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Original Research

Core and Surface Temperature Modification During Road Transport and Physical Exercise in Horse After Acupuncture Needle Stimulation

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ABSTRACT

In this study, the effect of acupuncture on skin temperature (T_{SKIN}), including six body regions (neck, shoulder, ribs, flank, internal thigh, and back), rectal temperature (T_{RECTAL}), serum levels of total proteins, hematocrit, magnesium, calcium (Ca), phosphorus, and chloride was evaluated in five Thoroughbred horses. Horses competed in two official races. For each race, animals were transported from their stables to the racetrack. Horses transported and competed in the first race represent the control group. Two weeks later, the same horses competed in the second race. Before road transport, they were treated with acupuncture. From animals, the T_{SKIN}, T_{RECTAL}, and blood samples were collected at rest; after unloaded, 30 minutes after unloaded, at rest in the transit box, at the end of the race, and 30 minutes after the race. A significant effect of transport and exercise was found on all studied parameters ($P < .01$), except for Ca and T_{SKIN} of neck ($P > .05$), in both groups. Transported and exercised horses subjected to acupuncture treatment showed statistically significant higher values of T_{RECTAL} and T_{SKIN} of flank ($P < .01$). Thoroughbred horses display a classic hemodynamic response to transport and exercise; acupuncture affects body temperature and skin temperature of flank region in both transported and exercised horses suggesting a controlling effect of acupuncture on thermoregulatory function, probably, by decreasing the activities of sympathetic function and manifested as vasodilatation, arterial blood flow, and skin microcirculation increase.

1. Introduction

Transport and physical exercise represent stressful stimuli which can lead to homeostasis disruption with direct impact on animal health status and physical performance of the athletic horse [1–3]. Athlete horses are used to travel before competitions, but, after transport, some of them show lower performance than usual [4]. To limit health problems related to transport and exercise stress, it is important to evaluate the health status of the horses before and after the physical effort, to optimize the environmental conditions inside the truck or to provide them with electrolytes and antioxidants. The evaluation of body temperature represents a valuable tool to monitor the physiologic status, welfare, and the stress response of animals. Monitoring horse surface temperature allows the evaluation of function of individual parts of the body. The

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assessment of horse surface temperature changes resulting from transport and/or exercise could allow detecting inflamed areas caused by stress of musculoskeletal system that could account for a decreased welfare and physical performance [5]. During exercise, about 20% of the metabolism in the muscle cells is used for work and the remaining 80% becomes heat [6].

Similarity to human, skin is the only heat dissipation way of the equine body; when the body energy metabolism and heat production increases, heat dissipation through the skin increases, too, and so the surface temperature rises [7]. Heat removal rate is generally determined by the heat transfer rate from the core to the surface of the body through blood vessels. In particular, vasodilation allows more blood to flow through the arteriole, thus venting the heat by convection and conduction through the superficial capillaries, if vasodilatation is not sufficient sweating starts [8]. Sweating can lead to fluid and electrolyte losses that if uncompensated, can lead to thermoregulatory instability, hypovolemia, imbalance in electrolyte serum concentration, and when the deficit becomes serious, horses can show clinical signs of dehydration compromising the physical performance [1,9]. Sweat loss of electrolyte, in particular, causes the onset of peripheral fatigue and weakness [10].

It has been demonstrated that acupuncture treatment leads to alleviation of muscle tension, improvement of local blood flow, increase of pain threshold, and modulation of autonomic nervous system [11,12]. Acupuncture stimulation induces alterations in microcirculation, including the increase in the skin and muscle blood flow [13], and it lead to the release of biological factors, such as nitric oxide [14,15] and calcitonin gene-related factor [16], which play important roles in the modulation of vasodilation [17].

It has been well established that acupuncture can influence skin temperature and blood flow in human [18,19]. However, to the best authors' knowledge, no studies have been currently published on the influence of acupuncture treatment on thermoregulation and hydration status of equine species. Therefore, the aim of the present study was to evaluate how the values of rectal and skin temperatures as well as hydration indices change following acupuncture stimulation in Thoroughbred horses before and after road transport and physical exercise.

2. Materials and Methods

2.1. Animals and Study Design

All treatments, housing and animal care reported below were carried out in accordance with the standards recommended by the EU Directive 2010/63/EU for animal experiments. Five clinically healthy and regularly trained Thoroughbred horses (five geldings, mean age 4 ± 1 year; mean body weight 437 ± 15 kg) were used with the informed consent of the owners. Animals were stabled in individual boxes (3.5 × 3.5 m) at the same training center located in Sicily, Italy (38°00′49″N, 15°25′18″E, 80 m above sea level) under natural photoperiod (sunrise at 6:11 AM, sunset at 5:13 PM; mean temperature 23°C, relative humidity 70%). Horses were fed, twice a day (7 AM and 5 PM), a total food amount of about 2.5% of horse body weight (forage-to-concentrate ratio 70:30), and water was available ad libitum. The horses competed in two official 1,300-meter races at "Mediterraneo" racetrack (Siracusa, Sicily, Italy).

For each race, the five horses were transported from their stables to the racetrack in a 5-horse truck. Each animal traveled, tethered with a 50-cm rope on each side of the halter, in an individual tie box (length 2.3 m; width 0.85 m), giving a total space of about 2 m^2 and made two journeys of 145 km. Each journey was made 2 weeks after the previous one. The driver and the route were always the same.

Thermal and hygrometric records were carried out inside the box for the whole study by means of a data logger (Gemini, UK). The same instrument was placed approximately 5 cm from the center of the ceiling in the van during transport in order to measure the ambient thermal and hygrometric records inside the truck throughout the transport. The temperature in the box ranged between 24°C and 16°C (maximum/minimum), whereas the relative humidity ranged between 25°C and 67%. Temperatures inside the truck ranged between 24°C and 21.5°C (maximum/minimum). The relative humidity inside the truck ranged between 68% and 75%.

Horses transported and competed in the first official race represent the control group (CG). Two weeks later, the same horses competed in the second official race. Before road transport, they were subjected to acupuncture treatment (acupuncture group, AG) and were loaded after 30 minutes onto the truck calmly and without the use of force. Acupuncture was performed once a day for 30 minutes across all animals. A stainless-steel needle (diameter 0.25 mm, length 30 mm, Dongbang Acupuncture Inc, Qingdao, China) was inserted vertically into a depth of 2–3 cm, and stimulation was produced by bidirectional twisting of needles, as described in the previous studies [20,21]. In particular, Table 1 shows the name and location of the selected acupoints received from acupuncture group (AG). For acupuncture stimulation, stainless needles were inserted into the left or right side of selected acupoints. The locations of acupoints were found according to the anatomical structures.

2.2. Body Temperature Measurement

From each animal, rectal and skin temperatures were measured by the same operator at rest in their box at 8:30 AM; after being unloaded from the vehicle and housed in the transit boxes, 30 minutes after unloaded, at rest in the transit box, at the end of the race, and 30 minutes after the race. Rectal temperature (T_{RECTAL}), taken as representative of body temperature, was measured by a means of a digital thermometer (HI92704, Hanna Instruments Bedfordshire, UK), inserted 15 cm in the rectum. Skin temperature (T_{SKIN}) was measured at six locations (neck, shoulder, ribs, flank, internal thigh, and back) with an infrared thermometer (Testo 826-T1) having a sensitivity of 0.2°C.

2.3. Blood Sampling and Laboratory Analysis

From each animal, blood samples were collected by the same operator at the same time points of the body