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Research Article

Establishment of Diagnostic Imaging Protocol for Detection of Tissues Changes Related to Lips Stretching as a Popular Cheating Cosmetic Procedure in Dromedary Camels

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Abstract

Cosmetic enhancement in camels is currently rampant in the Gulf region, and the use of one of the most common cheating method known as "lips stretching" for purposes of rejuvenation. This article reviews the role of ultrasound, EMG, IRT and CT imaging in diagnosis and highlighting its importance in tracking the effects and complications of lips stretching on the tissue as a popular cheating cosmetic procedure in dromedary camels and monitoring the changes that occur in the nature of the tissue at long intervals, whether they are recent or old changes. This study was carried out at the Salam Veterinary Group hospital (Saudi Arabia). A total number of 180 clinically healthy one-humped camels (Camelus dromedarius) of either sex were enrolled; animals were divided into two groups, i.e., control group and stretched group, within each group, half of the subjects (n = 45) were young (from 6 months to 2 years of age, n = 45) and adult (more than 5 years of age, n = 45). Lips stretched groups were further divided into 3 subgroups, each one consisting of 15 camels to be stretched for 3, 4 and 5 times. Upon ultrasound, tissue tearing in adult groups was less than in young groups in all cases that underwent the same number of stretching times as well as at the end of the experiment on day 150, fibrosis at adult age groups was greater compared to young age groups. Camels in stretched lips groups that evaluated by IRT on day 150, the temperatures values dropped below the normal temperature in control group and this would be a result of overstretching damage lips tissues and tends to result in a buildup of fibrotic tissue that led to increase tissue thickness and reduction of healthy blood flow. On EMG we found that in all stretched groups the average amplitude for lips muscles was significantly decreased for young and adult groups compared to control groups then the amplitude begun to increase again but not complete recovery as normal. CT scan, showed the normal dermis in the control group as an isodense structure. While after stretching in all groups the tearing in tissues and edema appeared hypodense areas within isodense structure of the dermis with formation of hyperdense structure as bright white shades with white spots within soft tissue but in a smaller amount at young ages compared to adult ages in all stretched groups..

Keywords: Dromedary Camels; Lips Stretching; Ultrasound; Electromyography; Infrared Thermal Imaging; Computed Tomography

Abbreviations

KACF: King Abdulaziz Camel Festival; SR: Saudi Riyals; US: Ultrasonography; IRT: Infrared Thermography; EMG: Electromyography; CT: Computed Tomography; n: Number

Introduction

In the last decade of camel domestication, it is used as an essential source of milk, meat, hide and hair especially in developing countries [1,2].

In the Arabian Gulf countries, there has been increasing interest in camel racing in recent years and the sport is developing along the lines of thoroughbred horseracing [3].

In the past few years, annual camel beauty pageants have been held in the Gulf countries, especially in Saudi Arabia, the United Arab Emirates, and Kuwait. The King Abdulaziz Camel Festival (KACF) is an international cultural, economic, sport and entertainment event taking place in Riyadh (Saudi Arabia) every year. Due to its rising popularity, it turned into a heritage festival, attracting people from across the Gulf Cooperation Council who travel to showcase their animals; each year, thousands of camels are paraded across Saudi Arabia to compete in this beauty competition.

The criteria for the top beauty prize are extensive and include benchmarks for color, coat texture, leg length, and naturally voluptuous, pouty and pendulous lips. The upper and lower lips of the one-humped camel have their musculatures (M. Orbicularis Oris, M. Mentalis, M. Incisivus Superioris and M. Incisivus Inferioris) which are innervated by the infraorbital nerve (the terminal branch of the maxillary division of the trigeminal nerve) and mental nerve (the terminal branch of the mandibulo-alveolar n) [4]. Injury, excessive pressure, inflammation, toxic substances, or any congenital malformations can impair their proper function.

Lately, some owners have resorted to employ estheticians to shape and enlarge the camel contender 's lips to give it an extra suppleness and increase the chances to win the cash prizes, which may reach 10 million Saudi Riyals (SR), with a total of 120 million SR on the line for the winners. Facial beauty rejuvenation using lip stretching is therefore a popular cheating cosmetic procedure. Due to the seemingly "non-medical" context of these procedures as well as social prejudices and the conception that such information is not relevant, camel buyer may fail to disclose their use. However, the aftermath of these procedures, including focal inflammation, fat necrosis, and calcifications, may pose ethical concern and also diagnostic dilemmas when incidentally encountered by a radiologist interpreting imaging of the face performed for unrelated reasons [5,6].

In human medicine, high-resolution ultrasound has proven to be a useful diagnostic method for the detection of any tissue changes, its characterization, and evaluation of its complications [7,8].

Infrared thermography (IRT) is a remote and noninvasive method to assess the surface body temperature from skin surface points to external inflammations or differences in blood circulation [9]. In human medicine, the technology of IRT is used in several disorders such as studying the circulatory and lymphatic systems, rheumatic diseases, cosmetic surgery and in cancer diseases especially for the diagnosis of mammary gland cancer in women [10,11]. In veterinary medicine, IRT is currently used in the diagnosis of inflammation of the sensitive structures of the hoof and the mammary tissue [12,13]. Infrared thermography has also been used for scanning mammary stress induced by milking [14] and to measure stress and fear of humans in sheep [15]. In camels, the feasibility of utilizing an infrared-thermographic technique for early diagnosis of mastitis in dairy camels has also been investigated [16].

Electromyography reveals the presence, location and extent of such damage. Measuring the electrical activity of the examined muscles helps to reveal the cause of their weakness, paralysis, or the cause of involuntary muscle twitching. EMGs help to differentiate peripheral neurogenic and myogenic lesions as well as central paralysis, to demonstrate the impaired neuromuscular transmission in myasthenic syndromes, and to demonstrate myotonia and other diseases with spontaneous activity [17]. Since an EMG is a relatively non-invasive technique, it can be performed in a conscious animal and can be used during locomotion to study normal or pathological muscle work. EMGs have become a useful extension of the clinical examination [18].

In recent years, computed tomography (CT) has become more readily available in the veterinary field. for investigation of a variety of diseases [19]. CT is useful to detail the anatomy and structure of the head bones, muscles and soft tissues of varied tissue density in large animals [20,21] and is also useful for imaging hard and soft tissues in small animals [22,23]. CT is used to investigate the complex structure of some organs that have higher density resolution and no overlap of other anatomical organs [21,24]. CT has been used to describe head abnormalities in camels, llamas, horses, goats, dogs, and cats [25,26].

Materials and Methods

Camels population

This study was carried out at the Salam Veterinary Group hospital (Saudi Arabia). A total number of 180 clinically healthy one-humped camels (*Camelus dromedarius*) of either sex were enrolled; animals were divided into two groups, i.e., control group and stretched group, within each group, half of the subjects (n = 45) were young (from 6 months to 2 years of age, n = 45) and adult (more than 5 years of age, n = 45). Lips stretched groups were further divided into 3 subgroups, each one consisting of 15 camels to be stretched for 3, 4 and 5 times. Lips stretching was performed once/day, day after day for 3 times in the first group, four and five times for the second and third group respectively, as shown in figure 1.

