninth day of hospitalization in improved general condition. Performed control examination after 7 days with serum values of white blood cell 8.1, AST 81 U/L, ALT 145 U/L, CK 421, myoglobin 47.3, and D-dimers were 862 ng/mL for which he was prescribed an acetylsalicylic acid 100 milligram. The antibodies assigned to autoimmune hepatitis were negative.

This case is presented with previous patient consent receipt information.

DISCUSSION

Heat stroke during exertion can occur in the first 60 minutes during exertion and can be activated without exposure to high ambient temperatures.[4] In our presented patient, the heat stroke occurred after 2 hours and 2 minutes from the beginning of the run, with an air humidity of 84% and an outside temperature of 24-29ºC. There is a general consensus that a running cadence should be between the range of 160-180 steps per minute, however, we know that this will vary depending on speed, height, level of experience and distance.[5] On admission in an unconscious state with pronounced convulsive activity as a result of CNS dysfunction which is one of the clinical manifestations of heat stroke.

Complications of heat stroke include acute respiratory distress syndrome, disseminated intravascular coagulation, acute renal impairment, hepatic injury, hypoglycemia, rhabdomyolysis, and cramps.[6] According to a group of authors, biochemical findings may reveal coagulopathy, azotemia, elevated liver enzymes, elevated muscle enzymes, and leukocytosis.[7] Biochemical findings on admission in our patient in addition to rhabdomyolysis with increased values of CK, myoglobin, LDH, hs-TnI, and leukocytosis. The characteristic triad of symptoms, muscle pain, weakness, and pigmented urine was also present.

FIGURE 1: Cadence and heart rate.

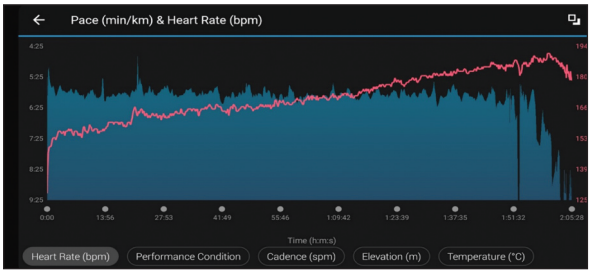

FIGURE 2: Pace and heart rate.

TABLE 1: Biochemical findings during hospitalization.

	During admission	2 day	4 day	5 day	7 day	8 day	9 day
CK (s) (24-173 U/L)	1,603	Immeasurable	86,301	73,715	32,511	10,285.4	3,455
CK-MB (s) <25 U/L	511	/	569	464	173.1	86.3	50
LDH (s) <248 U/L	551	/	2,216	1,835	579.56	/	302
AST (s) 10-34 U/L	54	683	2,059	1,938	1,264.94	/	231
ALT (s) 10-45 U/L	26	228	1,189	1,159	1,264.94	/	571
AP (s) 38-126 U/L	/	/	85	85	94	/	84
GGT (s) 9-64 U/L	/	25	40	72	94	/	74
Urea (s) (2.7-7.8 mmol/L)	7.5	13	6.6	7.6	8.42	/	6.3
Creatinine (s) (45-109 umol/L)	225	150	79	78	82.64	/	72
Myoglobin (s) (<75.0 ng/mL)	/	¬ 1,000	760	861	1,013.18	991.14	1,623.51
Na (s) (137-145 mmol/L)	145	139	137	137	137	/	142
Ca (s) (2.1-2.6 mmol/L)	2.6	1.8	2.2	2.18	2.28	/	2.2
K (s) (3.8-5.5 mmol/L)	5.9	3.6	4.6	4.3	4.33	/	4.6
Glycaemia (3.5-6.1 mmo/L)	5.9	5.8	5.9	5.8	5.91	/	5.1
hs-Troponin I (s) female <15.6 male <34.2 ng/L	66	1,329	75			12.21	/
WBC 4.0-10 (×109/L)	15.9	13	16.3	17.8	16.5	/	10.9
Er 4.2-5.5 (×1,012/L)	5.8	5.2	5.1	4.9		/	4.89
Hb female 120-160 male 140-180 g/L	175	159	158	148	156	/	154
Hct 0.37-0.54%	0.49	0.44	0.43	0.41	0.43	/	0.43
PLT 10 na 3/uL	221	38	71	90	176	/	224
CRP (s) (<6 mg/L)	1.5	8	9	/	7.06	/	30.5
Total bil/dir/ind 6.8-20.5/1.5-6.8/5.1-13.6 µmol/L	/	/	33/14/18	35/17/20	21.2/10.4/9.8	/	9.6/5.0/4.6
Total prot/alb/glob 63-83/35-50/27-35 g/L	/	/	61/40/21	59/39/20	/	/	64/38/26
Urine finding with sediment	pH 5.0 blood+++	/	pH 5.0 blood+++	/	/	/	/
D-dimer (<500 ng/mL)	/	4,464	2,862	/	/	/	

