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The relationships between scrotal surface temperature, age and sperm quality in stallions

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ABSTRACT

In horses, spermatogenesis normally occurs at an average intratesticular temperature of 35 °C; therefore, mechanisms for testicular thermoregulation are essential. Measuring the scrotal surface temperature by thermography is one of the methodologies used to evaluate the effectiveness of testicular thermoregulation. The objective of this study was to determine the relationship between the control of scrotal surface temperature and sperm quality in horses of different ages. In total, 24 Quarter Horse stallions were divided into three groups: YS (young stallions), AS (adult stallions) and OS (old stallions). Initially, we calculated the testicular volume (TV) and evaluated various aspects of the semen (sperm kinetics, plasma membrane integrity and sperm morphology) for all the animals. We also evaluated rectal temperature (RT), body surface temperature (BST,) and average scrotal surface temperature in the testicular region (SST) before (M0) and after sun exposure (M1). Differences were observed ($p < 0.05$) between the RT and BST before and after sun exposure in all three groups. However, there were no differences ($p > 0.05$) in the SST values at these two time points, thus demonstrating the efficiency of the mechanisms for testicular thermoregulation. The SST was similar ($p > 0.05$) among all three groups. Based on these results, we conclude that fertile stallions of different age groups are able to maintain SST and measuring the heat radiating from the scrotum using a digital infrared thermographer. We can also conclude that measuring the heat radiating from the scrotum using a digital infrared thermographer is a practical and efficient tool for monitoring SST in horses.

1. Introduction

Testicular thermoregulation in domestic animals is dependent on the contraction and relaxation of the dartos and cremaster muscles, the activity of the sweat glands, heat irradiation of the scrotal surface and arteriovenous heat exchange via the pampiniform plexus counter-current mechanism (Ashdown and Hancock, 1980; Coulter and Kastelic, 1994; Setchell, 1991).

In horses, normal spermatogenesis occurs at an average intratesticular temperature of 35 °C. The majority of testicular problems in stallions are related to changes in the ability to control testicular temperature (Alvarenga and Papa, 2007).

In situations where there are fever events or increases in testicle temperature because of environmental or pathological conditions, such as infections, oedema, dermatitis, bleeding

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(Blanchard et al., 1996) and testicular torsion (Ball, 2008), the animal cannot maintain a scrotal temperature within ideal limits even though the processes of intratesticular temperature regulation are efficient (Moule and Waites, 1963). An elevated testicular temperature leads to an increase in cellular metabolism and, consequently, a greater tissue oxygen demand. Hypoxia can lead to cell death, thus initiating testicular degeneration (Blanchard et al., 1996). After evaluating the effect of thermal stress on bovine semen, Fernandes et al. (2008) observed a reduction in semen quality after scrotal insulation, whereas Mawyer et al. (2012) did not observe this result in miniature horses.

To evaluate the efficiency of testicular thermoregulation, testicular temperature measurements can be performed by introducing sensors into the gonads. However, this invasive procedure can pose risks to the animal (Coulter et al., 1988). Therefore, Coulter et al. (1988) evaluated ram testicular temperature using a non-invasive infrared thermography method and showed that there were no differences between these measurements and those obtained using the invasive sensors.

Despite the high incidence of reproductive problems related to testicular temperature control, there are only a few studies that have evaluated testicular temperature control in cattle (Barros et al., 2009; Coulter et al., 1997; Kastelic et al., 1996), goats (Coulter et al., 1988; Kastelic et al., 1999; Maloney and Mitchell, 1996), humans (Gold et al., 1977; Lafaye and Hermabessiere, 1980) and horses (Staempfli et al., 2006). Therefore, the objective of this study was to determine whether there is a correlation between the control of scrotal surface temperature (SST) and sperm quality in horses of different ages.

2. Materials and methods

We used 24 healthy Quarter Horse stallions without anatomical or functional alterations to their reproductive tracts as subjects and conducted the study from November to January 2010 (Latitude 22°53′09″S and Longitude 48°26′42″W). The animals were divided into three groups according to their ages: young stallions (YS) included stallions between 2 and 3 years old (2.6 ± 0.6, $n=9$), adult stallions (AS) included stallions between 5 and 15 years old (7.8 ± 3.4, $n=10$), and old stallions (OS) included stallions 17 years old or older (20.3 ± 2.5, $n=5$).

Rectal temperature (RT) measurements were obtained using a dry bulb thermometer, and the scrotal (SST) and body surface temperature (BST) were obtained using an infrared thermographer (Infra Cam™, FLIR Systems Inc.) on hot days (temperature >30 °C) in two stages: when the animals were previously conditioned in a shady environment (M0, 30.2 ± 0.7 °C) and after 1 h of sun exposure during intense daytime sunlight (M1, 37.5 ± 1.1 °C). The infrared thermographer was placed 1 m from the scrotum and neck. The images were stored and analyzed using ThermaCAM Quick Report™ software. The analysis of SST was performed using thermographic images of the testicular side of the scrotum; the temperature was measured at seven different testicular locations (two cranial, two caudal and three medial locations, (Fig. 2)) using the

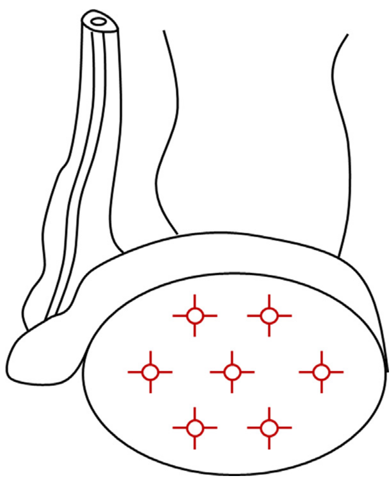

Fig. 2. Schematic design of the testicle with seven points analyzed at each side of the scrotum.

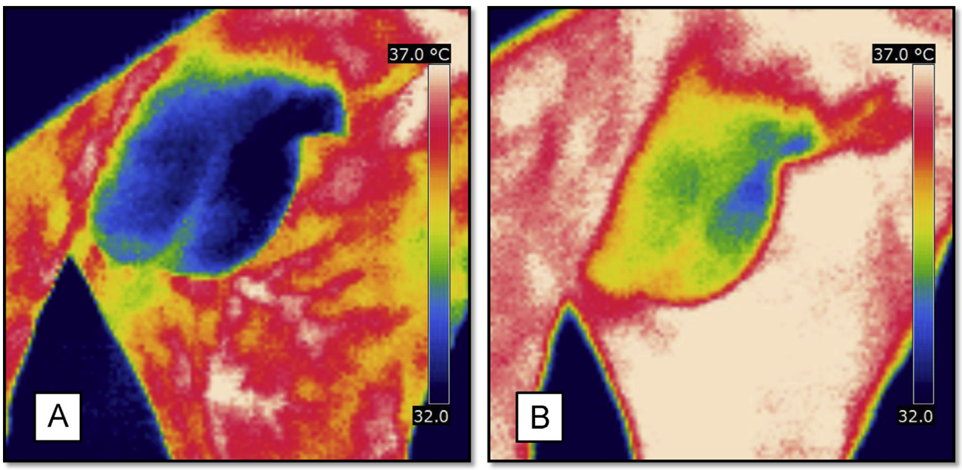

Fig. 1. Thermographic image A is a superficial scrotal thermograph from a stallion before exposure to the sun (M0), and thermographic image B is a superficial scrotal thermograph of the identical animal after one hour of sun exposure (M1).