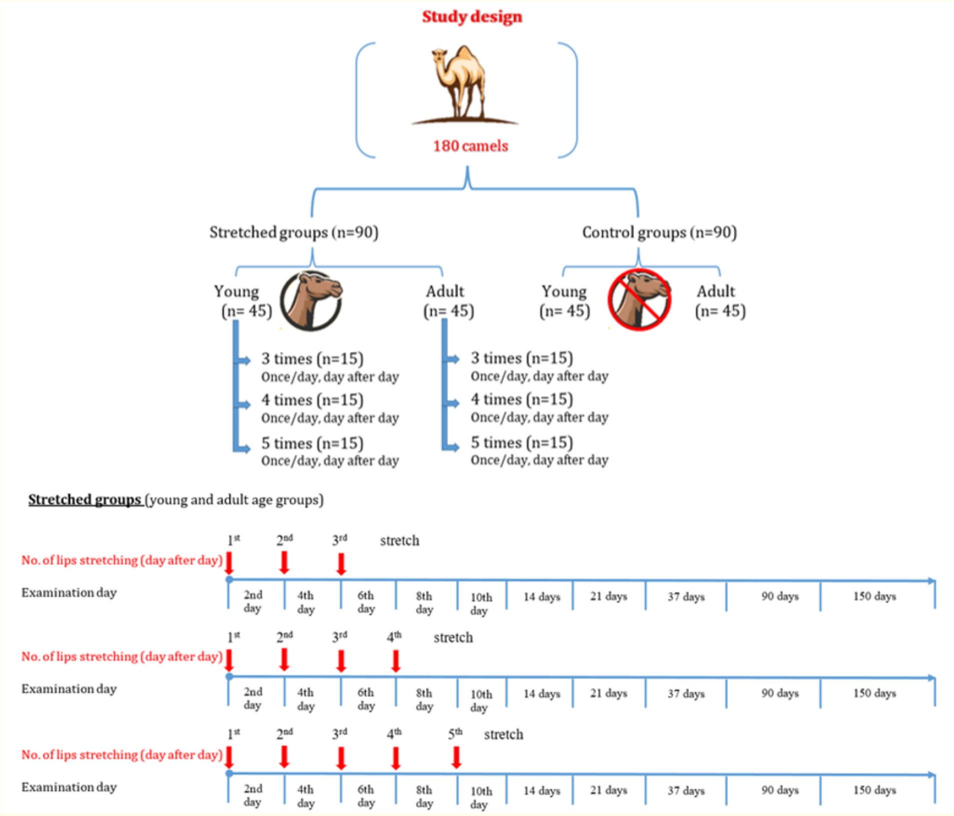

Figure 1: Diagram of study design. n; number.

All camels were visually inspected in a standing position for any apparent lips abnormality at 0 day and tested by ultrasound, IRT, EMG, and CT. Camels in stretched groups, the upper and lower lips were stretched using the hands of a hired person that are experienced in facial beauty enhancement using lip stretching. The lips were pulled in downward direction, from medial to lateral and from caudal to rostral for a period of 15 minutes for the upper lips and 15 minutes for the lower lips and the examination were carried by ultrasound, IRT, EMG, and CT at 2, 4, 6, 8, 14, 21, 37, 90 and 150 days from the beginning of stretching. Specifications like thickness and length of lower and upper lips (Length from commissures to the most rostral point of lips) were determined. The measurements were taken using a slide gauge caliper, rounded to the next 0.5 mm, using straight measurements between easily defined endpoint and maximal or minimal dimensions, as often as possible.

All camels were manipulated in sternal recumbency. First, the forelimb of each camel was bent and tied with a rope on the carpal joint. The head was then held and the animal was pushed until it was positioned in a sternal recumbency. The fore-and-hind limbs were then tied by a rope near the carpal and hock joints, respectively. A rest period was allowed for all animals prior to all examinations.

Ultrasonography Investigations of the camel lips

After positioning the camels in sternal recumbency, hand palpation of the lips preceded the ultrasonographic examination for further identifying softening or hardening of the lip tissue.

High-resolution ultrasound (MyLabTMOMEGA, Esaote S.P.A., Italy) was used for scanning of the upper and lower lips. The ultrasound unit was equipped with 4 probes (microconvex 11R, 3.0–11.0 MHz; linear T-shaped 50mm (appleprobe), 4.2– 15 MHz; and linear array probe, 10–22 MHz). The linear T-shaped and the linear array transducers were used for scanning of the upper and lower lips. The examination was performed after applying ultrasound gel to the scanning area. A fixed distance of about 5 mm between the area to scan and the probe was set. Both upper and lower lips were scanned from medial to lateral and from dorsal to ventral and the changes were stored and analyzed. Images were acquired in B-mode and Color Doppler at the maximum transmit frequency (18 MHz, harmonic), and a gain set to 45 and 60 dB of dynamic range.

Infrared Thermography of the camel lips

The thermographic camera used was a Hti-Xintai (China) (Infrared resolution 256x192, thermal sensitivity of 0. 07°C, temperature range of - 20^{o}C degrees to 550°C, automatic hot/cold detection). The infrared camera was also equipped with laser pointer, LaserSharp® Auto Focus for consistently in-focus images and laser distance meter that calculates distance to the target for precisely focused images and displays distance on screen.

Images must be collected out of direct sunlight and wind drafts, and lips should be free of dirt, moisture or foreign material. So, after cleaning the lips from any dirt, the thermographic measurements of all animals group were taken at 8.00 to 11.00 AM with ambient temperature was minimum 6-17°C (11.5 ± 4.7°C) and maximum 20-27°C (24.5 ± 3.0°C) and relative humidity 26-80% (50.7 ± 18.7%).

A period of rest was allowed for all animals before examination to avoid 'stress-induced hyperthermia' (SIH) which is a common response to acute stress or to repeated stressing episodes. Abnormal or asymmetrical temperature distributions have been used as indicators of underlying problems with blood circulation or inflammatory responses. When assessing a thermal image, asymmetry of 1^{o}C or more is often significant and indicates possible pathology. The thermographic camera was positioned perpendicularly at a distance of 0.2 meters from mucosal surface of lips and the images were obtained in triplicate by a trained researcher. Thermographic profiles were analyzed using Hti-Xintai® IR Image Tools software (China) where the experimental parameters and emissivity $\varepsilon = 0.95$ were assumed. After processing, maximum, minimum, and average temperature values of the mucosal surface of lips of each of the animal's head region were obtained.

EMG of the camel lips

The neurophysiological tests were performed under Sedation which was performed in all camels (n = 180), each time by I.V. administration of xylazine (Bomazine 10%, BOMAC Laboratories Ltd., New Zealand) at dose of 0.2 mg/kg, IV [27,28].

ES was performed according to a standardized diagnostic protocol using biphasic multipulse trains of constant voltage generated by an intraoperative neurophysiological monitoring system (The Neuro-MEP-Micro, Ivanovo, Russia). The system has a high acquisition quality with a sampling rate up to a 100 kHz. The electrical stimulator uses ultra-fast switching between two outputs. The system is delivered together with a comprehensive Neuro-MEP software package to control acquisitions and measures from the laptop, to visualize the EMG measures, create comprehensive summary graphs.

Two Cable, color coded red and black for disposable electrode with 2 Alligator clip - touch-proof (L 0.2 m, Russia) were mounted with 5 cm apart and parallel to each other on the upper and lower lips on each side and Stimulation electrode with steel stimulation points (2.5 m) was applied to nerve supply at its emergence from infraorbital foramen and mental foramen at the upper and lower lip respectively.

