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Ultrasound and Anatomical Study of the Auricular Cartilages of Camel (*Camelus dromedarius*) Referring to its Surgical Applications in Cosmetic Operations

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Abstract

The aim of this study was to describe the anatomical structure of the pinna cartilages as well as to determine and test the importance of high-frequency ultrasound in the measurement of layer-thickness of auricles that known as the base information of surgical applications. Twelve heads of apparently healthy camels, 1-4 years old, were used in this study. The study showed that the pinna consists of a thin lamina of elastic cartilage covered with skin and hair. It is supported by three cartilages namely auricular, scutiform and annular cartilages connected to the skull. They are propped up by ligaments. Moreover, the study reviewed the normal auricular cartilage of the external ear appearance and dimensions. Also, the results of the research showed nerve supply of the cartilages from the cranial and caudal auricular branches of the auriculo-temporal nerve. While the blood supply of the cartilages by two arteries; the caudal and rostral auricular arteries. Also, the results showed ultrasound imaging of the normal auricular cartilage and its true dimensions. This study points to the importance of surgical application of the auricular cartilage as a result of its exposure to many injuries and wounds, especially the shearing with a view to cosmetology. Also, the results showed ultrasound imaging of the normal auricular cartilage and its true dimensions. The purpose of this work gets detailed information of the cartilages of the ear in camel with an indication of their surgical applications.

Key words: Anatomical External ear, Camels, cartilage, surgical applications.

1. Introduction

The ear is considered a sensory hearing organ responsible for hearing and equilibrium. Moreover, it also gathers sound waves together to the external acoustic meatus, which conveys these waves to the tympanic membrane [1]. Pinna skin is thin and exactly attached to the periosteum of the cartilage [2].

The anatomical researches of the cartilages of the external ear were scarce in the domestic animals, especially the camel. Few veterinary researchers and human ear specialist described the anatomical features of the cartilages of the external ear in camel [3,4], in buffalo and cattle [5], in buffalo and bovine [6], in cattle [7], in horse [8] in domestic animals [9,10,11]. They mentioned that cartilages of the external ear were composed of three cartilages; auricular, scutiform and annular cartilage except in dogs which is composed of only two cartilages, auricular and annular cartilages [12]. The shape of the ear is designed by the auricular cartilage in most domestic animals, which gives it permanent hardness [13]. The pinna has many appearances that make it particularly evaluable by ultrasound [14]. Some animals such as sheep may be a useful model for surgical training in some external and
middle ears in humans and sheep [15,16] in humans and pig [17].

2. Materials and methods

Twelve healthy camel’s heads of both sexes and different ages (1-4 years) were used in this study. They were obtained from the Buraidah slaughterhouse, Qassim region, and the Veterinary Teaching Hospital, Qassim University, KSA. Eight heads were preserved in 10% formalin solution, and then were washed by water consequently.

These heads were dissected to investigate morphological anatomical study of the cartilages, ligament, blood and nerve supply as well as the measurement of the auricle.

The measurements of the auricular cartilage were performed as follows: The length of the head is the distance extension between the top of a noose to the nickel crest. The length of the auricle is the distance between the annular ligament to the top of the auricular cartilage. The diameter of the pinna was the distance between its two borders. The distance between the two pinna on the parietal bone according to the midline. The nomenclature used was adoptive by [19].

Ultrasonography Technique

To confirm the normal sonography of ear pinna, of four camel’s heads (female and male) were studied. The sonography apparatus used was Eickemeyer, MAGIC P1 attached with prop convex, Frequency range (MAGIC P1): 2.5-5 MHz extended field-of-view software was used to acquire images of the whole pinna length and thickness.

A great quantity of water was used in the camel ear to allow the typical image of the pinna. A piece of cotton inside the pinna was used during the examination to prevent the entrance of the water, Longitudinal, and extended field-of-view images were obtained.

Measurements of the camel were taken to establish the thickness of the cartilage in millimeters at the middle of the antihelix in the longitudinal axis, and measurements of the lobule in millimeters were taken from the dorsal to the ventral aspects of the epidermal layer in the longitudinal axis.

3. Results

The anatomy of the external ear cartilages in the camel includes; the pinna (auricle) which is the externally and three cartilages as well as the arteries and nerves supply.

The auricle or pinna (Figure 1) is a cartilage projection from two sides of the caudal part of the head, with its large end-directed dorsolateral. It is reinforced by a number of cartilages of different shape and location. It consists of a thin lamina of elastic cartilage covered with skin containing hair.

The skin is thin and closely attached to the auricular cartilage with hair, closely attached and connected to the parts surrounding the muscles and the beginning of the external acoustic meatus. The auricle is funnel slanted laterally, the middle part is wider than the apex and distal part. It has two borders and two surfaces.

The two borders are lateral and medial, the medial border is larger than the lateral one and convex along its extension, while the lateral border is convex proximally and concave distally, while the two surfaces are caudal and rostral.

The caudal surface of the pinna is convex and smooth with little hair, while the rostral surface is concave, covered by hair and presents simple prominent longitudinal ridges called antihelix ridges. Depressions are not as complex as human as well as the antihelix fosses (Figure1), the fosses approach at the ear opening forms the auricular conchae. So the antihelix is described as curved around a deep capacious cavity forming the concha. Near the concha and in the distal part of the auricle forms the tragus, which is spherical bump small that partially covers the ear hole that demarcates the lateral margin of the opening of the ear canal. It is separated from pinna by cranial and caudal intertragic incisures.

Figure 1: A photograph shows auricle (pinna) and its parts in camel.

The Cartilages of the ear:
The external ear has three cartilages that comprise of:
The auricular cartilage (Figures 2,3,5,6,7,8,10,11):

It is the outer portion of the ear. It identifies the shape of the ear, which is funnel-shaped. It composes of a single piece and supports the external ear. It is connected with the skull by annular cartilage through the auricle.

It has two borders and two surfaces: The two borders are lateral and medial, the medial border is larger than the lateral one and convex along its extension, while the lateral border is convex proximally and concave distally. The two surfaces are caudal and rostral.

The caudal surface is convex, while the rostral surface is concave, and presents simple prominent longitudinal ridges called antihelix ridges and depressions are antihelix fosses (Figure1). The distal part of the auricle forming the tragus is spherical small bump that partially covers the ear hole.

The scutiform cartilage (Figures 3,11):

It has a disc shape located on the skull in the temporal region in connection with the ear and temporal muscles. Cranially to the auricular cartilage, it has two facets; superficial and deep. The superficial facet is somewhat convex from side to side while the deep one is concave. The cranial border is thin and rounded; however, the caudal border is wider and thicker. Its medial angle is prolonging by appointed process of about 0.5 cm in length. It is covered with some rostral muscles of the ear.

The annular cartilage (Figures 4,9):

It lies at the lower part of the auricular cartilage. It has a round shape like a ring. It is united medially by elastic tissue and rolled into a short tube, with a diameter of about 1 cm. It consists of two curare; left and right crus. It contacts the distal extremity of the auricular cartilage and contributes a cartilaginous part forming of the entrance of the external acoustic meatus. Furthermore, it surrounds the external acoustic meatus.

The results also showed that the average thickness of normal auricular cartilage was 0.4, the sub cutis and cartilage layer was 0.8 mm thick. The average thickness of the auricular cartilage in the camel's ear was 3 ± 1 mm (range,2.5-3.5 mm).

Concerning the applied anatomy of the auricular cartilage, the auricular cartilage is liable for many diseases and injuries turn to require treatment. The sonography is considered basic for the inference of diseases to distinguish between persuasion, vascular lesions, and tumors.

The length and thickness of the auricle cartilage are essential for cosmetic cheating (shearing), especially in the top of auricular cartilage in camels that increase the animal's beauty. The ratio between the length of the ear and the length of the head was, for example, 1/8 in all cases.
The results showed that the relationship between the head length to ear length ratio was almost constant. Also, the relationship between both the length and the width of the ear was almost constant. The width of the ear was about 1/2 lengths in most of the studied specimens.

The auricular cartilages of the external ear derive the nerve supply (Figure 12) from the cranial auricular branch and a caudal auricular branch from auricular-temporal nerve from the facial nerve. The cartilages received the blood supply by two arteries; the caudal and rostral auricular arteries (Figure 13).

The caudal auricular artery originates from the external carotid artery directly, while the rostral auricular artery arises from the superficial temporal which emerges from the external carotid artery. The caudal auricular artery branches into three arteries on the convex surface of the auricle, the medial, intermediate and lateral auricular branches supply the caudal surface of the auricle, while the venous drainage of the ear occurs by the caudal auricular vein that comes from the external carotid vein. It drains lateral auricular, intermediate auricular and medial auricular veins.
Figure 11: A photograph shows auricular cartilage (A.c) and scutiform cartilage (S.c) after dissection in camel.

Figure 12: A photograph shows the nerves supply of the cartilages of the camel ear; Auricular temporal nerve (Au.t.N), Cranial auricular branch (Cr.A.b) and Caudal auricular branch (Cd.A.b).

Figure 13: A photograph shows the blood supply of the cartilages of the camel ear; Caudal auricular artery (Cd.A.A), Medial auricular branch (Med.A.b), Intermediate auricular branch (Inter.A.b), Lateral auricular branch (Lat.A.b).

Figure 14: A diagram showing the relationship between the ear and head lengths in camel.

Figure 15: A diagram showing the relationship between ear length and width in camel.

Knowing the scales of the length, width and thickness of the auricular cartilage can have an indication of the consistency of the length and width of the ear with the head sizes to be considered as a sign of camel beauty, and this relates to a type of strain that often has the highest degrees of beauty, especially in camel festivals.
Table 1: The following table shows the relationship between the lengths of the head and the ratio between them, as well as the distance between the two ears and the thickness of the auricular cartilage in the camels.

<table>
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<th>Number of specimens</th>
<th>Length cm</th>
<th>Width cm</th>
<th>Length of head/cm</th>
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4. Discussion

The gross anatomy of cartilages of the external ear of the dromedary camel was nearly similar to the other domestic animals. In this study, the external ear consisted of the pinna including the auricular cartilage (external cartilage), internal cartilage (The scutiform cartilage and the annular cartilage).

The pinna was supported by two cartilages, the scutiform and annular cartilages. It was flattened sheets of elastic cartilage in domestic animals [18]. Moreover, it was a wonderfully diverse structure with breed-related differences in shape and conformation in the canine [21].

The current results concerning the description of the auricular cartilage in agreement with those of [4] in camel, [6,7] in domestic animals and [18] in buffalo and cattle. Furthermore, the study showed that the rostral surface of pinna forms a 2-3 antihelix longitudinal ridge and fosses on the inside of the ear cavity; also, auricular cartilage forms the tragus. This result disagrees with those of [6,7] in domestic animals and [18] in buffalo and cattle that mentioned in both animals the antihelix was a transverse ridge on the concave surface. On the other hand, the tragus in this study was spherical small bump while it was rectangular in buffalo and cattle [18].

The study revealed that there are three cartilages; the auricular, scutiform and annular cartilages.

These findings were coinciding with those of [4] in camel and in other domestic animals, in buffalo and cattle [6,8,18]. Moreover, our results were different than that of dogs which contain two cartilages, the auricular and annular only [12].

