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Infrared Thermography in Healthy Arabian Camels (*Camelus dromedarius)*

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ABSTRACT

The present clinical investigation was accomplished during the events of the fifth King Abdulaziz Camel Festival (KACF), Kingdome of Saudi Arabia. It was planned to investigate surface thermographic measurements in healthy dromedary camels. A total of 4627 dromedary camels were examined for cosmetic medicine; 90 camels were tested for infrared thermography (IRT). Eighteen anatomic were evaluated and results were tabulated. These included upper lips, lower lips, nostrils, nasal alae, pinna, maxilla, mandible, eyeball, neck, chest, abdomen, hump, tail sides, perineum, udder, testis, penile sheath and foot. Seventy-four camels with injected or stretched lips were also examined. A control group consisting of 25 camels was used. Injected lips with fillers were detected in fourteen camels and extended lips were discovered in other sixty dromedaries. When tested by IRT, the injection sites appeared darker than that the surrounding tissue. There were no significant differences between the values in injected lips compared to that in controls. Similarly, there were no significant differences between the values in stretched lips compared to that in controls. The stretched lips appeared longer, flabby and puffy. When tested by IRT, the mucosal surface in the stretched lips appeared lighter and heterogeneous compared to the darker and homogenous pattern in the non-stretched lips. Concluding, the thermographic values of this study are reference values for healthy camels in a similar environment. The obtained results also showed that IRT is highly feasible and shows promise for detecting lesions such as injected or stretched lips. However, it is not enough and should be combined with clinical and ultrasonographic examinations.

Key words: Animal health, Animal husbandry, Infrared devices, Pathophysiology, Physiology.

INTRODUCTION

The clinician resorts to many circumstances to inject a tranquilizer in order to examine the camels to evaluate their general condition; including measuring body temperature, and in most cases, the veterinarian is forced to examine the camels while they are lying down. For 6 successive seasons, the camel beauty show is held in Saudi Arabia where camels are enrolled from various countries. Due to the high fame and the high prize money, some camel owners resort to performing plastic surgery for their camels through filler injection in the head or extending the lips (Tharwat and Al-Hawas 2021).

Infrared thermography (IRT) is now considered a painless diagnostic innovation that measures surface body temperature. Different skin temperatures can be identified from skin surface points to external inflammations or differences in blood circulation (Stelletta et al. 2012). The infrared camera is functioning by detecting the thermal energy discharged from the surface followed by transforming it into an electrical indicative symmetrical to the power of the IRT (Usamentiaga et al. 2014). The feasibility of utilization IRT in clinical field is not only accomplished by its non-invasiveness, integrity, and lesser eventuality of pseudo results caused by temperature elevations, but also by the accuracy of assessments gained using this technology (McCafferty 2007; Cilulko et al. 2013).

In humans, the methodology of IRT is applied in several affections for example examining the blood and lymph circulations, plastic surgery and neoplastic diseases especially for the detection of mammary tissue tumor in human females (Fauci et al. 2001; Vargas et al. 2009). In veterinary field, IRT is presently used in the verification of some affection that leads to an elevation in skin temperature for example inflammation of the sensible framework of the hoof and inflammation of the udder (Schaefer et al. 2004; Stelletta et al. 2007). Furthermore, it has been found that a correlation exists between the

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superficial temperature of the testicles and their function (Brito et al. 2012; Yadav et al. 2019). In addition, IRT became useful for identifying reproductive changes in different (Talukder et al. 2014). IRT has also been applied for scanning mammary stress induced by milking (Tangorra et al. 2019) and to estimate stress in sheep (Cannas et al. 2018). In camels, the feasibility of utilizing an infrared-thermographic technique for early diagnosis of mastitis in dairy camels has also been investigated (Samara et al. 2014). An article describing the application of IRT in camels with either injected or stretched lips in dromedary camels has been published recently (Tharwat et al., 2021a). This study was carried out to report the results of IRT in different anatomic regions in healthy dromedary camels.

MATERIALS AND METHODS

Ethical Approval

The Committee of Animal Ethics, Research of Scientific Deanship, University of Qassim, Saudi Arabia approved the experimental procedures of this study (QU-IF-2-1-3-25504).

