A Study on the Strain and Function of One-Humped Dromedary Foot Pad

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Abstract

The purpose of this study is to describe and identify the evident analysis of one humped dromedary foot. The analysis impacts in fine sand of the camel sole in slipper regions, which would be used in diagnosis of foot and footpad disorders. Behaviour of sole pad penetration into sand was predicted on camel's fore and rear feet using computed technique, for the corresponding sections at the same weights and speeds and for their selected identity. For analysis, a 3D model was used. The results revealed that, their planter surfaces were separated from the ground by foot pad and the interdigital notch of the sole pad were appeared with various scales and colors.

Keywords: Dromedary, Foot Pad, Interdigital Notch, Strain

1. Introduction

This era is the era of scientific prosperity and the era of the emergence of Quran miracles. It has many aspects of the Qur'anic miracle from multiple angles which man is seen as neutral to the book of Allah. These aspects of the verse, Allah the almighty say in Holy Quran (Then do they not look at the camels - how they are created?) [1], commanding people to speculate on his creatures that indicate his absolute power and greatness. They are flamboyant while walking. The miracle of Allah in creating camels is marvellous and their structure is unique. They are very strong and powerful. Nevertheless, they can transport very heavy loads.

The dromedary walks only on the pads of the two last phalanges, instead of on the sole of the foot, and is therefore regarded as a hoof less digitigrade [2]. The interdigital notch of the dromedary sole pad is a particularly important component of its locomotor analysis because they bear the weight of the body mass.

Various aspects of dromedary have been studied, including computed tomography studies; El-Shafey and Sayed-Ahmed 2012 [3]; El-Shafey and Kassab 2013 [4]. It has many features, has long legs that end with beautifully created hooves which consist of two toes on each foot, each one of them has a big flat nail. And underneath each toe a wide fleshy skinny pad which allows the camel to walk easily on rocky slippery ground or loose sand without sinking with what it carries of heavy weights as well as its huge body. The foot pad expands when the camel stomps on the ground and can walk up on soft sand, which is difficult for any other animals.

Dromedary is a fascinating animal and very little study has been reported. It is a unique among artiodactyls in their regular employment of pacing gait and having a unique foot morphology assumed to be an adaptation for this mode of locomotion [5, 6]. The designed wide spread feet enables camel to walk on shifting sand in the desert and rough rocky terrain whereas the footpad is used to grip onto rock and steep inclines. Their feet are secondarily digitigrade, with a splayed-toed foot, loss of hooves addition of a broad foot pad and loss of the interdigital ligaments, allowing the divergence of the third and fourth digits [6-7]. Imaging techniques add a major value to evaluation of soft tissue. Computed technique such as SOLIDWORKS, through its high spatial resolution and moderate differentiation of tissue contrast is a fastened exceptionally useful technique for visualizing to be proved. Imaging techniques of color scale play a major role in the modern research [8, 9]. The main objective of this study was to describe corresponding images of the foot pad in one-humped camel, which provides data, would be used for evaluation and diagnosis of sole foot pad abnormalities.

Penetration processes are highly dissipative and dissipation occurs in small regions. [10] In a ground firing test of cannonballs, inactive cannonballs are fired onto the particle medium like sand. When a cannonball penetrates into sand, the kinetic energy of the cannonball turns into frictional energy. If many cannonballs are fired into sand, the sand. Particles tend to get hardened due to large frictional heat. Because of the hardening phenomenon, the number of cannonballs that can be fired is limited, and much cost is needed to change the hardened sand. For an efficient management of an impact test site, the temperature distribution in the sand should be known causing hardening phenomenon.

2. Compositional and Physical Properties

As the camel toe is one of skin types in its own compositions, as well as it is distinguished by its particular mutations in blood vessels. The sunken layer has sweat glands (tubular, ramified and highly twisted) arranged in egg-shaped clusters [11], as it is about 24 mm deep of the outer surface of the dermis layer, figure-1. The difference between the sweat glands on the surface of the camel's body and the sweat glands in the sole is in the way that cells are secreted. Whereas it is tubular and corrosive (apocrine) on the camel's body, it is non-corrosive (merocrine) in the sole. These glands mitigate the temperature of the toe or maintain the temperature stability when the heat of the sand that camels walk on increases.

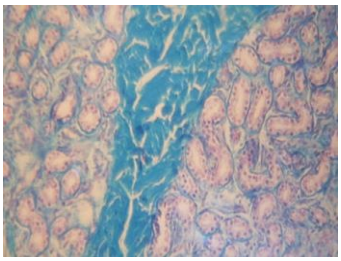


Fig.1. Sweat glands clusters underneath the dermis layer in the camel sole

The length of the camel soles is about two meters from shoulders, and that is due to its long legs which keep the body away from the hot ground. The sole has high physiological and mechanical abilities. It is designed in a way not to be instilled in sand and not to cause obstruction in movement. It is also a dielectric material which protects the camel from lightning strikes that occur in clouds. Furthermore, it is a water pad and used to store water as the toe tissues store water in strand chains. As the stored water increases, the strand wraps more and vice versa. When there is a need for water, the blood absorbs water from the toe and the strand breaks to stay alive for more than three months without water. The camel retains water in the toe in gelatine and crystal pieces that is converted into liquid water which flows with blood plasma when needed.