The auricular cartilage designates the shape of the ear as a funnel. A similar finding was observed in buffalo and cattle [18], in cattle sheep and deer.
They recorded that the basal part of the auricular cartilage was coiled to form a tube, which enclosed the cavity of the concha.

The shape of the auricle is determined by supporting the auricular cartilage in most domestic animals, this is sufficiently stiff to keep the auricle erect at all times [15]. The auricular cartilage was flattened and sheet of elastic cartilage in pet animals [6,7] while the structure diverse with strains differences in shape, size, and Morphology in dogs [19].

Concerning the scutiform and annular cartilage, this study observed that the scutiform was disc shape lamina while the annular cartilage was circular, like a ring, and united medially by elastic tissue. It formed the cartilaginous part at the distal part of the auricular cartilage. Our results agreed with those of [4] in camel, in domestic animals [6,8], in buffalo and cattle [18], in cattle sheep and deer [22]. In camel which observed the scutiform cartilage was a diamond plate, triangular plate of cattle and buffalo [23,24].

The annular cartilage was quadrilateral plate carved to form about three-fours of a ring and united by elastic tissue and rolled into a short tube. Moreover; The presence of scutiform cartilage was not reported in dogs [12].

In this work, we found the cartilages of the external ear derived the nerves supply from the cranial auricular and caudal auricular branches. The blood supply was given by caudal auricular and rostral auricular arteries coming from the superficial temporal arising from the external carotid artery. Similar finding was observed in camel [4], in domestic animals [7], in human [9,10], in bovine [17], in cattle and buffalo, in horse [18]. Whilst their results disagree with those of [1] that reported, the skin of the ear canal is innervated by four cranial nerves: the trigeminal; the facial; the glossopharyngeal; and the vagus nerves. Arrangement of the nerves and blood vessels in conjunction with the ridges on the rostral surface was observed [22]. The spaces between the ridges were relatively free of larger blood vessels, nerves and hair, in cattle, sheep, and deer. The vertical ramus of the mandible in equine was described [27], whereas; the caudal auricular artery was not described. Except for small arteries supply, the cranial surface of the auricular cartilage in a rabbit, pig, and cattle was used for many years in the tissue engineering of human auricular cartilage [28,29].

According to the ultrasound and the applied anatomy of the auricular cartilage of the external ear, the pinna has many features that render amenable for evaluation to injuries and treatment [14]. This study confirmed that auricular cartilage was an important surgical land.

Our results showed the distance between the ears was age-dependent. In large camels, it is up to approximately 10 cm, while in camel calves was only 4 cm. This explains the growth of parietal and temporal bones in large camels than in camel calves where these bones were small and cartilaginous [26] that maintained the two parietal bones that arise from two primary ossification centers for each bone, which appear at the parietal eminence. Ossification progresses radially from the central focus toward the periphery of the bone. Nonetheless, at term, the parietal bones are relatively broad, particularly in the Prieto-temporal region [26,27].

Any cut of one or both of the ears, to beautify the animal will change the proportions obtained, especially in some breeds that are characterized by long ears from the level of the head, in contrast to the strains studied.

The ear-shearing process close to the top of the auricular cartilage does not cause any bleeding or pain to the animal or any complications because this area lacks blood and nerves supply.

Concerning the shearing operations, our result agreed with those of [28,32] that reported cartilage wound healing was a tentative balance between deposition of type I collagen in the form of cicatricial tissue and repair by expression of type I collagen. Small full-thick cartilage defects are replaced by fibrocartilage.

These results demonstrated an approximation of the thicknesses of the different layers of reconstructed and natural external ears [29]. On the other hand, the cartilage formation makes the sonography diagnostic without the necessity of using intravenous contrast agents that can play an advantage over magnetic resonance imaging [14]. The 20-MHz B-Mode ultrasound was suitable for the evaluation of the methods of plastic surgery in malformed auricles. This results are consistent with those of [29]. The ultrasound image analysis allows non-invasive follow-up of inflammatory skin diseases, like atopic dermatitis, psoriasis and may be used for monitoring the effectiveness of therapy in skin lymphomas and sclerotic skin diseases [30,31].
Finally, the gross anatomy of the cartilage of the external ear helps in increasing the scientific knowledge of the shape and structure of the ear. Ultrasound of the ear is a valuable complement method of examination of the ear of camels that can be easily readied in the field.

Besides, ultrasonography provides information about the condition of the auricular cartilage (shearing case) and could be used as a reference for more searches concerning ear injuries in camels.

Conclusion

The findings of the current study showed detailed information on the anatomical features of the external ear of camel using gross anatomy and blood and nerves supply. Ultrasonography findings allow practical application of auricular cartilage in injuries diagnosis. Such findings are essential in the subject-shearing ear of camels.

Authors contributions G. A. (Syria) planned and conceived the search. The data. G. A. (Syri), interpreted the results and designed the figures. Wrote the manuscript. The author read and approved the final manuscript.

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Competing interests

The authors declare that it has no financial or personal relationships, which may have inappropriately influenced them in writing this article.

References

Ultrasonography of the gastrointestinal tract in healthy and diseased camels (*Camelus dromedarius*)

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**Abstract**

The aim of this mini review was set to describe ultrasonography of the normal appearance, size, shape, and position of various gastrointestinal organs in dromedary camels including the rumen, reticulum, omasum, abomasum and small and large intestines. First part of this review will deals with technique of ultrasonography of the GIT in healthy camels. The rumen and its glandular sacs were visualized occupying the major portion of the abdominal cavity, filling most of the left side of the abdomen. It was best seen in the left paralumbar fossa. In the later region, the large caudodorsal ruminal sac was visualized close to the spleen and left kidney. The cranial glandular sacs were seen deep in the right and left 5th intercostal spaces in 20 (91%) camels. The ventral part of the reticulum was best imaged in 17 (77%) camels from the left and right paramedian region just behind the sternal pad. The omasum was best imaged through the right 6th to 8th intercostal spaces in 18 (82%) camels. The abomasum could be best visualised from the right 9th and 8th intercostal spaces in 14 (64%) camels. Small intestinal structures were best seen low in the right paralumbar fossa. The large intestine was usually easy to differentiate from the small intestine based on its marked gas content and relatively large diameter. Second part of this review article deals with ultrasonography of the gastrointestinal disorders in particular intestinal obstruction and chronic enteritis caused by paratuberculosis.

**Key words:** Camels, Gastrointestinal, Intestinal obstruction, Paratuberculosis, Ultrasonography.

1. Introduction

Diseases of the gastrointestinal tract (GIT) of the camel are of great importance including impaction, bloat, ulceration and swallowed foreign bodies, enteritis, constipation, abomasal and intestinal obstruction, peritonitis, as well as abdominal hemorrhage, ascites and neoplasia [1-6]. Many of these diseases can be effectively treated in their early stages, but efforts to recognize them or their severity are hampered by camel stoic nature and vague clinical signs [3]. Due to large-sized abdomen of camels, even experienced clinicians may not be able to pinpoint the organ affected and diagnose the gastrointestinal disease. In addition, transrectal palpation in camels gives access only to the caudal viscera [1,2]. Exploratory laparotomy is usually performed in cases of camels with unexplained gastrointestinal illness [2]. Most owners consent to this invasive procedure only when the prognosis is good, and when there is a reasonable chance that the animal can be cured. Exploratory laparotomy should be avoided in camels with a poor prognosis because it may inflict additional pain, it can be considered as an expansive diagnostic test and the
animal cannot be slaughtered for human consumption waiting for withdrawal times [3].

Recent data on the use of ultrasound in scanning of the normal gastrointestinal tract in camels (*Camelus dromedarius*) has been reported [7]. In addition, data on the use of ultrasound in medical and surgical affections of many abdominal disorders has been published [5,6,8,9]. This mini review article emphasizes the ultrasonography of the normal appearance, size, shape, and position of various gastrointestinal organs in dromedary camels. In addition, it reviews the ultrasonographic findings in camels with GIT disorders.

**Ultrasonography of the rumen and glandular sacs**

The rumen and its glandular sacs were visualized occupying the major portion of the abdominal cavity, filling most of the left side of the abdomen. It was best seen in the left paralumbar fossa. In the later region, the large caudodorsal ruminal sac was visualized close to the spleen and left kidney. The rumen wall was smooth and echogenic with an average wall thickness of 0.3±0.11cm. Reverberation artifacts running parallel to the ruminal wall were seen in the region of the dorsal gas cap. In all examined camels, the contents of the rumen could not be seen. Motility of the rumen was seen as shifting, retreating, and eventual replacement of portions of the wall during gastric contraction cycles. Because of the lack of penetration and large volume of the rumen, it was not possible to measure the size of the rumen.

The cranial glandular sacs were seen deep in the right and left 5th intercostal spaces in 20 (91%) camels. In the other 2 (9%) cases, these glandular sacs were visualized deep in the 6th intercostal spaces to the right and left of the thorax. The caudal glandular sacs were imaged in the 9th intercostal space just ventral to the abomasum and liver in 18 (82%) animals. The ventral parts of the caudal glandular sacs in these 18 camels could be imaged lying against the paramedian region 10 cm to the right of the umbilicus. In the other 4 (18%) cases, these glandular sacs could not be imaged at all. The contents of glandular sacs appeared echogenic with gaseous inclusions, and hypoechogenic fluid. The cranial and caudal glandular sacs had a wall thickness of 0.64±0.22 cm. Both of them could be seen as series of hyperechoic, semicircular protrusions, curving away from the ventral body wall [7] (Figure 1A).

**Ultrasonography of the reticulum**

The ventral part of the reticulum was best imaged in 17 (77%) camels from the left and right paramedian region just behind the sternal pad, about 33±9 cm cranial to the umbilicus. In the other 5 (23%) camels, the reticulum could not be imaged from this position. In these animals, the reticulum could not be imaged as it is not possible to perform ultrasonography in the standing animal. The reticulum had a thick wall (1.17±0.3 cm) that appeared as a half-moon-shaped structure with an even contour (Figure 1B). The reticulum had a biphasic contraction, and the period between 2 successive biphasic contractions was 50±13 seconds in camels in which reticulum could be imaged. The first contraction was incomplete and was followed by an interval of incomplete relaxation; this was followed immediately by a second complete contraction where the reticulum could not be seen on the monitor. An interval of complete relaxation follows, in which the reticulum returned to its initial position [7].

**Ultrasonography of the omasum**

The omasum was best imaged through the right 6th to 8th intercostal spaces in 18 (82%) camels. In the remaining 4 (18%) camels, it was visualised through four consecutive intercostal spaces (right 6th to 9th). The omasum was visible as a tubular structure extending between these intercostal spaces and coursing along the body wall approximately parallel to the long axis of the camel. Only the wall of the organ closest to the transducer was visible; its wall appeared as a thick echogenic line. It had a wall thickness of 1.1±0.7cm and a transverse diameter of 8.74±3.4cm. The content of the omasum could not be seen probably because of its content. The organ appeared largest in the 7th intercostal space and decreased in size cranially and caudally from this point (Figure 1C). The distance between the dorsal limit of the omasum and the midline of the back was 66±14, 76±16 and 84±15cm at the right 8th, 7th and 6th intercostal spaces, respectively. In the 6th intercostal space, the cranioventral ruminal sac was visible ventral to the omasum. Similar to the reticulum, an active motility was visualized in the omasum, but in a shorter duration (23±14 seconds) [7].