CK: Creatine kinase; CK-MB: Creatine kinase-MB; LDH: Lactate dehydrogenase; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; AP (pNPP): Alkaline phosphatase; GGT: Gamma-glutamyl transferase; Na: Sodium; Ca: Calcium; K: Potassium; hs-Troponin I: High sensitive troponin I; WBC: White blood cell; Er: Red blood cell; Hb: Hemoglobin; Hct: Hematocrit; PLT: Platelets; CRP: C-reactive protein; Total bil/dir/ind: Total bilirubin/direct/indirect; Total prot/alb/glob: Total protein/albumun/globulin.

The second day of hospitalization with elevated serum AST, ALT, LDH, thrombocytopenia, and diarrhea suspected of hypoxic hepatitis and intestinal ischemia. The pathophysiology of liver injury in healthy young athletes includes hypoxia/relative tissue ischemia secondary to decreased splanchnic flow, increased free radical production, oxidative stress, and exertion-induced mitochondrial dysfunction.[8] All of these factors lead to hepatocyte damage and lysis more or less pronounced depending on the nature and duration of the effort, which in extreme cases can lead to liver shock or classic "hypoxic hepatitis".[9]

Henrion et al. proposed criteria for diagnosing hypoxic hepatitis: (a) clinical conditions of heart, circulatory or respiratory failure; (b) a significant but temporary increase in serum aminotransferase activity; and (c) exclusion of other alleged causes of hepatitis, namely viral hepatitis or drug-induced liver injury.[10] For the diagnosis of hypoxic hepatitis according to Henrion et al., serum aminotransferase values should be 20 times above the upper reference value, while a group of authors uses lower cross-sectional values, 2.5 to 10 times above the upper reference value.[10,11] When the criteria are met, a diagnosis of hypoxic hepatitis can be made without performing a liver biopsy, but a biopsy can provide a definitive diagnosis.[12] Similar experiences for a young, healthy athlete with hypoxic hepatitis and rhabdomyolysis as a result of heat stroke during a marathon are reported by Azzopardi et al.[13] In his presentation of the case,

Khan et al. report a 48-year-old healthy, young athlete with heat stroke and the development of hypoxic hepatitis, confirmed by liver biopsy.[14] The heat stroke-induced reduction in intestinal blood flow causes gastrointestinal ischemia, adversely affecting cell viability and cell-wall permeability. The resulting oxidative and nitrosative stress damages cell membranes and opens tight cell-to-cell junctions, allowing endotoxins and possibly pathogens to leak into the systemic circulation, overwhelming the detoxifying capacity of the liver and resulting in endotoxemia.[15]

Recognition of clinical symptoms and signs in the acute phase of heat stroke and in areas with temperate continental climates is crucial to initiate timely treatment, to reduce mortality. Hypoxic hepatitis and rhabdomyolysis are complications of heat stroke that need to be diagnosed and appropriate treatment provided in order to improve the prognosis of these conditions.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Aleksandra Babulovska;* ***Design:*** *Aleksandra Babulovska;* ***Control/Supervision:*** *Aleksandra Babulovska, Natasha Simonovska;* ***Data Collection and/or Processing:*** *Aleksandra Babulovska, Zanina Perevska;* ***Analysis and/or Interpretation:*** *Kristin Kostadinovski;* ***Literature Review:*** *Kiril Naumoski;* ***Writing the Article:*** *Aleksandra Babulovska;* ***Critical Review:*** *Natasha Simonovska;* ***References and Fundings:*** *Zanina Perevska;* ***Materials:*** *Kristin Kostadinovski.*

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