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Original Research

Use of Thermography for Functional Evaluation of Stallion Scrotum and Testes

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ABSTRACT

The aim of this study was to assess whether correlations could be made between the temperature of stallion testes, before collection, and the motility score (MS) rating given to the subsequently collected ejaculate. Thermography was used as a noninvasive means to image the scrotal surface temperature. The collected thermograms were analyzed, first, to establish a thermal gradient "norm" or "optimum range" (OR) of a testis and, second, to establish whether a relationship could be found between testicular temperature immediately before semen collection and the MS of the semen subsequently collected. The study involved 10 stallions giving 85 semen collections over two collection sessions, autumn 2011–spring 2012. The study found an apparent association between stallions that conform to the OR and greater MS ratings. Based on the results, it is concluded that thermography could be used as a monitor to provide a noninvasive indication of subclinical testicular factors that may affect a stallion's fertility and provide an early indication that further veterinary investigation may be required.

1. Introduction

Thermography is a noninvasive diagnostic technique that measures and displays a visual image of the infrared radiation emitted by any object. It measures the surface temperature and is used for medical diagnostic purposes because it can show a relationship between surface temperature and lesions in the underlying structures.

In this study, thermography was used to monitor and capture for later analysis, images of the scrotal surface temperature (SST) of stallions immediately before a semen collection. In Theriogenology, a branch of veterinary medicine concerned with reproduction, motility scoring is one assessment used to decide whether a particular ejaculate is qualitatively viable for freezing. The collected thermal data in this study were then used to establish a quantifiable testicular thermic optimum range (OR) against which to assess whether a deviation from the OR could be used to predict changes in the motility score (MS) of the subsequently collected spermatozoa.

It has long been established that the male scrotum embodies a delicate mechanism to ensure an optimum internal operational temperature for the testes [1–3] with studies by Kastelic [4–9] showing the testes of bulls use a delicate venous network (pampiniform plexus) which surrounds the internal spermatic artery, as a counter-current heat transfer system that absorbs heat from the artery to vein, along with sweating from the scrotal area, to regulate the testicular temperature.

Thermography has been used on various animal species in past research articles [10] as a noninvasive means to identify the SST to assess the health of testes and provide an early indicator of possible testicular degeneration. In 1938, Langerlof [11] first identified a relationship between scrotal temperature and sperm motility in male domestic

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animals. Subsequent research by Waites and Setchell [12,13] established that a significant increase in bovine and ram scrotal temperatures, generated either externally or internally (fever and/or infection), had a detrimental effect on not only sperm motility but also morphology. Purohit [14] further developed understanding of the dynamic interplay involved in maintaining the optimum scrotal temperature and identified any disturbance in vasomotor tone would also result in an increase in the SST—the duration of the disturbance being directly related to the nature and the severity of the cause.

The normal stallion scrotal thermal pattern, as common to all species, is symmetrical right to left, is maintained at 2°C–6°C below body temperature, and has a constant decrease in thermal gradient from base to apex of between 3°C and 4°C [14].

Acute and chronic testicular degeneration, directly related to spermiogenesis and infertility, have been identified where there is (1) a lack of thermal symmetry; (2) a reduction in SST gradient from base to apex; and (3) an increase in scrotal temperature >2°C–3°C [14,15]. Under normal circumstances, stallions have the ability to self-regulate testicular temperature, as reported by Ramires-Neto [16], in which the testes of 15 stallions were shown to have an ability to maintain their gradient characteristics, irrespective of age or increase in ambient temperature.

Although gross abnormalities in thermographic gradient, seen in previous research articles [14], were not expected to be found, the object of this study was to assess whether subtle differences in testicular thermic banding of normal, healthy stallions immediately before collection bore any relation to the sperm motility of subsequently produced ejaculate.

Motility scoring is one of the first assessments used in Theriogenology to decide whether a particular ejaculate is qualitatively viable for freezing. Ejaculate achieving a score of less than 60% is generally regarded as being less viable when attempting to produce frozen semen to a commercially accepted standard and therefore has an impact on the wider distribution of a stallion's breeding capacity. Early identification of a downturn in a stallion's MS correlated to a change in SST may provide the trigger for preemptive veterinary evaluation.

Table 1
Stallion data.

Stallion Data		
Stallion No.	Breed	Age
001	Arabian (Arab)	11
002	Warmblood (W/Blood)	6
003	W/Blood	10
004	W/Blood	6
005	Arab	6
006	Arab	11
007	Akhal-Teke	16
008	Arab	11
009	Arab	9
010	Arab	7

2. Materials and Methods

2.1. Stallions

The 10 stallions used in this study were healthy, premium stock from a broad cross-section of equine disciplines. Age ranged from 6 to 16 years (Table 1).

Between five and 15 collections, or attempted collections, were made from each stallion, over two collecting sessions—autumn 2011 and spring 2012. Three stallions appeared in both sessions, and one stallion (006) had a single testis.

2.2. Thermographic Equipment

A Fluke Ti55 Infrared Thermal Camera was used, having a thermal sensitivity of ≤0.05°C at 30°C (50 mK) and ≤0.07°C at 30°C (70 mK) with a detector data acquisition rate of 60 Hz/60 Hz or 7.5 Hz/7.5 Hz. The detector had a focal-plane array of 320 × 240 pixels with a vanadium oxide uncooled microbolometer thermal sensor with a 25-μm pitch. Two lenses were used, 10.5 mm and 20.0 mm, both having the same aperture (F/0.8) and using the same IR spectral band width (8μm - 14μm).

2.3. Thermographic Parameters

All images were taken in a draft-free environment. A temperature span of 7°C was used (29°C–36°C) so that each

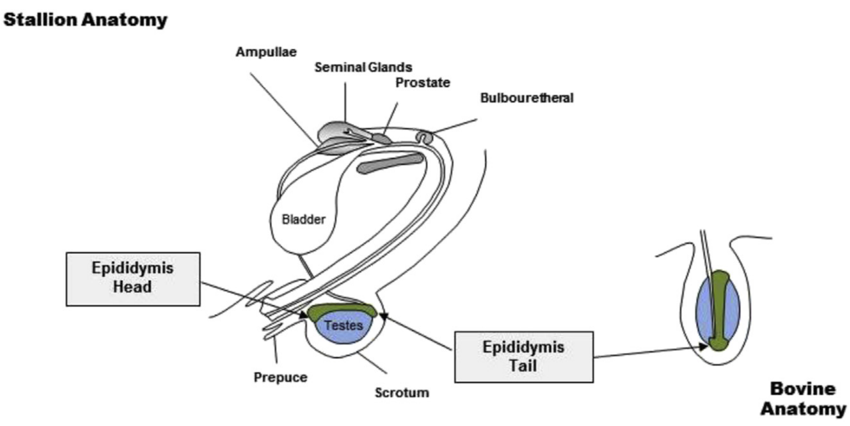

Fig. 1. Stallion anatomy.