**Ultrasonography of the abomasum**

The abomasum could be best visualised from the right 9th and 8th intercostal spaces in 14
(64%) camels, while in 3 (14%) animals it could be observed in the 9th intercostal space and in 5 (22%) camels in the 8th and 7th intercostal space. Its diameter was largest in the 8th intercostal space (9.1±1.1cm), followed by the 9th (7±1.6cm) and the 7th (5.4±0.45cm) intercostal spaces (Figure 1D). At postmortem examination, the abomasum was differentiated from the duodenum by its large diameter. Duodenum at necropsy had a diameter of 3.8±0.32 cm. The abomasum had a wall thickness of 0.76±0.46cm. In the 9th intercostal space, the abomasum lies between the glandular sacs of the caudodorsal ruminal sac and the hepatic parenchyma. The abomasal wall appeared as a narrow echogenic line and the contents appeared as a heterogeneous, moderately echogenic structure with echogenic stippling. Abomasal contractions were not observed in any of the examined camels, but movement of the abomasum contents was seen. In none of the 22 examined animals the pylorus was identified and imaged [7].

Ultrasonography of the intestines

Small intestinal structures were best seen low in the right paralumbar fossa. It had had a wall thickness of 0.43±0.14cm and a mean diameter of 2.62±0.47cm. Its contents were almost very hypoechoic, heterogeneous and it contracted every few seconds. Boluses of hypoechoic fluid ingesta could be seen, but were rarely present more than those few seconds before the intestine contracted. Individual segments of intestine were difficult to discern in areas of collapsed intestine because of the lack of contrast between wall and lumen; gas shadowing was not seen. Because of the absence of the gallbladder in camels, it was very difficult to identify and image the duodenum in any of the examined cases. Therefore, the duodenum, jejunum and ileum could not be differentiated from one another ultrasonographically. More than 10 loops of small intestine were imaged adjacent to one another from the lower right flank and lateral abdominal wall and from the 9th to 11th intercostal spaces [7] (Figure 2A).

The large intestine was usually easy to differentiate from the small intestine based on its marked gas content and relatively large diameter. Because of the gas, only the wall of the large intestine close to the transducer was imaged where it appeared as a thick echogenic line. The wall of the large intestine furthest from the transducer could not be imaged. The cecum was imaged chiefly in the caudal right flank. It was thin-walled (0.37±0.05 cm), had a diameter of 13.8±1.6cm. Its lateral wall appeared as a thick echoic, crescent-shaped line. Owing to the presence of gas, the content of the cecum could not be imaged in any of the camels (Figure 2B). The tip of the cecum could also not be imaged because of its caudal position. Segments of ascending colon could be seen in the right paralumbar fossa. The proximal loop of the large colon appeared as thick, echogenic, continuous and slightly curved lines. It was thin-walled (0.51±0.08 cm) and had a diameter of 3.5±0.8cm. The spiral colon was confined in all camels to the caudal ventral half of the abdomen. It appeared as structures with thick echoic lateral walls with a number of echogenic arched lines next to each other [7].
Figure 2. Ultrasonogram of the Intestines in dromedary camels. Image A shows jejunum. It was taken low in the right paralumbar fossa. Image B shows cecum. J = jejunum; DS = dorsal; VT = ventral.

Practical application of ultrasonography in GIT disorders in camels

Intestinal obstruction

Intestinal obstruction is relatively rare in camels. It may be partial or complete. Massive intestinal parasite infestation, plastic foreign bodies and enlarged mesenteric lymph nodes may all cause intestinal obstruction [2]. Camels suffering from pica usually eat hair, leading to the formation of phytochozoas and trichochozoas that may reach the intestine causing obstruction. Other causes of intestinal obstruction include impaction of the spiral colon, dilatation and torsion of the caecum and strangulation of the intestine in inguinal hernia [10]. Ultrasonographic findings, such as changes in luminal diameter, motility and intestinal wall thickness, have been used to diagnose intestinal problems in other ruminant species. In a study reported recently [8], ultrasonographic findings in camels with either partial or complete intestinal obstruction included dilation of the small intestine with a marked reduction or absence of intestinal motility. Fluid was seen between loops of intestine. Accumulation of ingesta in the omasum/abomasum chamber was detected, some of which also had accumulation of ingesta in the rumen. These findings when taken together are indicative of ileus as found in cattle. Clinical manifestations include depression, reduced gastrointestinal motility, abdominal distension, dehydration, recumbency and vomition.

In camels with partial obstruction, rectal examination reveals the presence of very hard, spiny fecal particles and distended viscera. In animals with complete obstruction, rectal findings show a small amount of black feces stained with mucus or no feces at all. Case history may inform swallowing foreign bodies such as plastic bags and ropes. In these cases, rectal examination reveals the presence of small amounts of hard feces and distended rumen. Rumenotomy, if performed, shows presence of plastic bags, ropes, glass, hairballs, wires and nails. Ultrasonographic findings includes distended small intestinal loops with markedly reduced or absent motility. The foreign body obstructing the intestinal lumen may be visualized as a hyperechoic material. Hypoechoic fluid with or without fibrin may also be seen among the intestinal loops [8] (Figure 3). Necropsy findings may include presence of constricted intestines around enteroliths, paralytic ileus and mesenteric torsion.

Ultrasonography of chronic enteritis caused by paratuberculosis (Johne’s disease)

Johne’s disease or paratuberculosis is characterized by persistent and progressive diarrhea, weight loss, debilitation and eventually death. The disease occurs worldwide and affects cattle, sheep, goats, farmed deer, and other domestic and wild ruminants [11]. In dromedary camels, paratuberculosis is a chronic wasting and fatal disease manifested clinically by persistent diarrhea that terminates in death [12]. In tropical areas with intensive camel farming, paratuberculosis presents a serious economic problem due to culling of clinical cases, reduced milk production and the costs of laboratory testing and control measures [3]. Although the organisms can be shed in milk, the fecal-oral route is the primary mechanism for transmission of Mycobacterium avium subsp. paratuberculosis (MAP) and this is
reflected in disease control recommendations. These are similar in most countries and are mainly based on removal of clinical cases, identification of subclinical cases by clinical tests, and hygienic neonate-rearing through feeding MAP-free colostrum and milk. Definitive diagnosis of Johne’s disease is based on culture and identification of MAP from feces or tissue. Unfortunately, the organism is slow growing (four to sixteen weeks, and it requires special enhanced media). Other diagnostic tests used to screen herds and make a diagnosis in individual livestock species include AGID, complement fixation, competitive ELISA, histologic pattern of a granulomatous reaction, Ziehl-Neelsen staining (acid-fast) of tissue and feces, polymerase chain reaction (PCR) and DNA probes [3].

Introducing ultrasonography for examining camels with Johne’s disease can be helpful in screening cases waiting for confirmation by definitive tests (culture, ELISA or PCR). The procedure is especially valuable in determining macroscopic intestinal lesions as well as enlargement of the mesenteric lymph nodes that reflect the severity of the inflammatory changes, which were confirmed at postmortem examination (Tharwat et al., 2011; Tharwat et al., 2012). In camels with paratuberculosis, history includes progressive weakness, loss of body condition, and chronic intermittent diarrhea. A rectal smear stained with Ziehl-Neelsen stain showed acid-fast bacilli. DNA extracted from feces, rectal samples and lymph nodes resulted in amplification of 229-bp PCR product, which is the specific product of Mycobacterium avium subsp. paratuberculosis- IS900. Transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall. At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. The mesenteric and hepatic lymph nodes were highly swollen [12] (Figure 4 A).

**Figure 3.** Ultrasonographic findings in camels with intestinal obstruction. Ultrasonographic findings included distended intestinal loops with markedly reduced or absent motility (A, B, C). Image D shows a hypoechoic fluid with fibrin (white arrow) between intestinal loops; black arrow points to the intestinal wall. In one camel with partial obstruction, the intestinal lumen contained localized hyperechoic material consistent with foreign body (E). Corrugated ruminal wall was scanned in one camel with intestinal obstruction (F). IL = intestinal loops; FB = foreign body; F = fluid; DS = dorsal; VT = ventral.

**Figure 4.** Ultrasonographic finding in camel with Johne’s disease. Image A was taken from ventral abdomen on the right side where corrugated intestinal wall was seen. A clear folded intestinal mucosa is imaged (B, stars). Image C shows the intestinal edema and peritoneal effusions where anechoic fluid (F) was seen. Image D shows five (1-5) mesenteric lymph nodes are imaged enlarged with anechoic capsule and echogenic contents. Left image shows clumps of echogenic tissue interspersed with fluid pockets are imaged between the intestinal loops.
In another camel with confirmed Johne's disease, transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall and intestinal edema with peritoneal effusion (Figure 4B). At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. Intestinal edema with anechoic abdominal effusions was also imaged. In another camel with confirmed Johne's disease, transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall. The most outstanding sonographic findings were the visible enlargement of mesenteric lymph nodes that was confirmed at necropsy. Enlarged lymph nodes had anechoic capsule and with echogenic contents. Clumps of echogenic tissue interspersed with fluid pockets were imaged between the intestinal loops (Figure 4C). Pericardial and pleural effusions were imaged as an anechoic fluid. At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. Fluid was found in the pericardium and in the pleura [12] (Figure 4D).

In conclusion, ultrasonographic examination of the GIT of camels can be helpful in determining its disorders. Confirmation of such disorders is still required through laboratory and postmortem examinations.

References

Gastrointestinal nematodiasis in dromedary camels at Qassim region, Saudi Arabia: prevalence, hematology and treatment outcomes

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Abstract

A cross-sectional study was carried out in Qassim region, central of Saudi Arabia to determine the prevalence of gastrointestinal nematodes in dromedary camels, estimate the hematological changes associated with such infestation in addition to study the efficiency of albendazole and ivermectin in the treatment of infested animals. Among 1195 examined camels, the prevalence of gastrointestinal nematodes was 7.28%. Gender had no significant effect on the disease prevalence where the prevalence was 7.53% in females and 5.88% in males. On the other hand, age had a significant (p = 0.0001) effect on the prevalence where lower prevalence was recorded in camels under three years (3.18%) compared to those over three years (9.94%). Camels infested with gastrointestinal nematodes showed observable signs only in young camels while adult animals appeared clinically normal and rarely showed clinical signs. The signs observed in young camels were in the form of emaciation in spite of good appetite, pale mucous membranes and weakness. Hematological examination revealed a significant decrease in the erythrocyte counts (p = 0.0001) and hemoglobin concentration (p = 0.001) in infested camels compared with the healthy controls. Concerning the treatment outcomes, albendazole either alone or in combination with ivermectin twice with 2 weeks interval gave 100% cure rate both clinically and parasitologically. However, treatment-using ivermectin alone gave only 93.33% parasitological cure. It can be concluded that the prevalence of gastrointestinal nematodiasis is less prevalent in Qassim region, Saudi Arabia and the age factor has a significant effect on the prevalence but the sex factor has no effect. In addition, albendazole either alone or in combination with ivermectin is the drug of choice in the treatment of gastrointestinal nematodiasis in dromedary camels in this region.