The scientific truth in the camel's toe is that it is characterized as a soft elastic tissue like dough and semicircular in shape. The dimensions are (18*19 cm) in the front legs and (16*17 cm) in the rear legs. The reason of the difference in dimensions, that the front half is heavier than the back half because of the head and the neck. Unlike human, the toe has a small incision in the front that looks like inseparable two fingers. Therefore, camels are called uncloven hoof as stated in Holy Quran [12]. What is remarkable in the toe is its strength and durability that can carry a huge animal which may weigh more than 700 kg as well as more than 250 kg of load. The sole pad carries this weight and does not explode - despite its softness-, even it expands when it comes into contact with the ground and then return to its normal size when rising from the ground, "Glory to Almighty Allah.". Camels walk in the desert carrying loads for long hours on hot sand or rocky slippery ground on which the temperature may reach more than 70 degrees Celsius. The dromedary foot pad consists the following:

1. Thin layer of hard skin, its thickness of about 11 mm.
2. Padded layer for the skin.
3. Flexible tissues.
4. Phalanx bone.
5. Pad of fat based on the Phalanx bone.

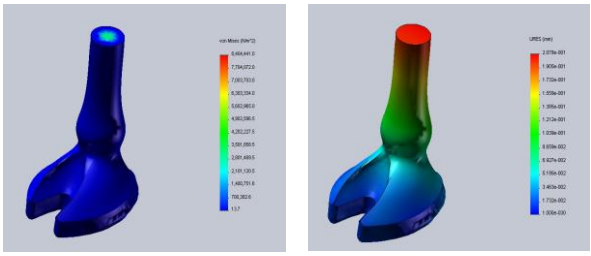
3. Penetration Depth of Dromedary Foot

Figure 2 shows the picture of dromedary foot. Its bones are the densest tissue of the foot and handled it like a wrought calcium, where the sole pads characterized by its round shape with short interdigital cleft (notch), figure-2.



Fig. 2. View of dissected dromedary foot

Since there is no significant differences between the right and left sides of the digital bones in the thoracic and pelvic limbs, and to obtain reliable results the material of the sole pad proposed as rubber.



(A) (B)

Fig. 3. Static nodal stress and displacement of dromedary foot

Figure 3, (A) represents the static nodal Stress of Min: 13.712 N/m^2, Max: 8.40444e+006 N/m^2, where (B) shows static displacement of Min: 0 mm, and Max: 80.207809 mm. The reaction forces (N) for the three (X, Y, and Z) axes of figure 5 are; -0.00217844, 1488.27, -0.00279227, respectively.

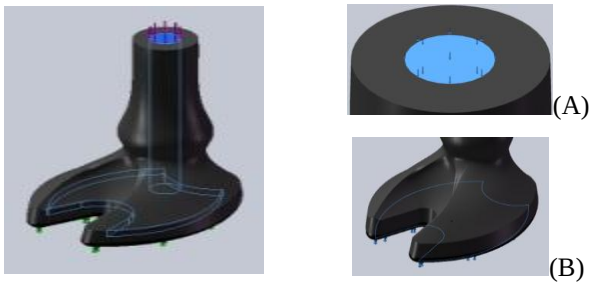


Fig. 4. Boundary condition of dromedary foot

Figure 4 shows the linear elastic isotropic of the dromedary foot, (A) apply normal force, and (B) fixed geometry.

4. Breadth of Foot Pad

The digital bones of the dromedary are particularly important components of its locomotor anatomy because they bear the weight of the body mass. Four different computed images figure 5, were obtained and labelled for feet sole pads. The images provided excellent depiction and details of explicit analysis when compared to their real

actual movements. The properties of the sand were selected from SOLIDWORKS explicit material data. The equivalent strain of figure 5 located at the range of 1.97237e-007 and 0.0089892. The gravitational acceleration was applied to both the sand and sole pad.