Multipulse ES (electric stimulation) was performed with 3 biphasic pulses per train (ppt), pulse width (pw) of 0.1 ms/ phase and interpulse interval (ipi) of 1.0 ms. The stimulation voltage was increased using a stepwise protocol: 0, 2, 4, 6, 8, V. At each voltage, transcranial stimulation was performed twice. The diagnostic MEP parameters were retrieved at respectively 2, 4, 6 and 8 V above motor threshold (MT). No further ES stimulations were added to the clinical diagnostic protocol for the current study.

When motor thresholds (MT) were reached for both muscle groups of lips, stimulation was continued to MT + 2 V or otherwise stopped at 8 V. At each occasion of stimulation, the motor responses were recorded for later retrieval of MEP (myogenic evoked potentials) amplitudes, MLTs (motor latency time) and waveform morphology.

Computed tomography of the camel lips

The CT examinations were conducted using the robot, also called EDAMIS (Equine Dual-Arm Multi-modality Imaging System), was developed in the United States by Orimtech LTD. The robot is more than 3 metres tall and weighs almost 6 tonnes.

Prior to image acquisition, machine-specific calibration and warm-up protocols should be followed; this takes approximately 30 min. A fast calibration and tube warm-up should be performed on a daily basis only if the machine is to be used for scanning. It is preferable to maintain the temperature of the CT room at 20–28°C with humidity of 30–60%. A requirement of 7.1 kW peak heat output is necessary to support the equipment in the CT scanning room.

After the CT machine setup, the camels were loaded after immobilization on Haico's adjustable height feature surgical table after slight sedation as mentioned before. A head collar should be substituted for a blindfolded rope or webbing halter to avoid metal image artefacts. Once the camel is sedated, the head is extended onto a cradle to perform CT.

The area of clinical interest will dictate the extent of the scan. For camel head imaging, the starting point is positioned caudal to the temporomandibular joint and the scan length is approximately 100 cm rostrally. Once the position of the scan is confirmed, the room is cleared of additional personnel and the scan can commence once the camel handler is safely positioned. CT images were obtained using the following parameters: cranial vision of image (V.V.F.), 3 s exposure time, 120 kV, 130 mA and 0.45 mm slice thickness and 3 mm image spacing. Best image quality for soft tissue was obtained by adjusting window widths and window levels. For visualizing soft tissue lip structures, a soft-tissue window setting (window width, 1500; window level, 100) was used.

The scanner consists of two robotic arms and several cameras that register the camel's movements. The arms of the robot rotate around the blindfolded and sedated camel taking a series of images in as little as 30 seconds. These images are converted by a computer system into a detailed three-dimensional image, as in a conventional CT scan. The cameras allow movement correction to be made. Mild movements can thus be filtered out in order to guarantee razor-sharp image quality.

Data collection and statistical analysis

Data collected were initially documented in Excel (Version 14.0, Microsoft Corp., Redmond, WA, USA). Statistical analyses were achieved utilizing Statistical Package for the Social Sciences (SPSS) software (version 22.0, IBM, Armonk, NY, USA). Descriptive statistics like mean values (mean), standard deviations (SD), standard errors (SE) and coefficients of variation (CI) were produced independently for young and adult groups. Normality of the data was analyzed through the Kolmogorov-Smirnov test. An independent-samples t-test was utilized to compare the mean measurements among lips stretched and control groups and p-values under 0.05 were recognized to be statistically significant.

Results

The statistical comparison of different anatomical parameters like length and thickness of upper and lower lips of both control and stretched groups, in young and adult camels are given in table 1.

Parameters (cm)	Young	Adult	P value
Upper lip length (control)	3.4 ± 0.3	6.5 ± 1.2	*0.02
Stretched upper lip length 3x	4.2 ± 0.3	7.0 ± 0.8	
Stretched upper lip length 4x	4.5 ± 0.2	7.1 ± 0.2	
Stretched upper lip length 5x	4.7 ± 0.1	7.4 ± 0.4	
Lower lip length (control)	1.7 ± 0.4	2.8 ± 0.6	*0.03
Stretched lower lip length 3x	2.4 ± 0.5	3.2 ± 0.2	
Stretched lower lip length 4x	2.8 ± 0.1	3.3 ± 0.2	
Stretched lower lip length 5x	3.3 ± 0.2	3.5 ± 0.2	
Upper lip thickness (control)	1.3 ± 0.3	1.6 ± 0.2	*0.57
Stretched upper lip thickness 3x	1.4 ± 0.3	1.6 ± 0.29	
Stretched upper lip thickness 4x	1.6 ± 0.3	1.7 ± 0.2	
Stretched upper lip thickness 5x	1.6 ± 0.1	1.9 ± 0.4	
Lower lip thickness (control)	0.6 ± 0.6	1.0 ± 0.2	*0.54
Stretched lower lip thickness 3x	0.6 ± 0.25	1.1 ± 0.13	
Stretched lower lip thickness 4x	0.7 ± 0.2	1.2 ± 0.2	
Stretched lower lip thickness 5x	0.9 ± 0.1	1.4 ± 0.1	

Table 1: Mean ± SEM values of different gross anatomical parameters of upper and lower lips in young and adult camels from lips stretched and control group.

* Means having P < 0.05 are statistically different.

For all animals the length of upper lips is significantly (P < 0.05) increased in adult group (6.5 ± 1.2) than young group (3.4 ± 0.3).

For young and adult age group the length of upper lips is significantly (P < 0.05) increased at 5 times stretching group than control groups, where the length of upper lips ranged from 3.4 ± 0.3 to 4.9 ± 0.1 in control young group and 5 times stretching group respectively. While ranged from 6.5 ± 1.2 to 7.4 ± 0.4 in control adult group and 5 times stretching group respectively.

For the length of lower lips also, significantly ($P < 0.05$) increased at 5 times stretching group than control groups, where the length of lower lips ranged from 1.7 ± 0.4 to 3.3 ± 0.2 in control young group and 5 times stretching group respectively. While ranged from 2.8 ± 0.6 to 3.5 ± 0.2in control adult group and 5 times stretching group respectively.

The difference of the thickness of both lips was found non-significant ($P > 0.05$) in young and adult camels in control and stretched groups.

Ultrasonography of the camel lips

Camels under investigation tolerated the procedure as a number of well-trained assistants for camels were hired during clinical and imaging using different devices to ensure the safety of the examiner and ease of the procedure. The average age of the camels ranged from 6 months to 10 years, and their weights ranged from 150 to 650 kg.

During the examination of camels in control groups, there is no swelling, no Drooping, no swinging and no Hardness of the upper and/or lower lips was visually inspected or palpated by hand. While examination the upper and/or lower lips of camels in stretched groups, an overall swelling, drooping, swinging as well as different amount of fibrosis were observed and palpated by hand.

When examining the lips by ultrasound, the probe was firstly settled perpendicular to the labial tissue and then was placed longitudinal. A slight clockwise or anticlockwise rotation of the probe in an angle of 45° was then applied where the adjacent labial structures were imaged.

Upon ultrasound, the normal dermis in the control groups appeared as a hyperechoic structure easily differentiated from the hypoechoic subcutaneous tissue as illustrated in figure 2.