Camels

Current investigation has been performed during the fifth round of the KACF in the Kingdom of Saudi Arabia (November 29th - December 28th, 2020). A total of 4627 camels (*Camelus dromedarius*) were tested for cosmetic medicine especially fillers injection in the head as well as stretching the lips. Of the 90 camels (72 females and 18 males) were tested for IRT based on a history of absence of diseases, normal hematological and biochemical analyses and complete absence of skin lesions.

Camel Thermography

The thermographic camera used was a FLUKE® TiX580 (USA). It has a sensitivity of 0.05°C, a range of temperature of 20 negative degrees to 1000°C, automatic hot/cold discovery, detector efficacy of 640×480 (307,200 pixels), a spatial resolution of 0.93 mRad, D: S 1065:1, the field of view 34 °H × 24 °V, minimum focus distance 15 cm, an integrated color camera of 5.0 megapixels, and it provides 4x the pixel data with the on-camera super-resolution to create a 1280×960 resolution image. The infrared camera was also equipped with a laser pointer, LaserSharp® Auto Focus for consistently in-focus images and a laser distance meter that measures the distance to the goal for exactly focused images and shows range on monitor. Thermographic measurements were taken from 7.00 to 10.00 AM. During the festival period, the ambient temperature was a minimum of 6-17°C (11.5±4.7°C) and a maximum of 20-27°C (24.5±3.0°C), relative humidity 26-80% (50.7±18.7%) and wind speed 11-23km/h (15.2±6.3km/h).

IRT was used to measure skin temperature (°C) in 18 anatomic regions of the 90 selected camels either in standing or recumbent position. Tested anatomic sites included upper lips, lower lips, nostril, nasal alae, pinna, maxilla, mandible, eyeball, neck, chest, abdomen, hump, tail sides, perineum, udder, testis, penile sheath and foot. Two to three measurements were recorded in different points (upper, middle and lower third) for the neck, udder, penile sheath, testis and perineum and the average was taken. Images were taken 0.65-3.10m away from the camels.

RESULTS

Camels evaluated by IRT were selected on the basis of the absence of any dermatologic lesions, which could intervene with the thermographic temperature. Camels enrolled for the study were of various colors ranging from white to black colors that are represented in the beauty show. Camels ranged from five to ten years old, and their weighted 450 to 700kg. Of the 4727 tested camels during the fifth KACF, 14 (0.30%) were found to be injected with fillers in the lips and 60 (1.27%) camels had extended lips. None of these animals had a history of recent illness.

Table 1 shows the means and standard deviation together with the low and high thermographic temperature ranges of the 18 selected anatomic points of the camel body, alongside the 25, 50, 75, 95 and 99% percentiles, respectively. The palmer and planter foot surfaces were tested by IRT for comparison. The palmer foot surface had a higher skin temperature (24.9±3.3°C) compared to a planter foot surface value (23.3±3.0°C), but with a non-significant difference between them (P=0.06).

Fig. 1 shows anatomic sites for thermographic measurements of the upper and lower lips, nostril, nasal alae, neck, chest, abdomen and hump. Fig. 2 shows other tested points that included the udder, tail sides, penile sheath, testis, perineum and foot.

DISCUSSION

For the Arab peoples, especially in the Gulf area, camels constitute cultural, literary, heritage and civilizational legacies. Of course, they are substantial species in the Arabian Peninsula being used for production of milk and meat. During the past decade, there has been an overall rise attentiveness in camel race competitions (Tharwat et al. 2013; Tharwat and Al-Sobayil 2015; Tharwat and Al-Sobayil 2018; Tharwat 2021). In addition, during the last 7 years' camel beauty shows are being held regularly in Saudi Arabia where tremendous prizes are awarded. For this reason, plastic surgery on camels is currently rampant in the Gulf countries (Tharwat and Al-Hawas 2021; Tharwat et al., 2021a, b). To our information, this is the headmost clinical report investigating thermographic measurements of different anatomic sites in healthy camels.