Key words: Camels, Nematodes, Prevalence, Hematology, Treatment.

1. Introduction

In tropical and subtropical countries, parasitic infestation represents a major constraint for livestock production where, it directly or indirectly affects the production by reducing animal fertility and work capacity, decreasing food consumption, and decreasing body weight gain and milk production, and lead to mortality in heavily parasitized animals [1].

Adverse and difficult environmental conditions in the areas where camels are raised especially in dry seasons lead to decrease the availability of food for these animals and subsequently resulted in lower their resistance and make them easily vulnerable to diseases [2, 3].

Among the parasites that infesting dromedary camels, nematodes are found to be the most prevalent [4, 5, 6]. Camels can be infested by
nematodes, which may be specific for camels as *Haemonchus longisipes*, *Nematodirus Mauritanicus*, *Nematodirus dromedarii* or by other nematodes common for other hosts like sheep and goats as *Trichostrongylus prololurus*, *Tichostronglus vitrinus*, *Ostertagia mongolica*, *Nematodirus spathiger*, *Oesophagostomum venulosum* [7, 8].

Diagnosis of gastrointestinal parasites in animals is mainly based on epidemiological and clinical examinations while laboratory examination of fecal samples for the detection of eggs or larvae in the feces is the confirmatory tool [9].

In tropical and subtropical regions, resistance to modern broad-spectrum anthelmintics, which used in the treatment of gastrointestinal nematodes is a reality of rapidly increasing dimensions on many farms especially for *Haemonchus contortus* [10]. So this study was conducted to determine the prevalence of gastrointestinal nematodes in dromedary camels at Qassim region, central of Saudi Arabia, estimate the hematological changes associated with such infestation, also the efficiency of albendazole and ivermectin in the treatment of such infestation was studied.

2. Materials and Methods

2.1. Animals

A number of 1195 camels of different ages and sex were used in this study. These camels were managed extensively together with other livestock.

2.2. Epidemiological examination

Some epidemiological parameters including prevalence, gender and age predisposition were estimated [11].

2.3. Clinical examination

All examined camels were subjected to complete clinical examination [12].

2.4. Hematological examination

Two blood samples were collected from 10 camels parasitologically positive for nematode eggs and showed sever clinical signs and from 10 camels parasitologically free on tubes containing Ethylene Diamine Tetra Acetic acid (EDTA) as an anticoagulant. Complete blood counts were estimated using VetScan HM6, ABAXIS.

2.5. Faecal examination

Individual faecal sample was collected from each examined camel. Macroscopic and microscopic examinations were carried out. Direct smear, Concentration floatation technique, sedimentation technique and fecal egg counts were done for each sample [13]. Egg counts were done before treatment and again at 2 and 4 weeks post treatment.

2.6. Therapeutic trials:

Infested camels were divided into three groups. The first group (30 camels) was treated orally using albendazole 10% (Endjat 10% * Montajat Veterinary Pharmaceutical Co.) twice with three weeks interval at a dosage rate of 7.5 mg/kg body weight (3.75 ml/ 50 Kg B.W). The second group (30 camels) was treated using ivermectin (Ivermectin * Saudi pharmaceutical industries) as subcutaneous injection, twice with two weeks interval at a dose rate of 200 mcg/kilogram of body weight (1 ml/50 kg B. W.). The third group (27 camels) treated with both albendazole and ivermectin at the same dose and the same regime. Efficacy of the treatment was based on the reduction in the fecal egg counts 2 and 4 weeks post treatment.

2.7. Statistical analysis

Chi-Square and t-test were measured for the obtained data using the SPSS for Windows (Version 15.0, USA) statistical software program and probability (P-values) of less than 0.05 was considered significant.

3. Results

Out of the examined 1195 camels, the prevalence of gastrointestinal nematodes infestation was 7.28%. Owing to age predisposition, the prevalence in camel under three years was 3.18% and in camels over three years was 9.94% (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Prevalence of gastrointestinal nematodiasis in relation to camels’ age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Camels under 3 years</td>
</tr>
<tr>
<td>Camels over 3 years</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

* Significant p = 0.0001

Concerning sex predisposition, the prevalence of gastrointestinal nematodes infestation was
Table 2: Prevalence of gastrointestinal nematodiasis in relation to camels’ sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Total camels examined</th>
<th>No. infested camels</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>1008</td>
<td>76</td>
<td>7.53</td>
</tr>
<tr>
<td>Males</td>
<td>187</td>
<td>11</td>
<td>5.88</td>
</tr>
<tr>
<td>Total</td>
<td>1195</td>
<td>87</td>
<td>7.28</td>
</tr>
</tbody>
</table>

Camels infested with gastrointestinal nematodes infestation (Table 3) showed only signs in young camels. Adult camels rarely showed clinical signs. The signs observed in young camels were in the form of emaciation in spite of a good appetite. Diarrhea was observed only in 20 young camels. Hairs were easily detached from infested animals. All infested camels have normal body temperature.

Table 3: Clinical signs in 87 nematodiasis infested camels (No 87).

<table>
<thead>
<tr>
<th>Signs</th>
<th>%</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0/87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Off food</td>
<td>0/87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Weakness</td>
<td>70/87</td>
<td>80.45</td>
<td></td>
</tr>
<tr>
<td>Emaciation</td>
<td>60/87</td>
<td>68.96</td>
<td></td>
</tr>
<tr>
<td>Pale mucous membrane</td>
<td>70/87</td>
<td>80.45</td>
<td></td>
</tr>
<tr>
<td>Bottle jaw</td>
<td>2/87</td>
<td>2.29</td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td>20/87</td>
<td>22.98</td>
<td></td>
</tr>
<tr>
<td>Indigestible food in the feces</td>
<td>15/87</td>
<td>17.24</td>
<td></td>
</tr>
<tr>
<td>Easily detached hairs</td>
<td>75/87</td>
<td>86.20</td>
<td></td>
</tr>
</tbody>
</table>

Hematological examination of examined healthy and diseased camels revealed a decrease in the erythrocyte counts and hemoglobin concentration in infested camels compared with the healthy controls (Table 4).

4. Discussion

It has been shown that camels are vulnerable at the same degree or even higher to the prevalent disease-causing agents compared with other livestock [25, 26, 27, 28] despite the old notion that they are resistant [14].

The prevalence of gastrointestinal nematode infestations in examined camels was 7.28%. Higher prevalence rates were reported in Iran by Radfar and Gowhari (5) who reported 64% prevalence; in Nigeria by Rabana et al. (15) who reported prevalence of 41% and Ukashatu et al. (16) who reported prevalence of 77.8%; in Ethiopia by Birhanu et al. (17) who recorded 55.5% prevalence and in Iraq by Fadhil and Al-Zubaidi (18) who reported prevalence of 28.15%. The lower prevalence recorded in present study compared to the previous studies may be attributed to the awareness of the people about the parasites and improvement of the veterinary service in Qassim region in addition to the usual use of some anthelmintics which used in the treatment of other diseases such as mange. The differences in the prevalence rates among different studies may be attributed to the host immunity, differences in the method of management in each area in addition to the differences in the climatic condition (5).
Camels are less liable to helminthic diseases compared to other animals due to their typical browsing habit camels [19, 20].

Concerning sex predisposition, a non-significant increase in the prevalence was recorded in female than male camels where it was 7.53% in females and 5.88% in males. Similar observations were recorded previously by Radfar and Gowhari (5); Rabana et al. (15); Demelash et al. (21); Muhomed et al (22) and Desta (23) who recorded non-significant differences in female compared to male camels. On contrary, Fadhil and Al-Zubaidi (18); Wakelin (24); Al-Hakak et al. (25) reported a significant increase in the disease prevalence in female than male camels and attributed this to the exposure of female camels to some physiological factors as parturition that can reduce their immunity to infestation (24). In an abattoir survey in Nigeria, Ukashatu et al. (16) found male camels were harboring parasites more than the female camels and referred this to the largest number of the slaughtered males compared to the low number of the slaughtered female.

Concerning age predisposition, a significant difference in the prevalence of the gastrointestinal nematode infestations was recorded between the different age groups where lower prevalence was recorded in camel under three years (3.18%) compared to camels over three years (9.94%). Similar observations were recorded previously by Demelash et al. (21); Muhomed et al (22) and swai et al. (26) who recorded a significant increase in the disease prevalence in adults than young camels. On the other hand, Desta (23) recorded no effect on the camel age on the parasitism.

Parasitic helminthiasis is mainly subclinical or inapparent where affected animals appear clinically normal but are performing at below their full potential (20, 27). In this study, camels infested with gastrointestinal nematodes showed observable signs only in young camels while adult animals appeared clinically normal and rarely showed clinical signs. The signs observed in young camels were in the form of emaciation in spite of good appetite, pale mucous membranes and weakness. Similar clinical signs were recorded previously by Solanki et al. (27). Some Nematode species feed on blood and responsible for specific clinical symptoms linked to severe anemia, diarrhea, loss of body weight and death (28).

Hematological examination of examined healthy and diseased camels revealed a decrease in the erythrocyte counts and hemoglobin concentration in infested camels compared with the healthy controls. Similar results were recorded previously by Rabana et al. (15) and Solanki et al. (27) who recorded a significant decrease in hemoglobin, total erythrocytes count, packed cell volume, total leucocytes count and a significant increase in values of MCH as compared with helminths free camels. On contrary, Bamiyi and Kalu (29) recorded a non-significant difference between camels infested with parasitic gastroenteritis compared with those non-infested ones for blood parameters.

Concerning the treatment trials, albendazole alone or in combination with ivermectin twice with 2 weeks interval gave 100% cure rate both clinically and parasitologically. However, treatment using ivermectin alone gave only 93.33% parasitological cure. Similar findings were observed previously by Demelash et al. (21) who documented the efficacy of albendazole and ivermectin in the treatment of nematodiasis in camels and Kagira et al. (30) who found that the combination between ivermectin and albendazole are very effective in the treatment of nematodes in vervet monkeys and baboons. The intensive use of ivermectin in the treatment of mange in camels in Qassim region, KSA without veterinary supervision may lead to the development of drug resistance. Parasites can adapt to the commonly used anthelmintics resulting in the development of resistance (21, 31).

Finally, it can be concluded that the prevalence of gastrointestinal nematodiasis is less prevalent in Qassim region and the age factor has a significant effect on the prevalence but the sex factor has no effect. In addition, albendazole either alone or in combination with ivermectin is the drug of choice in the treatment of gastrointestinal nematodiasis in dromedary camels in this region.

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This work was performed at Veterinary Teaching Hospital, Department of Veterinary Medicine, Faculty of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia.

**Compliance with ethical standards**

This study was approved by the Animal Care and Welfare Committee, Deanship of Scientific Research, Qassim University, Kingdom of Saudi Arabia.