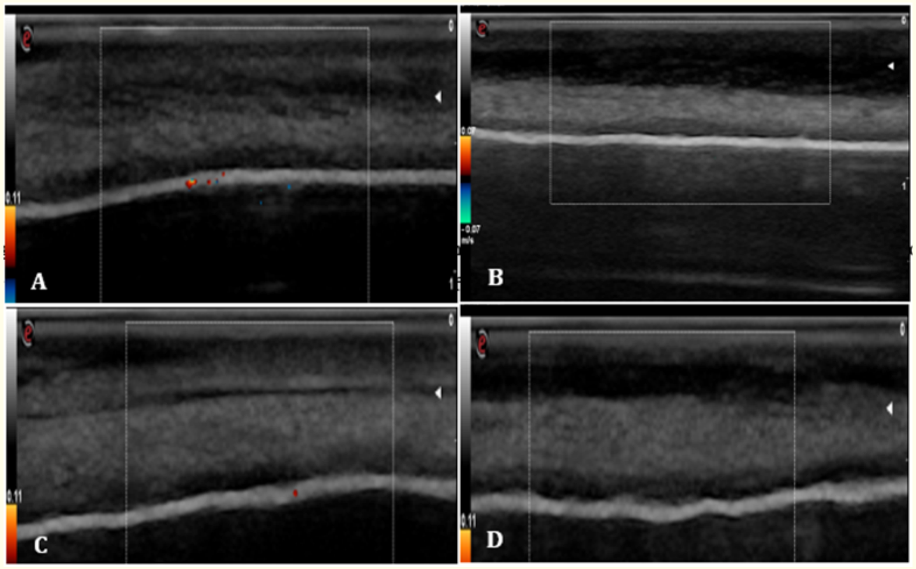

Figure 2: Ultrasonography showing Dermis appear as hyperechoic structure in control groups; A, upper lip of young group. B, lower lip of young group. C, upper lip of adult group. D, lower lip of adult group.

In the stretched camels, it was difficult to distinguish the subcutaneous tissue from the dermis. The stretched lips appeared anechoic and/or hypoechoic and was imaged as small or large, single or multiple areas of tissue tearing and edema formation as demonstrated in figure 3.

Tissue tearing in adult groups was less than in young groups in all cases that underwent the same number of stretching times where the percentage of tissue tearing in young age groups which was stretched 3 times was 93.75% at day 6, while in cases that were stretched 4 and 5 times the percentage of tissue tearing was 96.1 and 94.1% at day 8 respectively. In adult groups the tissue tearing percentage that stretched 3, 4 and 5 times was 85.81%, 85.1% and 90.8% at day 6, 8 and 10 after stretching respectively.

The percentage of tissue tearing in the young ages- groups that were stretched 3, 4, and 5 times at day 150 was 35.0%, 38.10%, and 36.95% compared to the adult ages groups in the same stretch-

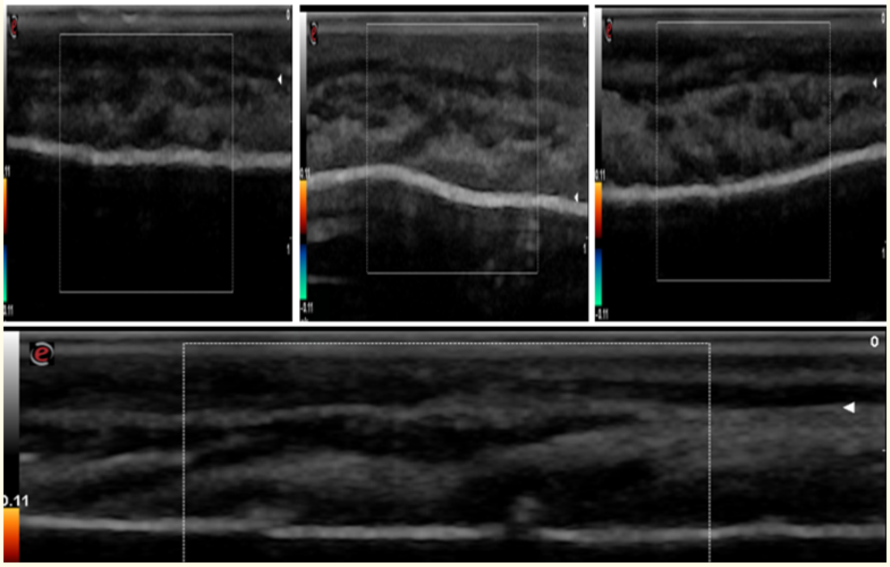

Figure 3: Ultrasonography showing anechoic area of tissue tearing within normal hyperechoic structure of dermis in stretched lips groups.

ing group, where the tissue tearing percentage reached 39.01%, 43.02%, and 48.59% with the same stretching times respectively as demonstrated in table 2.

Groups	Parameters	d2 %	d4 %	d6 %	d8 %	d10 %	d14 %	d21 %	d37 %	d90 %	d150 %
Young	Tissue tearing	64.7	73.17	93.75	90.45	89.24	85.18	64.93	36.5	35.3	35.0
3 times	Fibrosis	---	---	---	---	---	21.8	47.1	33.12	30.7	29.9
Young	Tissue tearing	66	88.6	94.6	96.1	94.8	88.8	69	40.2	38.35	38.10
4 times	Fibrosis	---	---	---	---	---	22.9	45	30.45	29.25	29.01
Young	Tissue tearing	68.8	75.75	90.33	94.1	92.7	91.8	73.95	48.97	37.2	36.95
5 times	Fibrosis	---	---	---	---	---	17.54	41.5	30.5	31.74	31.23
Adult	Tissue tearing	58.8	70.64	85.81	81.6	80.2	77.06	64.4	47.8	39.4	39.01
3 times	Fibrosis	---	---	---	---	---	26.43	49.4	36.7	32.5	32.33
Adult	Tissue tearing	56.3	64.1	82.5	85.1	83.8	78.3	68.9	49.21	43.4	43.02
4 times	Fibrosis	---	---	---	---	---	24.3	36.3	41.9	47.1	46.89
Adult	Tissue tearing	57.29	69.15	81.2	89.65	90.8	90.4	82.6	62.9	48.7	48.59
5 times	Fibrosis	---	---	---	---	---	22.5	46.6	53.1	65.12	64.91

Table 2: Average results about ultrasound of camel lips in all stretched groups in the different checking points expressed as percentage (%).

In all stretched groups, definitely at 14th day of Ultrasound imaging also showed hyperechoic images, with different degrees of hyperechogenicity, which clearly suggested presence of different amount of fibrosis as shown in figure 4.

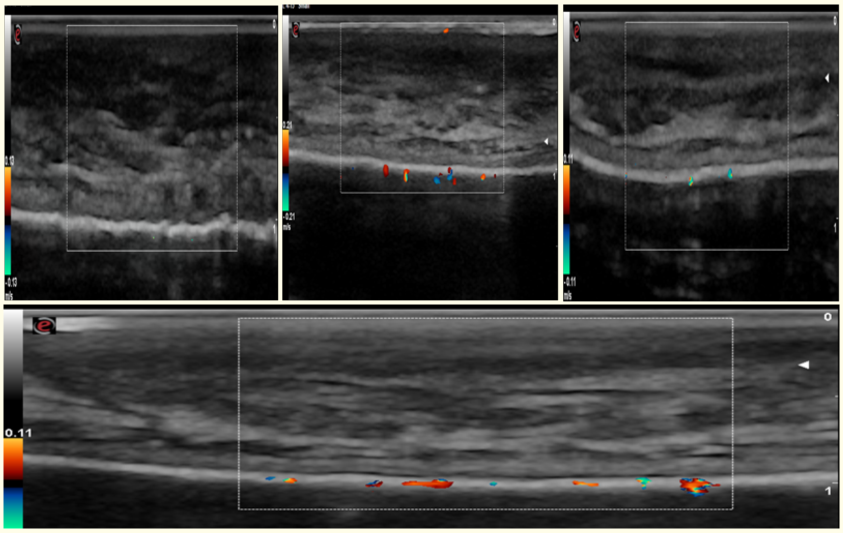

Figure 4: Ultrasonography showing hyperechoic images, with different degrees of hyperechogenicity, which clearly suggested presence of different amount of fibrosis which appeared as hyperechoic spots and small threads.