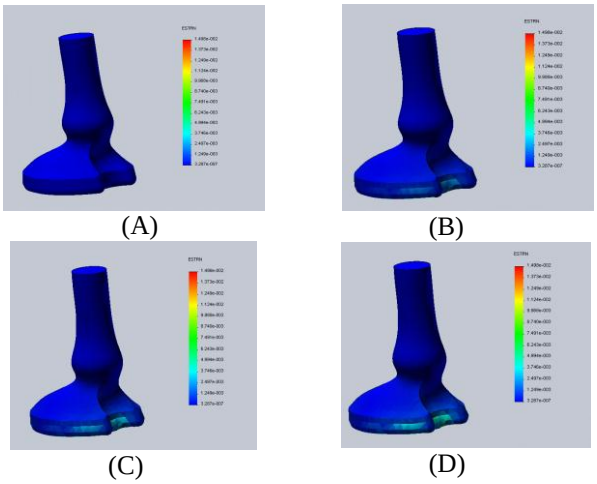


Fig. 5. Dorsal view of computed camel interdigital notch strain

5. Discussion

The data presented in this study would serve as an initial reference for the evaluation of imaging of the one-humped dromedary foot pad. SOLIDWORKS is a very useful tool and could be covered all aspects of research development process. It is a planar imaging modality, whereas a three-dimensional structure can obscure or confuse important findings. Figure 3, A, B, C, and D provide images at the level of the sole pad, showing somewhat round sole and interdigital notch connection with the ground movement. Noticed the exponential relationship between the interdigital notch and the sole pad, as the weights of the dromedary increase the interdigital notch increases squatting. The sagittal sections with their identical images were provided more excellent depictions of the computerized structures of the interdigital notch in camel footpad. The right side feet move forward together, then the feet of the other side, as if it walks on two legs not four. The feet cushion might serve to absorb mechanical shock, store and return elastic strain energy, protect against local stress and keep pressure low and exhibit similarities to the feet of humans [13].

6. Conclusion

It was concluded that, dromedary has unique feet peculiarities. Explicit Analysis with efficient imaging modality that provides images with superior soft tissue differentiation and no superimposition of the overlying structures, which can be used for better diagnosis of foot pad abnormalities. The dromedary feet have a wide padded interdigital notch that helps it to walk on the soft slippery sand without sinking in. The reason is that the toe is like a foot rest or fins but not fingers. The dromedary walks on hooves heads or fingers as other animals. It has a unique feature in its gait among quadrupeds.

References

[1] Holy Quran, Surat Al-Ghāshiyah 17.

[2] Jamal Nourinezhad, Yazdan Mazaheri, and Mohammad Reza Ahi, 2014, Metrical analysis of dromedary digital bones, Japanese Association of Anatomists, 90:113–122.

[3] El-Shafey A, Sayed-Ahmed A (2012) computed tomography and cross sectional anatomy of the metacarpus and digits of the one humped camel (Camelus dromedaries) and buffalo (Bos bubalis). Int. J Morphol 30:473–482.

[4] El-Shafey A, Kassab A (2013) computed tomography and cross sectional anatomy of the metatarsus and digits of the one humped camel (Camelus dromedaries) and buffalo (Bos bubalis). Anat Histol Embryol 42:130–137.

[5] Webb, S.D., 1972. Locomotor evolution in camels. Forma et Functio, 5: 99-112.

[6] Janis, C.M., J.M Theodor and B. Biosvert, 2002. Locomotor evaluation in camels revisited: A quantitative analysis of pedal anatomy and the acquisition of the pacing gait. J. Vertebrate Paleontol, 22(1): 110-121.

[7] Masahiko, M.T., Y. Tetsuya, K. So, B. Rai and H. Yoshihiro, 2002. Regional anatomy of the camel ll. Comparison of the sole pads of the forelegs and hind legs of the two-humped camel (Camelus Bactrainus). Yamaguchi J. Veterinary Med., 29:11-18.

[8] Olsen A.K., D. Zeidler, K. Pedersen, M. Sorensen, S.B. Jensen and O.L. Munk, 2007. Imaging S.B. Jensen and O.L. Munk, 2007. Imaging techniques: CT, MRI and Pet scanning, pp 387-395. In Swindle MM: Swine in laboratory. Surgery, aesthesia, imaging and experimental techniques. CRC press.

[9] Olsen, A. K. and M. Winter Dahl, 2009. Imaging techniques in large animals. Scandinavian J. Laboratory Animal Sci., 36(1): 55-66.

[10] Marvin E. Beckman, Werner Goldsmith, "The Mechanics of Penetration of Projectile into Target," International Journal of Engineering Science, vol. 16(1), pp.1-99, 1978.

[11] Saber, A.S. B. Schenk-Saber and A. Kelany (1988), "The foot pad glands of the dromedary (Camelus dromedaries)", XVII EAVA Congress, Regensburg F.R.G.

[12] Holy Quran, Surat Al Anaam 146

[13] Taylor, D.D., D.M. Hood, G.D. Potter, H.A. Hogan and C.M. honnas, 2005. Evaluation of displacement of the digital cushion in response to vertical loading in equine forelimbs, American J. Veterinary Res., 66: 623-629.