**Conflict of interest**

The author declares that he has no conflict of interest.
References


Effect of nomadic or intensive management system on reproductive performance, hormonal and blood biochemical changes in non-pregnant and pregnant Sudanese dromedary camels

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Abstract

This study was conducted to determine the effect of nomadic or intensive management system on hormonal and biochemical changes in non-pregnant, pregnant and postpartum Sudanese dromedary camel, in addition to effect on reproductive performance of non-pregnant camel. Two experiments were conducted, in Experiment 1: reproductive performance, blood biochemical and hormonal levels were examined for non-pregnant camels under nomadic or intensive management system. In experiment 2: blood hormonal and biochemical changes were compared during the different stages of pregnancy and post-partum period in dromedary camels kept under nomadic or intensive management system. Results of experiment 1 indicated that duration of estrus was significantly shorter, also, number of follicular cycles/breeding season were larger, while, longevity of female was higher dromedary camel kept under intensive than nomadic management system. Serum total protein, albumin, globulin, blood urea nitrogen, uric acid and cholesterol concentrations were significantly higher in non-pregnant dromedary camels kept under nomadic than intensive management system, however, T4 values were higher in intensive than nomadic system. In Experiment 2, total protein, globulin and uric acid levels were higher during the different stages of pregnancy in nomadic than intensive management system, however, serum glucose and T4 values were higher in those kept under intensive than nomadic management system. It could be concluded that management systems could affect the reproductive performance, hormonal and biochemical levels of non-pregnant dromedary camel and also hormonal and biochemical levels of pregnant and postpartum dromedary camels.

Key words: Sudanese camel, Intensive or Nomadic system, Reproductive status, Hormone, Blood biochemistry.

1. Introduction

Animal's performance is controlled by the interaction between the environment and genotype. Dromedary camels have the capacity to live and survive under the incredibly hard environment of the desert due to their biological and physiological peculiarities. All body functions of the dromedary camel are physiologically adapted to “water and food restrictions” and to a very hot climate [1]. Camel is an important animal in the dry regions because of its ability to provide milk, meat and transport for people under these harsh climatic conditions. In Sudan, camels are traditionally reared in extensive areas with low feed quality and availability [2]. Sudan as all African countries are facing different trends in urbanization, high growth demography and climatic change. These trends
have strong effect on camel farming [3]. Currently the methods of camel management are changing due to the shrinkage of grazing land and camel farms.

Fertility of camels kept under traditional system was low (45.3%) compared to the other farm animals. This was largely correlated with nutritional and other environmental stress. Moreover, during pregnancy, a variety of continuous physiological changes may occur in the mother with respect to the mother’s utero-placental blood flow, cardiovascular system, metabolic changes and also blood composition. The mother makes adjustment to provide an adequate supply of nutrient for the development of the fetus while maintaining maternal homeostasis and preparing for lactation [4]. The study of blood constituents could provide valuable information about the general health of animals [5], and how to manage camel’s farms and keep them in a stable physiological status. Only limited information’s on serum hormonal and blood biochemistry in one humped camel are available [6, 7], and comparison of blood values under different management systems seems to be important as these values reflect the well-being of the animal and are used extensively as diagnostic tests [8].

Therefore, the objective of this study was to evaluate, the effect of nomadic and intensive management system on some blood biochemical and hormonal changes in non-pregnant, in addition to its effect on reproductive performance of non-pregnant dromedary camel.

2. Material and Methods

2.1. Study area

This study was designed to investigate the effect of two management system including: First, the nomadic system in which camel herds were raised in Butana area, Sudan, which lies between Latitude 13 40' and 17 50' North and Longitude 32 40' and 36 00' East. Its climate is tropical continental climate and the temperature ranged between 32ºC to 46ºC. Camels were fed on Acacia shrub and short grasslands. The second group representing the intensive system, in which camel farms located in Khartoum which lies between 15.5518°N latitude and 32.5324°E longitude. The climate is hot dry from April to June and September to October. At Khartoum camel farms the animals were fed on green fodder and concentrate ration, while, water was available the whole day. The study was conducted during the period from January 2014 to January 2016.

2.2. Experimental design

2.2.1. Experiment 1: Effect of management systems on reproductive performance, hormonal and blood biochemical changes in non-pregnant dromedary camel

This experiment was conducted on 23 mature female dromedary camels kept at Butana area and representing the nomadic camel management system, and 17 mature female dromedary camel kept at a private camel farm at Khartoum and representing the intensive management system. In both groups, reproductive performance including: Duration of estrus/(days), duration of follicular wave/(days), number of follicular cycles/breeding season, number of services/conception, gestation length/(days), days open/(days), calving interval/(months), number of parturition/female, longevity of females/(years) and abortion per herd (%) were determined. All these parameters were determined according to a questionnaire filed by the owners.

2.2.2. Experiment 2: Effects of nomadic or intensive management system on hormonal and blood biochemistry during the different stages of pregnancy in dromedary camels

This experiment was conducted on 80 pregnant dromedary camels kept under nomadic and intensive management systems (40 per each group). Animals were classified according to the stage of pregnancy into: First trimester (from 1 to 4 months), 2nd trimester (from 5 to 8th month of pregnancy), 3rd trimester (from 9 to 12th month of pregnancy), and post-partum animals for up to the 4th month post-partum. Stage of pregnancy was determined according to the data presented by the owners, rectal palpation of animals and confirmed by trans-rectal ultrasonography.

2.3. Hormonal and blood biochemical analysis

In experiments 1 and 2, 10 ml blood samples were collected from camels by jugular vein puncture into plan vacutainer tube. Blood was centrifugation at 1400 rpm for 15 min, serum was separated and stored at -20°C for hormonal and biochemical analyses.

BIOMERIEUX diagnostic kits (France) were used to determine the concentrations of the following parameters in serum samples: total protein, albumin, total bilirubin, cholesterol and glucose. Also, creatinine, and uric acid as markers for kidney function was determined. All parameters were measured by using spectrophotometer (Jenway,
UK). Globulin level was determined by subtracting albumin from total protein values. Hormonal assay for estrogen, progesterone, triiodothyronine (T3) and thyroxin (T4) were determined by using specific ELISA kits and ELISA reader (CLINDIAG, MR-96 - 2015, Belgium).

2.4. Statistical Analysis:
The data obtained were analyzed by independent T-test to compare between the two management systems using SPSS (statistical package for social program software version 11). Independent samples T. test was used to analyze and compare means value of the two groups.

3. Results
The effect of intensive or nomadic management systems on reproductive performance in non-pregnant Sudanese dromedary camel was presented in Table 1. Data demonstrate that the duration of follicular wave, number of services per conception, gestation length, days open, calving interval and number of parturitions per female did not significantly differ between intensive and nomadic management system. However, duration of estrus was significantly (P<0.05) shorter, and the number of follicular cycles were larger (P<0.05) in non-pregnant dromedary camel kept under intensive than nomadic management system. Also, longevity of female was significantly (P<0.05) higher and the number of abortions per herd was lower (P<0.05) in camels under intensive than nomadic management system.

Table 1: Effect of intensive or nomadic management systems on reproductive pattern’s in non-pregnant Sudanese dromedary camel.

<table>
<thead>
<tr>
<th>Item</th>
<th>Management system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intensive</td>
</tr>
<tr>
<td>Duration of estrus/(days)</td>
<td>4.29±0.51*</td>
</tr>
<tr>
<td>Duration of follicular wave/(days)</td>
<td>16.57±1.81</td>
</tr>
<tr>
<td>Number of Follicular waves/Breeding season</td>
<td>7.32±0.34*</td>
</tr>
<tr>
<td>Number of services/conception</td>
<td>1.47±0.51</td>
</tr>
<tr>
<td>Gestation length/(months)</td>
<td>12.06±0.06</td>
</tr>
<tr>
<td>Days open/(days)</td>
<td>212.06±105.91</td>
</tr>
<tr>
<td>Calving interval/months</td>
<td>18.24±3.51</td>
</tr>
<tr>
<td>Number of litters/female</td>
<td>9.47±0.41*</td>
</tr>
<tr>
<td>Longevity of females/(years)</td>
<td>20.35±1.29*</td>
</tr>
<tr>
<td>Abortion per heard (%)</td>
<td>1.53±0.29*</td>
</tr>
</tbody>
</table>

Table 2: Effect of intensive or nomadic management systems on hormonal and blood biochemical changes in non-pregnant Sudanese dromedary camel.

<table>
<thead>
<tr>
<th>Item</th>
<th>Management system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intensive</td>
</tr>
<tr>
<td>Total Protein (g/dl)</td>
<td>7.34±0.124</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>3.16±0.047</td>
</tr>
<tr>
<td>Globulin (g/dl)</td>
<td>4.17±0.125</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>96.48±3.460</td>
</tr>
<tr>
<td>Total Bilirubin (mg/dl)</td>
<td>2.19±0.352</td>
</tr>
<tr>
<td>Cholesterol (mg/l)</td>
<td>44.68±2.613</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>4.04±0.083</td>
</tr>
<tr>
<td>Uric Acid (mg/dl)</td>
<td>5.05±0.377</td>
</tr>
<tr>
<td>Creatinine (mg/l)</td>
<td>40.81±1.26</td>
</tr>
<tr>
<td>T3 ng/ml</td>
<td>0.74±0.04</td>
</tr>
<tr>
<td>T4 µg/ml</td>
<td>0.90±0.03*</td>
</tr>
<tr>
<td>P4 ng/ml</td>
<td>1.61±1.79</td>
</tr>
<tr>
<td>E2 Pg/ml</td>
<td>27.89±8.61</td>
</tr>
</tbody>
</table>

Serum hormonal and biochemical changes during the different stages of pregnancy in camels kept under intensive or nomadic management systems were presented in Table 3. During the first trimester of pregnancy, serum levels of total protein, globulin, cholesterol and uric acid were significantly (P<0.05) higher for camels kept under nomadic than intensive management system. On the other hand, serum levels of blood urea nitrogen and T4 were higher (P<0.05) in camels kept under intensive than nomadic management system. No significant deference (P≥0.05) in blood glucose, creatinine, total bilirubin, T3, P4 and E2 were detected for non-pregnant camels kept under nomadic and intensive management systems.

Table 3: Effect of intensive or nomadic management systems on hormonal and blood biochemical changes during pregnancy in non-pregnant Sudanese dromedary camel.

<table>
<thead>
<tr>
<th>Item</th>
<th>Management system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>T3 ng/ml</td>
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<td>T4 µg/ml</td>
<td>0.90±0.03*</td>
</tr>
<tr>
<td>P4 ng/ml</td>
<td>1.61±1.79</td>
</tr>
<tr>
<td>E2 Pg/ml</td>
<td>27.89±8.61</td>
</tr>
</tbody>
</table>

(mEans± SEM) * Superscript within the same row differ significantly at P<0.05
trimester) serum concentrations of total protein, globulin, cholesterol, uric acid and creatinine were higher (P<0.05) in camels kept under nomadic than intensive management system. On the other hand, glucose, blood urea nitrogen and T4 values were higher (P<0.05) in the intensive than nomadic system. In post-partum camels, serum levels of protein and globulin were higher in nomadic than intensive management system, while, blood glucose and urea were higher (P<0.05) in camels kept under intensive than nomadic system. Overall, serum levels of albumin, total bilirubin and T3 values were not significantly affected either by the stage of pregnancy or the management system under which pregnant camels were kept.