At the end of the experiment on day 150, fibrosis at adult age groups was greater compared to young age groups, as the percentage of fibrosis reached 32.33%, 46.89% and 64.91% in the groups that were stretched 3, 4, and 5 times respectively, while in young age groups that were stretched 3, 4, and 5 times the fibrosis percentage was 29.9%, 29.01% and 31.23% respectively which not significantly different from results on day 90.

Infrared thermography of the camel lips

Camels evaluated by IRT in control groups were selected on the basis of absence of scars, injuries, or any skin diseases, which could interfere with the thermographic temperature and when tested by IRT, the mucosal surface of upper and lower lips appeared darker and homogenous pattern with average temperature 31.2±2.3°C for all camels as shown in figure 5. While the mucosal surface in the

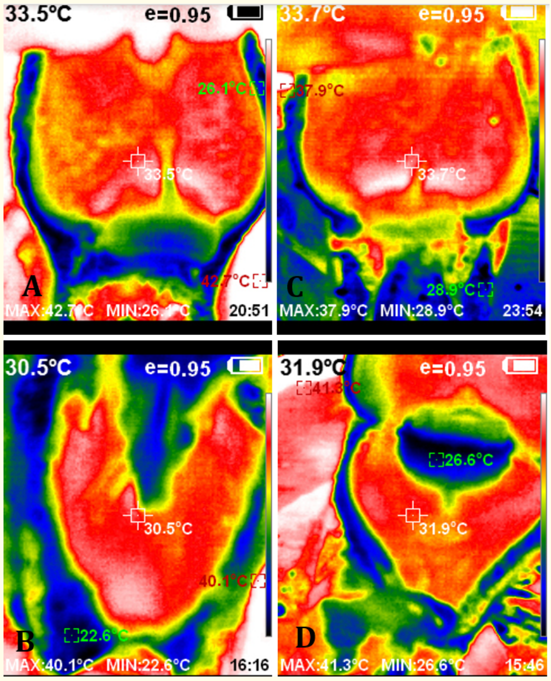

Figure 5: Infrared Thermography of the camel lips showed the mucosal surface of upper and lower lips appeared darker and homogenous pattern with average temperature 31.2±2.3°C for A, B, young camels and C, D adult camels.

stretched lips appeared lighter and heterogeneous compared to the darker and homogenous pattern in the non-stretched lips as shown in figure 6.

The average temperatures gradually increased until they reach the highest level at day 6 in all stretched groups where the average values were 34.05 ± 1.2°C, 34.4 ± 1.0°C and 32.6 ± 0.9°C for young age groups stretched 3, 4 and 5 times respectively and the values for adult groups stretched 3, 4, and 5 times were 31.95 ± 1.5°C, 33.45 ± 2.2°C and 31.85 ± 0.8°C respectively. On day 150, the temperatures values dropped below the normal temperature and became 25.1 ± 1.6°C, 26.15 ± 1.3°C and 28.0 ± 1.0°C for young age groups stretched 3, 4 and 5 times respectively, and 25.6 ± 2.2°C, 24.9 ± 1.7°C and 25.4 ± 1.4°C for adult groups stretched 3, 4, and 5 times respectively as shown in table 3.

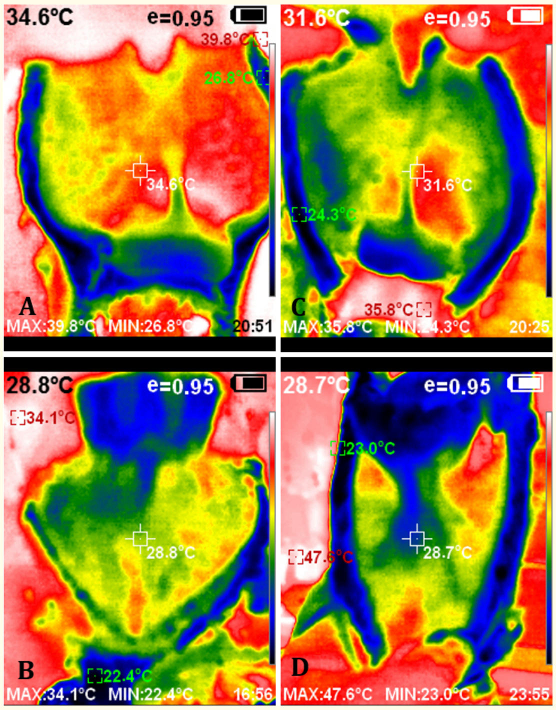

Figure 6: Infrared Thermography of the camel lips demonstrated that the mucosal surface in the stretched lips appeared lighter and heterogeneous with average temperature lower than normal 28.2±1.1°C for A, B, young camels and C, D adult camels.

Groups	°C	d2	d4	d6	d8	d10	d14	d21	d37	d90	d150
Young 3 times	Minimum	24.2 ± 0.2	21 ± 0.5	28.4 ± 0.4	27.3 ± 0.5	26.7 ± 0.6	22.4 ± 0.4	21.5 ± 0.7	20 ± 0.7	19.4 ± 0.8	19.2 ± 0.6
	Maximum	32.7 ± 0.6	34.1 ± 0.8	39.7 ± 0.8	38.1 ± 0.6	37.6 ± 0.7	33.2 ± 0.8	34.8 ± 0.9	31.3 ± 0.6	31.3 ± 0.6	31.0 ± 0.8
Young 4 times	Minimum	23 ± 0.9	22 ± 0.2	29.5 ± 0.7	28.3 ± 0.6	27.2 ± 0.7	24.2 ± 0.7	22.1 ± 0.8	20.7 ± 0.6	20.1 ± 0.7	19.7 ± 0.6
	Maximum	33 ± 0.3	35 ± 0.5	39.3 ± 0.4	39.7 ± 0.8	38.1 ± 0.7	38.3 ± 0.2	35.7 ± 0.8	32 ± 0.9	32.9 ± 0.8	32.6 ± 0.9
Young 5 times	Minimum	29.3 ± 0.5	30.1 ± 0.6	29.3 ± 0.3	30.1 ± 0.8	25.9 ± 0.8	30.1 ± 0.7	25.9 ± 0.6	25.8 ± 0.7	23.5 ± 0.8	23.2 ± 0.5
	Maximum	34.4 ± 0.7	40.5 ± 0.5	35.9 ± 0.2	35.1 ± 0.7	39.1 ± 0.4	35.1 ± 0.4	39.1 ± 0.5	37.4 ± 0.5	36 ± 0.9	35.8 ± 0.8
Adult 3 times	Minimum	23.4 ± 0.1	19.5 ± 0,3	28.6 ± 0.3	27.6 ± 0.5	26.2 ± 0.9	24.9 ± 0.9	24.1 ± 0.5	19.6 ± 0.7	19.5 ± 0.5	19.0 ± 0.9
	Maximum	31.9 ± 0.6	33.5 ± 0.9	35.3 ± 0.8	35.0 ± 0.9	34.9 ± 0.6	34.6 ± 0.3	34 ± 0.9	32.5 ± 0.8	32.7 ± 0.7	32.2 ± 0.7
Adult 4 times	Minimum	27.6 ± 0.3	24.2 ± 0.7	31.2 ± 0.7	30.3 ± 0.8	30.1 ± 0.6	30.4 ± 0.5	21.8 ± 0.7	19 ± 0.7	18 ± 0.6	18 ± 0.8
	Maximum	33.8 ± 0.8	34.3 ± 0.3	35.7 ± 0.6	36.4 ± 0.7	35.9 ± 0.7	34.1 ± 0.8	33.6 ± 0.5	32.5 ± 0.6	32.1 ± 0.7	31.8 ± 0.5
Adult 5 times	Minimum	28.1 ± 0.2	29.2 ± 0.6	30.1 ± 0.5	28.9 ± 0.7	27.1 ± 0.8	21.1 ± 0.7	20.1 ± 0.9	19 ± 0.9	18 ± 0.8	18.1 ± 0.8
	Maximum	33.4 ± 0.4	34 ± 0.9	33.6 ± 0.7	33.8 ± 0.7	33.4 ± 0.7	33 ± 0.6	32.1 ± 0.7	32.4 ± 0.6	32.8 ± 0.6	32.7 ± 0.7