The technology of IRT is currently applied in a diverse range of fields including industry, construction, and medicine. Applications in human and veterinary medical science emphasize its use as a general diagnostic tool in such areas as detection of oncology, orthopedics, reconstructive surgeries such as microvascular autologous breast reconstruction, and rehabilitation; while in surgery and anesthesiology it is used to monitor pain (Milosevic et al. 2018; Casas-Alvarado et al. 2020; Damião et al. 2021; Moreira et al. 2021; Mostafa et al. 2021; Kesztyüs et al. 2022). The use of IRT in veterinary medicine is now growing as an auxiliary tool for assessing several conditions either physiological or pathological (Harris-Bridge et al. 2018; Witkowska-Piłaszewicz et al. 2020; Machado et al. 2021; Tharwat et al. 2021a).

In animals, thermography is a satisfactory technology as it is safe and the infrared camera is distant from the subject being evaluated (Stewart et al. 2005). The temperature of air, heat transmission and radiance affect the

Table 1: Values of infrared thermography (°C) in 18 anatomic sites of healthy dromedary camels (n=90; 72 females and 18 males)

Variable	Mean±SD	Minimum	Maximum	Percentiles				
				25%	50%	75%	95%	99%
Upper lip	31.2±3.0	26.1	35.5	30.0	31.1	32.9	34.9	35.5
Lower lip	31.0±2.4	26.5	35.4	29.3	30.6	32.8	34.5	35.1
Nostril	24.1±4.0	17.8	32.9	20.1	23.6	27.0	31.3	32.6
Nasal alae	28.0±2.2	24.3	32.8	26.4	28.0	29.2	31.5	32.5
Pinna	23.9±4.3	18.1	33.0	203	24.0	27.3	30.4	32.3
Maxilla	29.9±2.6	26.0	33.6	27.9	30.8	31.4	32.8	33.4
Mandible	27.8±1.8	24.0	31.3	27.2	28.0	28.7	29.9	31.0
Eye ball	34.7±1.2	32.4	39.8	34.0	34.7	35.4	35.9	38.0
Neck	25.6±1.8	22.6	28.5	24.5	25.8	26.9	28.4	28.5
Chest	22.4±3.6	17.5	28.3	19.6	21.6	25.0	28.1	28.2
Abdomen	21.9±4.3	15.8	32.2	18.6	21.3	23.8	28.6	31.3
Hump	21.6±4.7	15.5	31.0	17.8	21.1	24.8	30.3	31.0
Tail sides	22.6±4.7	15.4	31.3	19.2	22.2	27.0	29.5	31.0
Perineum	33.7±2.4	27.8	37.2	32.3	33.8	35.3	37.0	37.2
Udder	29.6±3.4	22.2	35.8	27.5	29.6	31.5	34.7	35.5
Testis	26.6±2.0	23.0	31.1	25.4	26.4	27.6	30.4	31.0
Penile sheath	27.7±3.0	20.0	34.0	25.7	28.5	29.3	32.1	33.4
Foot	23.8±3.2	17.2	30.0	21.2	23.9	25.9	29.3	29.8