Table 3: Serum biochemical and hormonal levels in Sudanese camel during different stages of pregnancy and after parturition for Sudanese dromedary camel reared under different management systems

<table>
<thead>
<tr>
<th>Parameter</th>
<th>First trimester</th>
<th>Second trimester</th>
<th>Third trimester</th>
<th>Post-partum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein g/dl</td>
<td>Nomadic 8.1±0.20*</td>
<td>Intensive 8.4±0.20*</td>
<td>Nomadic 7.3±0.21</td>
<td>Intensive 7.3±0.28</td>
</tr>
<tr>
<td>Albumin g/dl</td>
<td>Nomadic 3.2±0.11</td>
<td>Intensive 3.3±0.24</td>
<td>Nomadic 3.1±0.10</td>
<td>Intensive 3.3±0.19</td>
</tr>
<tr>
<td>Globulin g/dl</td>
<td>Nomadic 5.0±0.25*</td>
<td>Intensive 5.1±0.28*</td>
<td>Nomadic 4.3±0.25</td>
<td>Intensive 5.1±0.25*</td>
</tr>
<tr>
<td>Glucose mg/dl</td>
<td>Nomadic 88.1±2.4</td>
<td>Intensive 103.6±4.9</td>
<td>Nomadic 113.0±4.3</td>
<td>Intensive 86.4±3.5</td>
</tr>
<tr>
<td>Bilirubin mg/dl</td>
<td>Nomadic 2.3±0.05</td>
<td>Intensive 2.0±0.04</td>
<td>Nomadic 2.4±0.04</td>
<td>Intensive 2.2±0.05</td>
</tr>
<tr>
<td>Cholesterol mg/dl</td>
<td>Nomadic 53.0±1.2</td>
<td>Intensive 57.7±1.3</td>
<td>Nomadic 74.3±2.7</td>
<td>Intensive 49.1±0.8</td>
</tr>
<tr>
<td>Urea mg/dl</td>
<td>Nomadic 4.0±0.04</td>
<td>Intensive 4.1±0.09</td>
<td>Nomadic 3.9±0.21</td>
<td>Intensive 4.5±0.15*</td>
</tr>
<tr>
<td>Uric acid mg/dl</td>
<td>Nomadic 6.8±0.19*</td>
<td>Intensive 5.5±0.29</td>
<td>Nomadic 8.9±0.75*</td>
<td>Intensive 5.5±0.48</td>
</tr>
<tr>
<td>Creatinine mg/L</td>
<td>Nomadic 43.3±1.23</td>
<td>Intensive 45.4±2.01</td>
<td>Nomadic 45.8±2.16</td>
<td>Intensive 38.9±2.41</td>
</tr>
<tr>
<td>T3 ng/ml</td>
<td>Nomadic 0.72±0.08</td>
<td>Intensive 0.69±0.09</td>
<td>Nomadic 0.82±0.09</td>
<td>Intensive 0.71±0.04</td>
</tr>
<tr>
<td>T4 µg/ml</td>
<td>Nomadic 0.60±0.03</td>
<td>Intensive 0.97±0.02*</td>
<td>Nomadic 0.69±0.06</td>
<td>Intensive 0.92±0.06*</td>
</tr>
<tr>
<td>P4 ng/ml</td>
<td>Nomadic 13.94±0.90*</td>
<td>Intensive 10.69±0.36</td>
<td>Nomadic 17.18±0.95*</td>
<td>Intensive 11.27±0.81</td>
</tr>
<tr>
<td>E2 Pg/ml</td>
<td>Nomadic 14.72±2.37</td>
<td>Intensive 18.98±2.18*</td>
<td>Nomadic 16.94±1.42</td>
<td>Intensive 16.27±0.56</td>
</tr>
</tbody>
</table>

T3= triiodothyronine, T4= thyroxin, P4= progesterone and E2= Estradiol (Means± SEM) * Superscripts within the same row differ significantly at P<0.05

4. Discussion

In the present work, management system had a significant impact on reproductive performance in non-pregnant Sudanese dromedary camels. In the present work, duration of estrous, number of follicular waves, number of litters per female and longevity of females were improved in non-pregnant dromedary camel reared under intensive than nomadic management systems. Also, lower percentage of abortion per herd. Moreover, number of litters per female and longevity of females were significantly (P<0.05) higher in non-pregnant camels kept under intensive than nomadic management systems. This could be due to the individual variation between animals kept under the two management systems. Furthermore, serum biochemistry and hormonal assay of livestock could reflect the physiological responsiveness of the animals to their nutrition, internal and external environment [11]. In this work, in non-pregnant camels, serum levels of total protein, albumin, globulin were significantly higher (P<0.05) for non-pregnant camels under nomadic than intensive management system. In the contrary, Bhakat et al. [12] reported that the level of total protein increased in intensive system management as compared to semi-intensive system management group. Also, Saini et al. [13] recorded higher concentration of total protein in intensive system compared to control traditional system. Those differences might be due to the environmental conditions or seasonal variation.
under which the experiments were conducted. Under nomadic system, dehydration of animals may lead to higher levels of protein, and metabolites. While, higher levels of globulin under nomadic system may reflect the health condition of animals compared with the intensive management system. Furthermore, in this study, uric acid and blood urea nitrogen were significantly \((P<0.05)\) higher in non-pregnant camels kept under nomadic than intensive management system. In camels, the metabolism of urea is strongly influenced by dehydration and there was a remarkable increase in uremia under this condition \([14-16]\). The urea appears to play a significant role during dehydration in the dromedary. Also, the nitrogen recycling in camel increases in the case of lower proteins in diet and/or dehydration \([17, 18]\). This great ability of urea recycling through the kidney, and its effectiveness does not deteriorate in the case of dehydration \([19]\).

It seems that feeding conditions are more diversified which can explain the variation observed in urea in different studies. It has been reported that the level of serum urea is related to the forage intake and consequently the energy and crude protein concentration \([20]\). Also, cholesterol levels were higher in camels under nomadic than intensive management system. This difference could be due to difference in feeding sources.

T4 values were higher \((P<0.05)\) in camels under intensive than nomadic management system. This finding is completely agreed with Yagil et al. \([21]\) who reported that an inhibition of thyroxin production in camels during periods of dehydration which decreases pulmonary water loss and reduced metabolism. In general, serum levels of thyroid hormones in camels are mainly affected by general body metabolism, season and water availability \([22]\). Results obtained in the current study signify that the nutritional status throughout the year could produce considerable changes in the reproductive and physiological responses of the dromedary camel.

During the first trimester of pregnancy, serum levels of total protein, globulin, uric acid and E2 were significantly \((P<0.05)\) higher for pregnant camels kept under nomadic than intensive management system. Higher E2 levels might be due to browsing habit of nomadic camels and open range where the shrubs herb could contain some alkaloid steroid substance that increase the level of steroid hormones in the blood of nomadic camels. These differences could be due to the harsh environmental conditions which could lead to dehydration and higher concentration of these metabolites. Meanwhile, serum glucose, T4 and P4 levels were higher \((P<0.05)\) in pregnant camels kept under intensive than nomadic management system. Similarly, other reports found that concentrations attained a higher value in camels raised under semi-intensive system when compared with the traditional nomadic system \([23-25]\). The blood serum levels of glucose, which could be considered a direct indicator of energy balance \([26]\). The increase in glucose level could be attributed to high carbohydrate meals or exercise \([27]\). Moreover, serum levels of thyroid hormones in camels are mainly affected by general body metabolism, season and water availability \([22]\). During the second and third stage of pregnancy, serum concentrations of total protein, globulin, cholesterol, uric acid, creatinine and P4 were higher in nomadic than intensive management system.

These higher values could be due to hemoconcentration as results of dehydration. Furthermore, the values for glucose, blood urea nitrogen and T4 were higher \((P<0.05)\) for pregnant camels kept under the intensive than nomadic management system. The thyroid hormones are of importance in adapting the endocrine system during pregnancy, as their very low blood levels leads to a decrease in energy metabolism and mobilization of body fat reserves \([28, 29]\). Limited food energy content decreases also the serum levels of triiodothyronine (T3) and thyroxin (T4) \([30]\). This difference could be attributed to the shortage of nutrition under nomadic conditions. The higher values for glucose and T4 in pregnant camels kept under intensive management system could reflect the good nutrition compared with the nomadic system.

Although, in post-partum camels, serum levels of protein and globulin were higher in nomadic than intensive management system, while, blood glucose and urea were higher \((P<0.05)\) in camels kept under intensive than nomadic system. Increased in glucose level could be attributed to high carbohydrate meals or exercise the increase in glucose level could be attributed to high carbohydrate meals or exercise. Also, it has been reported that urea in blood increases when protein content rises in the diet \([31]\).

**Conclusion**

Albumin, total bilirubin and T3 concentrations were not significantly affected either by the stage of pregnancy or management.
system. The reproductive performance of Sudanese camel kept under intensive management system was better in comparison to the nomadic systems, while the biochemical and hormonal level were better in the nomadic system and this as reflected by the changes in blood biochemical and hormonal levels.

**Ethics approval**

All the procedures performed in the current study were in accordance with the Guide for the Care and Use of Laboratory Animals published by the US National Institutes of Health (NIH Publication No.85-23, revised 1996) and were approved by the Ethical Committee for Animal Experimentation at College of Agricultural Studies, Department of Animal Production, Sudan University of Science and Technology, Sudan.

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**Conflict of interest**

The authors declare that they have no conflict of interest.

**Acknowledgement**

Authors gratefully acknowledge the National Research Centre of Egypt for the technical support during the course of the study.

**References**


intake, digestibility and nitrogen utilization by camels compared to sheep and goats fed low protein desert by-products. Options Méditerranéennes – Série Séminaires. 1989, 2, 75-81.


Case Report

First report of benign intraluminal esophageal inflammatory fibroid polyp infected with Candida albicans in camel: A case report

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Abstract

This report described a huge (7 cm × 4 cm; 120 g weight) benign intraluminal esophageal inflammatory mass in a 3-year-old dromedary she-camel at Qassim region. Clinically, the mass was invisible but palpable at the midline of the upper third region of the neck. The case manifested severe cachexia because of the inability to swallow for 30 days in addition to permanent frothy ptyalism. Ultrasonography confirmed the existence of a hypoechoic mass obstructing the proximal esophagus that failed to be displaced by the stomach tube. The animal was prepared to lateral cervical esophagotomy where a smooth-surfaced, encapsulated, discrete, well-circumscribed polypoid, ulcerated, and fleshy mass was excised. Histopathology revealed a type of benign mesenchymal polyps that rarely affect the human esophagus defined as inflammatory fibroid polyp infected with the local Candida albicans. In conclusion, the current case is the first report of intraluminal esophageal inflammatory fibroid polyp in camels.

Key words: Polyp, fibroid, esophagotomy, ultrasonography, mesenchymal, camel.

1. Introduction

The esophagus must be included during the examination of animals with underweight, progressive weight loss, ptyalism, dysphagia, and anorexia [12]. Except for dogs living in countries where Spirocerca lupi infestation is common, the esophageal tumors and inflammatory masses are extremely rare in animals [8]. Canine, feline, and equine intraluminal protruding esophageal tumors are almost exclusively squamous cell papilloma that may be transformed into squamous cell carcinoma [4,6,7,11,21]. Only one case report of feline intraoesophageal inflammatory fibrovascular, not fibroid, polyp was found in the literature. Clinically, it was confirmed by ultrasound examination as a heterogeneous hypoechoic swelling.