Table 3: Mean ± SEM values about Infra-red thermography in the different treatment groups in all checking points, expressed as minimum and maximum temperature (°C).

Day/GROUP	°C	Young 3 times	Young 4 times	Young 5 times	adult 3 times	adult 4 times	adult 5 times
D2	Minimum	24.2	23	29.3	23.4	27.6	28.1
	Maximum	32.7	33	34.4	31.9	33.8	33.4
	Mean ± SD	28.45	28	31.85	27.65	30.7	30.75
D4	Minimum	21	22	30.1	19.5	24.2	29.2
	Maximum	34.1	35	40.5	33.5	34.3	34
	Mean ± SD	27.55	28.5	35.3	26.5	29.25	31.6
D6	Minimum	28.4	29.5	29.3	28.6	31.2	30.1
	Maximum	39.7	39.3	35.9	35.3	35.7	33.6
	Mean ± SD	34.05	34.4	32.6	31.95	33.45	31.85
D8	Minimum	27.3	28.3	30.1	27.6	30.3	28.9
	Maximum	38.1	39.7	35.1	35.0	36.4	33.3
	Mean ± SD	32.7	34	32.6	31.3	33.35	31.15
D10	Minimum	26.7	27.2	25.9	26.2	30.1	27.1
	Maximum	37.6	38.1	39.1	34.9	35.9	33.4
	Mean ± SD	32.15	32.65	32.5	30.55	33	30.25
D14	Minimum	22.4	24.2	30.1	24.9	30.4	21.1
	Maximum	33.2	38.3	35.1	34.6	34	33
	Mean ± SD	27.8	31.25	32.6	29.75	32.2	27.05
D21	Minimum	21.5	22.1	25.9	24.1	21.8	20.1
	Maximum	34.8	35.7	39.1	34	33.6	32.1
	Mean ± SD	28.15	28.9	32.5	29.05	27.7	26.1
D37	Minimum	20	20.7	25.8	19.6	19	19
	Maximum	31.3	32	37.4	32.5	32.5	32.4
	Mean ± SD	25.65	26.35	31.6	26.05	25.75	25.7
D90	Minimum	19.4	20.1	23.5	19.5	18	18
	Maximum	31.3	32.9	36	32.7	32.1	32.8
	Mean ± SD	25.35	26.5	29.75	26.1	25.05	25.4
D150	Minimum	19.2	19.7	23.2	19.0	18	18.1
	Maximum	31.0	32.6	32.8	32.2	31.8	32.7
	Mean ± SD	25.1	26.15	28.0	25.6	24.9	25.4

EMG of the camel lips

Electromyography (EMG) is a sophisticated electrodiagnostic-neurophysiological method, which serves to diagnose neuromuscular system diseases. It is based on the measurement of the electrical potentials created by the skeletal muscle activity.

Within control groups, a healthy, pathologically unchanged lips muscles, spontaneous activity was observed, recorded and expressed as amplitude. The average of the amplitude for control group was 1.036 μV.

In stretched young groups the average amplitude for M. Orbicularis Oris, M. Mentalis, M. Incisivus Superioris and M. Incisivus Inferioris was significantly decreased ($P < 0.05$)in comparison to control groups on day 21 where recorded 0.2 ± 0.15, 0.45 ± 0.14 and 0.12 ± 0.16 μV for young groups that stretched 3, 4, and 5 times respectively, whereas in adult group, the average amplitude was also significantly decreased ($P < 0.05$) on day 37 when compared to the control group to be 0.1 ± 0.10, 0.1 ± 0.13 and 0.17 ± 0.13 μV in groups that stretched 3, 4, and 5 times respectively as s illustrated in table 4.

Groups	Parameters	d2	d4	d6	d8	d10	d14	d21	d37	d90	D150
Young 3 times	Amplitude	0.9 ± 0.1	0.75 ± 0.13	0.55 ± 0.12	0.49 ± 0.12	0.37 ± 0.14	0.3 ± 0.11	0.2 ± 0.15*	0.56 ± 0.15	0.68 ± 0.12	0.57 ± 0.12
Young 4 times	Amplitude	1.37 ± 0.11	0.68 ± 0.11	0.73 ± 0.15	0.56 ± 0.17	0.52 ± 0.13	0.48 ± 0.12	0.45 ± 0.14*	0.51 ± 0.14	0.84 ± 0.16	0.88 ± 0.11
Young 5 times	Amplitude	0.8 ± 0.14	0.6 ± 0.15	0.53 ± 0.12	0.12 ± 0.13	0.16 ± 0.16	0.12 ± 0.14	0.12 ± 0.16*	0.6 ± 0.12	0.46 ± 0.13	0.49 ± 0.13
Adult 3 times	Amplitude	0.48 ± 0.11	0.28 ± 0.14	0.11 ± 0.13	0.1 ± 0.12	0.2 ± 0.12	0.45 ± 0.12	0.46 ± 0.13	0.1 ± 0.10*	0.26 ± 0.14	0.28 ± 0.12
Adult 4 times	Amplitude	0.51 ± 0.11	0.55 ± 0.13	0.19 ± 0.13	0.1 ± 0.12	0.13 ± 0.13	0.28 ± 0.14	0.29 ± 0.14	0.1 ± 0.13*	0.2 ± 0.15	0.4 ± 0.16
Adult 5 times	Amplitude	0.73 ± 0.11	0.71 ± 0.12	0.37 ± 0.14	0.41 ± 0.11	0.17 ± 0.13	0.21 ± 0.13	0.39 ± 0.11	0.17 ± 0.13*	0.43 ± 0.12	0.48 ± 0.12

Table 4: Mean ± SEM values about EMG of camel lips in all stretched groups in the different checking points expressed as μV amplitude. *Means having $P < 0.05$ are statistically different when compared to control groups.

Computed tomography of the camel lips

On a CT scan, the normal dermis in the control group appeared as an isodense structure as illustrated in figure 7. While after stretching in all groups on day 2, 4, 6, 8 and 10, the tearing in tissues and edema appeared hypodense areas within isodense structure of the dermis as in figure 8, and started to decrease on day 14 with formation of hyperdense structure which begun to increase on day 37 and became more clear on day 90 and 150 as bright white shades with white spots within soft tissue but in a smaller amount at young ages compared to adult ages in all stretched groups as in figure 9.