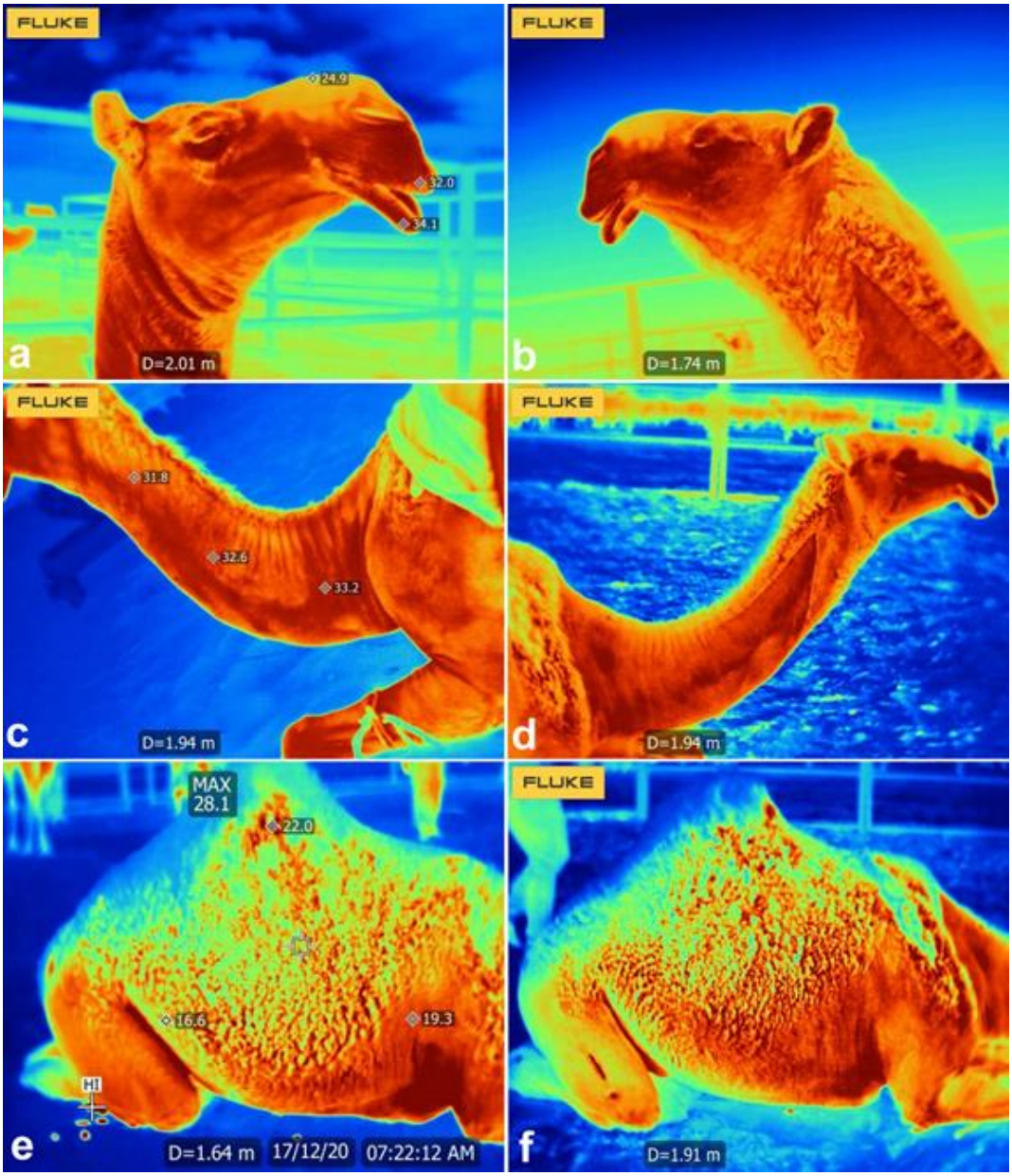

Fig. 1: Anatomic sites for thermographic measurements of the upper lips, lower lips, nostril, nasal alae, neck, chest, abdomen and hump. Images a, c and e show thermographic values in °C while b, d and f are without measurements for comparisons.