The excised mass was a polypoid structure approximately 3cm×1 cm. Histopathologically, the polyp is greatly similar to the fibrovascular polyps that rarely affect the human esophagus and consisted of a trabeculated fibrovascular matrix of mesenchymal cells and lymphocytic infiltrates [18].

Candida albicans is an opportunistic commensal in the alimentary tract of animals. With changes in the mucosal surface as in inanition or in the mucosal flora as in prolonged antibiotic therapy, this yeast becomes pathogenic for the mucosal keratinized squamous epithelium of mouth and esophagus, especially in young animals. The resultant mucosal damage may be induced by yeast-produced enzymes, including proteinases and catalases, or by neutrophil-produced enzymes such as myeloperoxidase. Lesions include multiple foci of mucosal necrosis, submucosal neutrophilic infiltrations as well as intralvesional polymorphic
forms of the yeast as pseudohyphae, true hyphae, and pale staining thin-walled blastopores [14].

2. Case presentation

2.1. Case history and clinical examination

A 3-year-old dromedary she-camel was submitted to the Veterinary Teaching Hospital of Qassim University during September 2019. The case history was an inability to swallow for 30 days. Thus, the animal appeared thin and very weak with profuse frothy salivation (Figure 1a). Except for cervical cauterization, the client said, no medication was attempted. Palpation of the neck exhibited a hard mass at the midline of the upper third region. Choke was suspected, so stomach-tubing trials were attempted but failed to push the mass downward towards the rumen.

2.2. Ultrasonography

The animal was prepared to ultrasonographic examination after intravenous (IV) light sedation (0.2 mg/kg xylazine HCl; Seton 2%, Laboratorios Calier, S.A., Barcelona, Spain). A 3.5-5 MHz sector and 7.5 MHz linear transducers (SSD-500, Akola, Japan) were used. Sonography showed a hypoechoic intraluminal swelling of the proximal esophagus (Figure 1b). Therefore, exploratory surgical interference was the approach of choice.

2.3. Surgical interference

The camel was admitted to an in-door clinic and prepared to lateral cervical esophagotomy. It was restrained with ropes in right lateral recumbency and deeply sedated by IV injection of xylazine HCl (Seton 2%, Laboratorios Calier, S.A., Barcelona, Spain) at a dose rate of 0.3 mg/kg. A stomach tube was placed on the level of obstruction. The neck region at the site of obstruction was prepared for aseptic surgery. Local analgesia using 2% lidocaine (Norbrook Laboratories, UK) at a dose rate of 10 mg/kg was infiltrated at the site of operation. A linear skin incision was made at the ventrolateral aspect of the neck as caudal as possible. Muscles of the neck were bluntly dissected to approach the esophagus. Two stay sutures were placed through the esophageal wall before making an incision to open its lumen.

The mass was attached to the esophageal wall and obliterating the lumen (Figure 1c). A blunt dissection for the mass was applied to relieve it from the esophageal wall, but it failed. Thus, esophageal resection and reconstruction were applied to the site of the mass. The esophageal wall was then sutured in two layers of lambert technique using polygylcolic acid 910 (Vicryl) no. 0 (United medical industries Co. Ltd., Riyadh). The surgical site was flushed with sterile normal saline and cervical muscles were sutured in a simple continuous pattern by Vicryl no. 0. The skin was then sutured by simple interrupted stitches using No. 1 silk suture (United medical industries Co. Ltd.).

Postoperative therapy with penicillin-streptomycin (Pen & Strep, Norbrook Laboratories, UK) at a dose level of 30,000 IU/kg for the penicillin, 10mg/kg streptomycin and 1.1 mg/kg flunixin meglumine (Finadyin, Schering-Plough) were given once IV then intramuscular for 5 consecutive days. Dextrose 5% in normal saline (2-3 L, Saudi Pharmaceutical solution industry, Riyadh, KSA) was given IV once 24 h postoperatively. A day later, the patient was allowed to suckle camel milk. Roughages were introduced gradually from day 7 postoperatively.

2.4. Pathological findings

Grossly, the mass appeared as nearly as a rounded polyp, approximately 7 cm length, 4 cm width, and 120 g weight (Figure 1d). Furthermore, it was encapsulated and focally ulcerated with a dry tan fleshy cut-surface. (Figure 1e).

Small fresh specimens were harvested from the mass, for histopathology, and immediately fixed in 10% neutral buffered formalin for 24 hours. Thereafter, the specimens were prepared through the conventional paraffin embedding technique (dehydration in ethyl alcohol, clearing in xylene, and embedding in melted paraffin wax at 60°C). Five
microns thick sections were cut and stained with hematoxylin and eosin (H&E), others were stained with periodic acid-Schiff reagent (PAS) for the detection of yeasts and Van Gieson stain for demonstration of collagen fibers [19]. Microscopic examination revealed that the mass was composed of a few mesenchymal cells with pale ovoid nuclei (Figure 2a) scattered within a dense edematous collagenous vascularized stroma (Figure 2b) that appeared red by Van Gieson stain (Figure 2c). The latter exhibited extensive widespread mixed inflammatory cells infiltrate of neutrophils (Figure 2d), eosinophils (Figure 3a), macrophages (Figure 3b), and lymphocytes (Figure 3c). In addition, microscopic multiple foci of necrosis composed of eosinophilic and basophilic cellular debris (Figure 3d), besides intralesional septate hyphae and pale stained, thin-walled oval and rounded yeasts typical of Candida albicans were evident (Figure 4a). Upon PAS staining, both yeasts and hyphae appeared red (Figures. 4b, c).

2.5. Outcome
The operated camel was confined in a stall rest and monitored daily for healing progress. It was discharged from the in-door clinic approximately 4 weeks postoperatively after regaining its normal appetite and health condition. Furthermore, neither postoperative complications nor evidence of recurrency was noticed along a 6-month-period of follow up.

3. Discussion
As veterinary tumorous lesions continue to move closer to human ones, it is likely that many of the diagnostic features used to identify human masses already used in veterinary practice. Additionally, differentiation between the inflammatory polypoid and tumor masses of the gastrointestinal tract represents a common diagnostic challenge for the pathologists [13]. Human inflammatory polyps are very rare benign polypoid lesions usually found anywhere in the gastrointestinal tract, rarely in the esophagus. They most often appear as pedunculated intraluminal polypoid encapsulated masses with frequent ulceration. They show a wide range in size, from 1 to more than 10 cm. The cut surface is tan or white, often with a glistening or fleshy appearance. Microscopically, two types of gastrointestinal polyps are known, the mesenchymal polyps that composed of spindled cells, and the epithelial polyps containing rounded cells. Both are hypocellular lesions with vascularized loose stroma containing a conspicuous inflammatory cells infiltrate, primarily of eosinophils, but also macrophages, neutrophils, and lymphocytes may be included [17]. The present mass was relatively huge measuring 7 cm × 4 cm, thus caused complete dysphagia. As a sequel of inanition, it was infected by the local Candida albicans. The noticeable ulceration may be
attributed to the desquamation of the necrotic mucosal cells. The inflammatory cells infiltrate was almost exclusively neutrophils rather than eosinophils. A possible explanation of this is secondary infection by \textit{Candida albicans}.

The human intraluminal esophageal mesenchymal polypoid masses include inflammatory fibroid polyp [5], fibrovascular polyp [22], lipomatous polyp [9], squamous cell papilloma [3], hemangioma [10], and granular cell tumor [20]. Infectious etiologic agents of inflammatory fibroid polyps have been reported [2, 15]; however, no agent has been identified in some studies [16]. Nowadays, most observers consider such polyps a form of reactive pseudotumor [17].

Early surgical excision of intraluminal esophageal inflammatory fibroid polyp is the treatment of choice concerning animal survival. Untreated polyps can become quite large and life-threatening [1]. The decision to enucleate the polyp or to euthanize the animal is based on several factors as nature, size, and invasion degree of the polyp as well as the health status of the animal. The present polyp was referred as a life-threatening lesion, which would have indicated a good prognosis if surgical excision had been attempted.

\textbf{Conclusion}

Ultrasonography was helpful in the detection of choking polyps, but histopathology still the cornerstone of the definitive and differential diagnosis of such lesions. The current mass was diagnosed as a benign intraluminal esophageal inflammatory fibroid polyp that should be included in the differential diagnosis of esophageal obstructive masses in animals. Furthermore, the surgical intervention is the only treatment to save the animal life. To literature, such polyp does not previously reported in the esophagus of any animal species. Therefore, it is the first report in camels that supports the concept of continuous movement of the veterinary tumorous lesions closer to human ones.

\textbf{Author contribution}

Elsayed Elmanakhly: Supervision; histopathology; writing; reviewing & editing.
Mohamed Tharwat: Clinical examination; ultrasonography; stomach tubing; gross photographing; writing & editing.
El-Sayed El-Shafaey and Madeh Sadan: Surgical excision of the polyp; writing & editing.
Abdullah Aljohani: Methodology, special staining, writing & editing.

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\textbf{Compliance with ethical standards}

This study was approved by the Animal Care and Welfare Committee, Deanship of Scientific Research, Qassim University, Kingdom of Saudi Arabia.

\textbf{Conflict of interest}

The authors declare that there no conflicts of interest.

\textbf{References}


Extraordinary periparturient disorders in dromedary camel

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Abstract

This study aimed to present and document some uncommon periparturient disturbances recognized in dromedary. Five female camels with extraordinary periparturient disturbances were examined and defined at the Veterinary Teaching Hospital of Qassim University. The five uncommon periparturient cases displayed (1) prepartum vaginal tearing accompanied by total uterine dislocation, (2) parturient vaginal tear and entrance of the fetus throughout the torn vagina, (3) parturient uterine prolapse attended by uterine tearing and crossing the fetus and intestine through the torn uterus, (4) postpartum vaginal rupture accompanied by displacement of the uterus and intestine, and (5) postpartum uterine prolapse involved with uterine tearing and displacement of the intestinal loops. The casual remark in greatest observed cases was the periparturient tearing or rupture of the vaginal wall accompanied with prolapse or displacement of the uterus and/or the intestine. The presumable causes of vaginal rupture and evisceration are tenesmus, injury due to the oversized fetuses, narrow cervix and uterine torsion. In conclusion, vaginal tearing has severe complexities on female camels that demands immediate intervention. Exceptional attention should be paid for female camels during late pregnancy, and shortly after parturition.

Key words: Camel, Dystocia, Postpartum, Pregnancy, Complications.

1. Introduction

Periparturient is defined as the time just before, during or immediately after parturition. The female dromedary camel is a seasonal breeder, with gestational length ranged from 12 to 13 months (1, 2, 3). The placenta is of diffuse type, while the opening, fetal and placental expulsive stages extended from 12 to 48 hr, 5 to 50 min and 0.5 to 3 hr, respectively (4, 5).

Dystocia has adverse effects on the calf viability, milk production and fertility (6). In a study on 60 cases of dystocia in female dromedary camels, uterine torsion was the most frequent cause (33.3%). Abnormal posture and feto-pelvic disproportion have been encountered for 26.7%, and 21.7%, respectively. Narrowing cervix, abnormal presentation, and vaginal prolapse have also observed as causes of dystocia (7).

The present study aimed to present some unusual periparturient complications observed in female dromedary camels at the Veterinary Teaching Hospital of Qassim University.