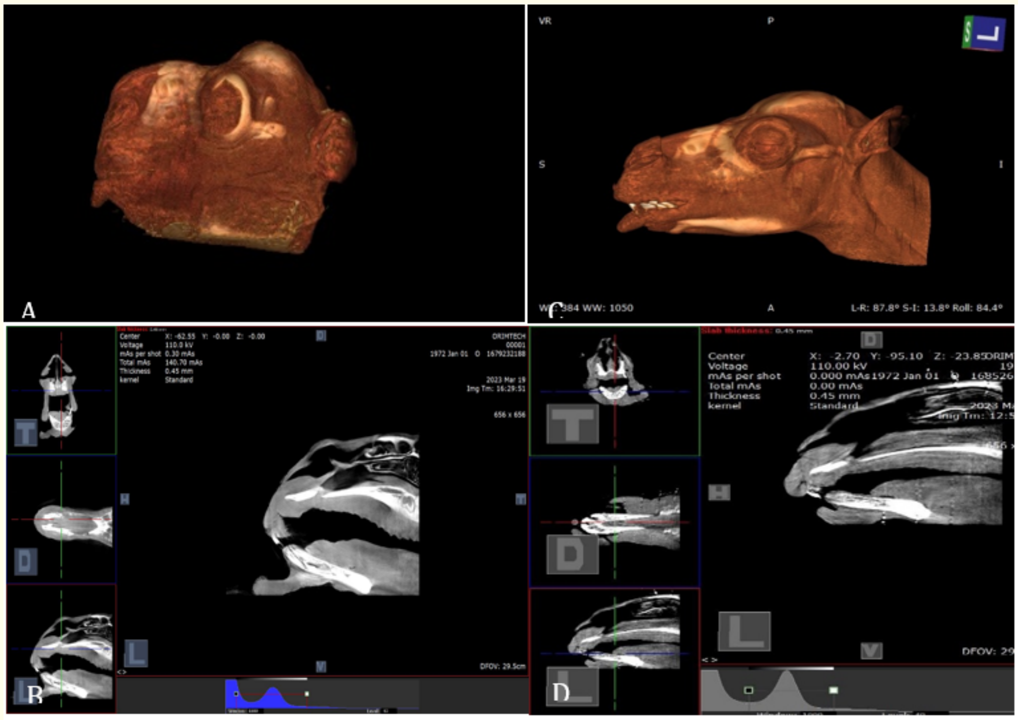

Figure 7: Computed tomography shown Normal lips appeared as an isodense structure (gray shades) for A, B, young camels and C, D adult camels.

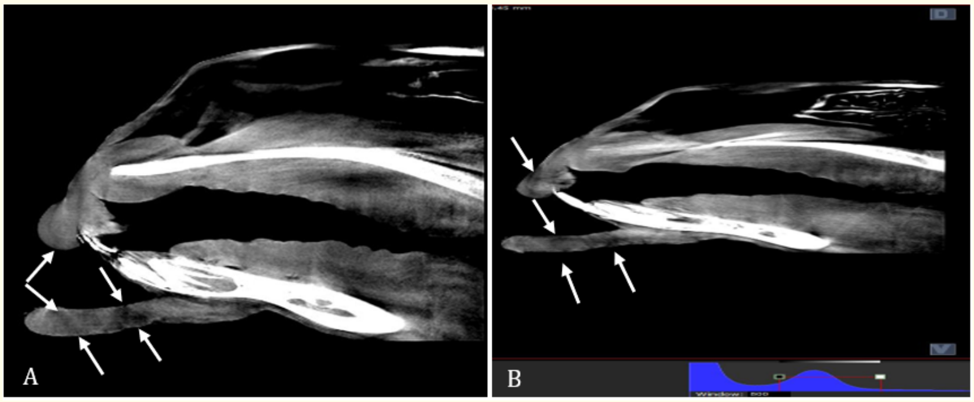

Figure 8: Computed tomography shown tearing tissue in stretched lips appeared as hypodenisity black shade areas (white arroaws) within normal isodense gray shade muscle of A, young and B, adult camels.

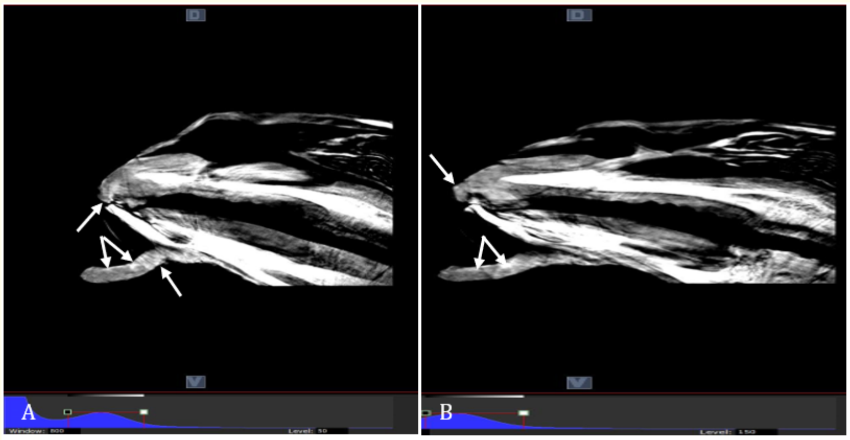

Figure 9: Computed tomography shown fibrosis in stretched lips appeared as hyper density lesion within normal isodense gray shade muscle of A, young and B, adult camels.

Discussion

Cosmetic enhancement in camels is currently rampant in the Gulf region, and the use of one of the most common cheating method known as "lips stretching" for purposes of rejuvenation. Years ago, authorities discovered dozens of breeders had stretched out the lips and noses of camels, used hormones to boost the beasts' muscles, injected camels' heads and lips with Botox to make them bigger, inflated body parts with rubber bands and used fillers to relax their faces [29].

To the best of the authors' knowledge, in veterinary medicine, there are no reports describing the detection of lips stretching and its effects on the lips morphology in dromedary camels. The present study was carried out to identify and describe the most frequent tissue's alterations resulting from lips stretching in the head region of camels using ultrasonography, Infrared thermography, electromyography and Computed tomography; moreover, the usefulness of these diagnostic methods to evaluate one of the most common cheating cosmetic procedure "lips stretching" in camel beauty enhancement was assessed.

High-resolution ultrasound imaging is extensively used in the workup of muscle injuries. With the advent of the latest generation high-resolution ultrasound scanners equipped with high-frequency probes and advanced B-mode and Doppler technology, muscle tissue can be imaged in exquisite detail allowing the depiction of subtle abnormalities [30,31].

Ultrasound can be used as an important and easily accessible modality to evaluate the location, extent and severity of a muscle injury, can provide information that predict the prognosis of muscle injury [32,33].

The ultrasound features of muscle with mild (grade I) injury that appears as an echogenic area in the muscle, normal healing typically presents as a decrease in the size of the lesion and return to normal echotexture. In the case of more severe injury (Grade II and III), the hypoechoic areas corresponding to fluid collections gradually decrease in size and isoechoic or echogenic tissue corresponding to scar tissue gradually fills the gap [34,35].

In the present study, Ultrasound imaging showed anechoic and/or hypoechoic features and was imaged as small or large, single or multiple areas of tissue tearing and edema formation.

The typical US appearance of scar tissue is that of an echogenic homogeneous or inhomogeneous irregular area which may be surrounded by a hypoechoic halo [30]. The hypoechoic area may be associated with significant posterior shadowing, which is an artifact caused by the presence of irregularly oriented dense fibrous tissue. Minimal amount of scar tissue may be depicted as irregular thickening of the muscle fascia or aponeurosis, which can only be appreciated when compared to the contralateral asymptomatic side [34].