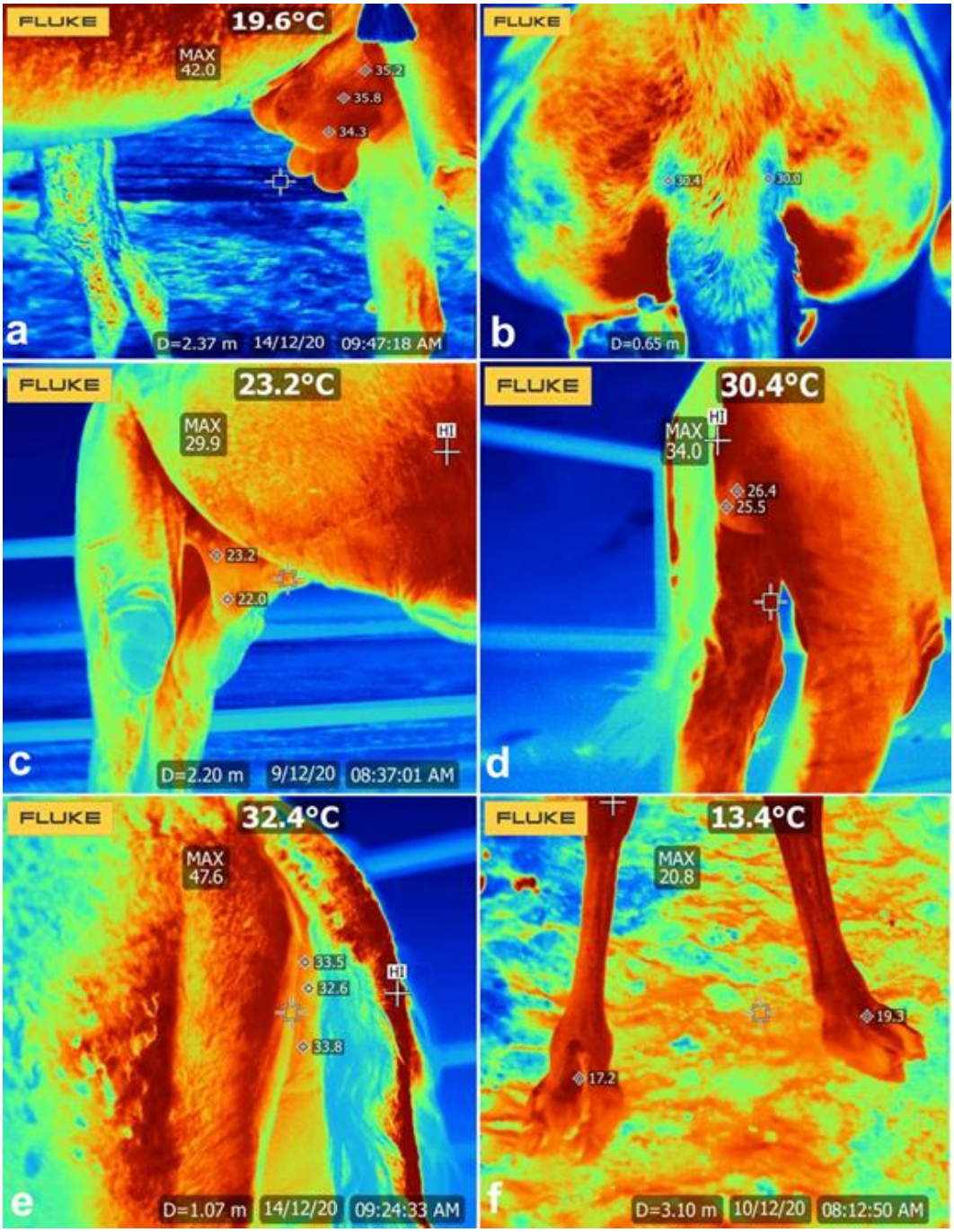

Fig. 2: Other tested anatomic sites that include udder (a), tail sides (b), penile sheath (c), testis (d), perineum (e) and foot (f).

temperature of the body surface of animals which is measured also by the flow of blood and rate of metabolism of the deep tissues. Therefore, measuring of the superficial temperature through IRT may discover changes in regional flow of blood due to either infection or inflammation (Eddy et al. 2001). IRT detect the locative temperature of a goal area and produces a visible chart of the spatial temperature of tested area by utilizing pseudo color scales to symbolize pre-defined temperatures (Harris-Bridge et al. 2018).

In this study, the thermographic measurements in the 18 tested sites are considered references for healthy camels. However, care must be considered when compared with camels in different geographic locations with different ambient temperatures, relative humidity and different wind speed. In a report published on dogs, Omobowale et al. (2017) clarified that measurements of temperature by using non-contact IRT were bad in uniformity as well as harmonization versus rectal temperature and utility of IRT in clinical filed flatness depending on exact standardization and hence not advisable for application in the field. However, a report carried out on cattle by Stumpf et al. (2021), showed that by IRT of the mammary side, the veterinarian may be able to exactly expect an animal's rectal temperature. Unfortunately, in this study correlation among rectal thermometry and ambient temperature and thermographic measurements in different anatomic sites were not performed therefore another study is required to emphasize such correlations.

Conclusion

The obtained thermographic values of different anatomic sites in camels are considered reference values for healthy camels in similar geographic locations or in areas with similar ambient temperature, relative humidity and wind speed. Other studies are needed however to validate whether there is a linkage between the rectal temperature and ambient temperature and thermographic values in different anatomic sites.

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