During the remodeling phase of muscle injury, the regenerated fiber contains a small amount of well-organized scar tissue. 10 days after injury, scar maturation is complete; however, it takes weeks to months to return to pre-injury muscle strength [35,36].

In the current study, in all stretched groups, definitely on day 14 from stretching the Ultrasound imaging also showed hyperechoic images, with different degrees of hyperechogenicity, which clearly suggested presence of different amount of fibrosis at the reticular dermis and subcutaneous cellular tissue levels than the control group. Where the fibrosis appeared as hyperechoic spots and small threads.

Young ages groups whose lips have been stretched for 3, 4, and 5 times are more susceptible and affected by tissue tearing and swelling in the lips, and less affected by fibrous tissue formation, because at young ages the rate of tissue healing is much faster and better compared to adult ages groups that also stretched for the same times as young ages groups.

In animals, thermography is a satisfactory technology as it is safe and the infrared camera is distant from the subject being evaluated [37]. The temperature of air, heat transmission and radiance affect the 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 [38]. 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 [39].

Healthy Camels evaluated by IRT were selected on the basis of the absence of any dermatologic lesions, which could intervene with the thermographic temperature. The thermographic measurements of the upper and lower lips were 31.2±3.0 and 31.0±2.4 respectively [40].

In this study, Camels evaluated by IRT in control groups were selected on the basis of absence of scars, injuries, or any skin diseases, which could interfere with the thermographic temperature and when tested by IRT, the mucosal surface of upper and lower lips appeared darker and homogenous pattern with average temperature 31.2±2.3°C for upper and lower lips of all camels.

At day 6 in all stretched young and adult groups the average values for thermographic temperature were significantly higher than control group this may be due to the inflammatory reaction of tissue tearing from stretching, while on day 150, the temperatures values dropped below the normal temperature compared to normal groups and this would be a result of overstretching damage lips tissues and tends to result in a buildup of fibrotic tissue that led to increase tissue thickness and reduction of healthy blood flow.

Electromyography is an electrodiagnostic method in which the electrical activity (potentials) of the patient's muscle fibers and nerves are detected and recorded. Electromyography (EMG) is the recording of insertional, spontaneous, and voluntary electric activity of muscle [41].

Studies of individual muscles provide the possibility of directly identifying the affected muscle fibers [42] and EMG is one of the methods that can be used for the assessment of neuromuscular disorders [43].

Evaluation of the peripheral motor system, when the main clinical symptom is neuromuscular weakness, consists of electromyography itself, measurements of the motor nerve conduction velocity, evaluation of F-waves, and repeated stimulation of motor nerves [44].

An electromyographic examination is widely used to record the typical electrical activity (action potentials), to identify denervated muscles and to characterize myopathies. Typical electrical activities, which is detected by the EMG can be divided into spontaneous activities that consists of potentials which are not dependent on the mechanical stimulation, and abnormal activities [45].

Within a healthy, pathologically unchanged muscle, spontaneous activity can be observed, but these waves must be distinguished from models indicating abnormal activity. Four types of normal spontaneous activity can be recognized: insertional activity, miniature potentials of end plates, end plate spikes and action potentials of motor units [43].

The input or insertional activity is caused by the mechanical irritation of the muscle fiber, needle puncture or when the muscle is completely atrophied and might be replaced by connective or adipose tissue (also ossifying or fibrotic myopathies). This activity can be absent or reduced and prolonged when the muscles are denervated. Increased or prolonged insertional activity can be a sign of early denervation atrophy, but it is also seen in myotonic disorders and myositis [46-48].

EMG used as a part of the neurological examination in a patient suffering from facial paralysis with hypothyroidism. The EMG of the main facial muscle groups was performed using a concentric needle electrode. They found a slightly abnormal spontaneous electrical activity, where fibrillation potentials and positive sharp waves were recorded. After the hypothyroidism treatment, the facial paralysis resolution and improvement of the patient's clinical findings were recorded. Re-examination of the EMG revealed some regenerative findings, poly-phasic potentials, and an increasing number of phases of the motor unit in the muscles of the head, indicating the patient's recovery [49].

In this study we found that in all stretched groups the average amplitude for lips muscles was significantly decreased on day 21 and day 37 for young and adult groups respectively compared to control groups and this may be due to the muscles fiber damage then the amplitude begun to increase again on day 90 and 150 due to partial muscle recovery from tearing but not complete recovery as normal due to fibrous tissue formation in lips tissue.

The density of the body tissue determines the degree to which the x-rays are attenuated. In turn, this affects the brightness and contrast of the imaged tissues. Those tissues with high attenuation coefficients (strong absorption) show up white like bone and scars, and those which absorb with low attenuation coefficients (weak absorption) show up black like water, edema. This is quantified by the Hounsfield Scale of radiodensity, where the Hounsfield unit for bone +1000 and scars +400 so, appears white while the soft tissue Hounsfield unit is +40 to 80 so, appear gray whears the water Hounsfield unit is 0 so, appear black [50]. In our results, on a CT scan, the normal dermis in the control group appeared as an isodense structure with Hounsfield unit 45.

Acute muscle injury appeared as areas of hypodensity within the muscle 1-2 d following injury. This suggests that inflammation and edema are the major component of injury, not bleeding as commonly assumed [51]. Tissue tearing are characterized by tearing of fibers and a subsequent inflammatory reaction with increase fibrous or scar tissue at a site of tearing. The inflammatory reaction involves edema and more tissue water. On CT examination this edema would be expected to produce an area of lower density than normal muscle due to different linear attenuation coefficients of water and muscle [52,53].

Findings of this study suggested that tissue tearing of the lips is detected acutely on CT examination as a lower density lesion and the presence of hypodenisity areas within normal muscle would tend to support inflammation or edema as a major component of the tissue tearing. The area of hypodenisity on the CT resolve with time; however, the muscle of lips does not always return to the normal. Where at different sites of tissue tearing developed fibrosis on followup CT examinations.

Conclusion and Recommendations

This article reviews the role of ultrasound, EMG, IRT and CT imaging in diagnosis and highlighting its importance in tracking the effects and complications of lips stretching on the tissue as a popular cheating cosmetic procedure in dromedary camels and monitoring the changes that occur in the nature of the tissue at long intervals, whether they are recent or old changes. Where Dynamic ultrasound with Doppler imaging ideal to follow up lips tissue injury from stretching and depict complications, as it is widely available, quick and allows dynamic and contralateral scanning that facilitates the depiction of minimal lesions and allows an early accurate diagnosis of tissue changes. Electromyography reveals the presence, location and extent of such damage. Measuring the electrical activity of the examined muscles helps to reveal the cause of their weakness. Infrared thermal imaging is a noninvasive imaging modality used as a screening tool for measuring the surface body heat and produces a color map that represents the heat distribution along the lips. Where lips stretching leads to changes in the local dermal microcirculation and subsequent alteration of surface heat of lips. CT scan is a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce images of the inside of the lips. It shows detailed images of any changes in nature of lips tissue, including the edema and fibrosis formation. Therefore, based on our results we recommend the use and application of this diagnostic protocol followed in this study as a guide and screening method for changes resulting from lips stretching and other methods which used as cheating cosmetic procedures in dromedary camels.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contribution

The authors confirm contribution to the paper as follows: study conception and design, data collection, analysis and interpretation of results and draft manuscript preparation: Ellawatty WAE., Karem H.: All authors reviewed the results and approved the final version of the manuscript.

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