2. Cases presentation

First case

An 8 y pluriparous female camel was admitted to the clinic in poor physical condition with the uterus (pregnant and non-pregnant horns) and ovaries appeared outside the vulva (Figure 1). She was dehydrated, hypothermic, depressed, non-ambulatory and in a state of shock. She was in the last month of pregnancy. A left dorsolateral tear was found in the vagina with a perforation of the wall close to the cervix. The animal was euthanized at the command of the owner.
Figure 1. Pre-partum vaginal tearing followed by complete uterine dislocation

Second case

In a 9 y pluriparous female camel and due to strong tenesmus during parturition against a closed cervix, the vagina ruptured and the fetus passed through the torn vagina. Sedation and epidural anesthesia could not prevent the steady strong contractions. Finally, the fetus followed by the intestine passed through the ruptured vagina (Figure 2). The animal was euthanized after consulting the owner.

Third case

A full-term, 10y pluriparous female camel was presented to the clinic with partial uterine prolapse and severe bleeding. The animal showed excessive contractions resulted in uterine tearing. The fetal legs and the intestine appeared through the torn uterus (Figure 3). The animal was in bad physical condition. She was euthanized at the request of the owner.

Fourth case

A 12 y pluriparous female camel was admitted to the clinic with a history of excessive traction due to a big-sized fetus. The uterus expelled through a tear in the left lateral wall of the vagina (Figure 4). The animal was recommended to be euthanized.

Fifth case

In a 12y pluriparous female camel, the pregnant horn prolapsed just after normal parturition. The uterus was accidentally torn. After 24 h, the animal was presented to the clinic with a torn uterus, while the intestinal loops expelled through it. The intestine and uterus were washed with normal saline, sutured and reduced to the normal position (Figure 5). Systemic antibiotic and anti-inflammatory drugs were administrated.
3. Discussion

To date, this is the sole report of cases of unusual periparturient complications in dromedary camels. The common finding in most observed cases was the periparturient tearing or rupture of the vaginal. Further, all these cases, except one (the fourth case), had no history of mechanical struggling or rough handling. The probable causes of vaginal rupture and evisceration are tenesmus, trauma due to the oversized fetuses, narrow cervix or uterine torsion. The circulatory disturbance in the reproductive organs caused by the uterine torsion potentially weakens the vaginal wall. This weakness, in addition to excessive tenesmus, results in increased tension in the uterine ligaments (8,9). The exact causes of uterine torsion, however, are not well defined, but they include factors such as vigorous fetal movement, rolling of the mare, sudden falls, a large fetus in a relatively small volume of fetal fluid, lack of tone in the pregnant uterus, a long mesometrium, and the presence of a large, deep abdomen (8,9,10).

Rupture of the gravid uterus has been observed in bitches, which may result from uterine torsion or trauma (11). Moreover, rupture during the whelping occurred in cases in which the uterine wall was compromised by the presence of infection, a dead fetus, uterine torsion, careless obstetrics procedures and in cases received large doses of oxytocin (12).

The exact pathogenesis of the third case (parturient uterine prolapse) is not fully understood, and the question was how did the uterus come first (prolapsed) before the fetus? Many possible explanations for what has happened but one scenario could be suggested; (a) insufficient opening of the cervix; (b) excessive straining; (c) prolapse of vagina followed by part of the uterus or even uterine rupture. In horses, a rupture can happen when the fetus enters the birth-path in a wrong position, in case of torsion, reflecrtion, or rarely spontaneously, often combined with, triggering or triggered by excessive labor (13-15).

The most suitable therapeutic approach for such patients is an intravenous fluids therapy, epidural anesthesia eventually preceded by sedation if the animal is very agitated and does not yet show any signs of shock. This should take care of excessive labor/straining. Repositioning of the torsion or the fetus is a must. There are drugs like prostaglandin E2 aimed at assisting slackening of the cervix, not 100% but may help (16). In any case, a cesarean section should be considered.

In conclusion, special precautions should be taken for female camels during late pregnancy, at and shortly after parturition. Separation of late pregnant camels and close observation during labor and the postpartum period are essential to control such periparturient complications. Moreover, early and definitive diagnosis can help in guaranteeing a successful outcome.

Conflicts of interest

The authors confirm that they do not have any conflict of interest.

References

Diagnosis and surgical repair of soft palate (Dulla) injuries in camel (Camelus dromedarius)

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Abstract

This study describes the clinical presentation of soft palate injuries and evaluates the surgical intervention in the treatment of such injuries in dromedary camels. Nineteen camels were included in this study based on the clinical evidence of soft palate injuries. The clinical findings of soft palate injuries in the studied camels differ according their cause, type and duration. Lacerated wound (n=6; 31.5%), impaction with feed materials (n=4; 21%), protrusion (n=3; 15.8%), punctured wound by the canines (n=3; 15.8%), gangrene (n=2; 10.6%), and hematoma (n=1; 5.3%) of the soft palate were precisely diagnosed in the studied camels. Clinically, the camels exhibited signs of dysphagia and mild dyspnea, in addition protruded dullaa was hanged out, fluctuating and edematous and camels were unable to withdraw the dullaa into the oral cavity. Long sharp teeth especially canines and entrapment of the feed material were the main causes of soft palate injuries in such animal. In conclusion, case history, clinical findings and surgical exteriorization of dulla provide diagnosis and subsequent surgical decision of various types of dulla injuries in dromedary camels. Moreover, successful surgical resection of the dulla could be used as curative treatment of some disorders in dromedary camels.

Key words:
Camel, injuries, palate, repair, soft.

1. Introduction

The importance of dromedary camel is conferred upon them through their significant contribution in milk, meat, wool and leather production, as well as camel race in many countries [1, 9]. Dulla (Gulla), the oro-ventral projection of the soft palate in camels, is better developed in adult males than in females and is frequently balloons out during rutting or breeding season as a form of sexual behaviour [2, 5, 10]. The dullaa is frequently injured in adult male camels during breeding season by sharp edges of cheek teeth or canines or by females during mating and by other male camel due to fighting together. In the other hand, blunt object or feed material and straws also causes its injury [9]. Abscesses, haematoma, food impaction, lacerated wounds as well as gangrene were reported as different surgical disorders of dulla in dromedary camels. Subsequently, inflammatory conditions with edematous swelling of the dullaa affect its withdrawal to the mouth and by the time, the condition becomes worse and complicated. Therefore these affections are considered as a common cause of soft palate surgery in such species [5, 9]. Surgical resection of the injured dullaa has been described in few reports and resection of the intact one from male racing camels has been used as a technique to increase the maximum oxygen uptake at speed, which overall improves track performance [5, 7].
Despite camel popularity and to the authors' knowledge; there are few reports on the detailed classification, etiology and treatment of the injured dulaa in camels. Therefore, the objectives of this study were to investigate the classification, possible causes and clinical presentation of dulaa disorders and to evaluate the efficacy of surgical resection in repair of such affection in dromedary camels.

2. Materials and methods

2.1. Animals

A total of nineteen dromedary camels (19 adult males) were admitted to Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Qassim University, Saudi Arabia between October 2018 and November 2019. Their ages were ranged from 48 to 120 months (mean ± SD: 88 ± 11 months), weighing between 450 and 750 kg (490 ± 120, mean ± SD) and of different breeds (11 Wadeh, 2 Ashaal, 3 Asfar and 3 Mejhem). Camels were included in the study based on case history and clinical evidence of dulla disorders. Different surgical disorders of dulla were classified according to their categories, cause and duration (time elapsed after appearance of clinical symptoms up to the presentation to the clinic), (Table 1) (Fig. 1 and 2). The committee of animal welfare and ethics, Laboratory Animal Control Guidelines of Qassim University approved the study protocol.

2.2. Clinical examination

Camels were clinically examined to determine the physical characteristics of dulla affections including cause, type, and duration. The age, breed, and sex of the camels were recorded. These parameters were evaluated, compared and analyzed. In all investigated camels, Type of soft palate injuries and ratio of its incidence in different camel breeds (n=19) are presented in Table 1 and Table 2 respectively.

2.3. Surgical treatment

Based on case history and clinical findings, surgical intervention (dulla amputation) of the affected camels was applied as a curative decision for overcoming of clinical symptoms. For camels undergoing surgery, routine clinical and hematological evaluations were carried out. Preoperative intravenous fluid therapy, normal saline 0.9% (1-2 litter, Saudi Pharmaceutical solution industry, Riyadh, KSA) and dextrose 5% (1-2 litter, Saudi Pharmaceutical solution industry, Riyadh, KSA) were administrated. Intramuscular (IM) administration of penicillin-streptomycin (Pen & Strep, Norbrook Laboratories, UK) at a dose rate of 30,000 IU/kg for the penicillin and 10 mg/kg streptomycin and flunixin meglumine (Finadyin, Schering-Plough, UK) at 1.1 mg/kg was done preoperatively. Sedation was performed via IV injection of xylazine HCl at dose rate of 0.3 mg/kg.

The camel was placed in sternal recumbency, with subsequent gentle pulling out of the entrapped dulla with the help of long sponge forceps and gentle pressure on the enlarged throat region. In case of protruded soft palate, it was held in hand with towel and was pulled out as much as possible. For surgery, aseptic preparation of the dulla was performed and the root of the dulla was anaesthetized with local infiltration analgesia using lidocaine HCl (lidocaine hydrochloride 2% Norbrook Laboratories, UK). When the appropriate depth of anesthesia had been achieved; to control hemorrhage, an interrupted, overlapping horizontal mattress stitches were performed using coated polyglactin 910 No. 1 (United medical industries Co., Ltd., Riyadh) and the dulla was resected approximately 2 cm away from the suture. The wound was routinely closed by simple continuous sutures.

Postoperative care and follow-up

Following surgery, the preoperative antibiotic was continued for 7 days and anti-inflammatory were continued for five successive days in addition to intramuscular [IM] injection of 10 ml vitamin AD₃E (ADVIT-DE, Morvel Laboratories P. Ltd.). The camel was confined in a stall rest for 4 weeks with daily monitoring of healing progress. Camels were discharged from the clinic approximately 4 weeks postoperatively. To evaluate the long-term results (6 months) of progress of health condition of the operated camels, a telephone survey was carried out. The owners were asked about discharge from the surgical site, and final functional results of the surgery.

3. Results

3.1. Clinical findings

Injuries of dulla were classified into six categories, lacerated wound (n=6; 31.5%) (Fig. 1A), impaction with feed materials (n=4; 21%), punctured wound by the canine (n=3; 15.8%) (Fig. 1B), protrusion (n=3; 15.8%) (Fig. 1C), gangrene (n=2; 10.6%) (Fig. 1D), and hematoma (n=1; 5.3%). Of the 19 studied camels, incidence of soft palate disorders was higher in Wadeh (white-colored camels, n = 11; 57.9%), than Asfar (light
brown-colored camels, n = 3; 15.8%), Mejhem (brown- to black-colored camels, n = 3; 15.8%), and Ashaal (reddish brown-colored camels, n = 2; 10.5%). Adult camels 4-10 years of age exhibited more dulla injuries than young one. In addition, male camels showed higher incidence (19; 100%) of dulla injuries (Table 1). The camels suffered from dulla entrapment exhibited signs of dysphagia, stretching and stiffness of the neck and mild dyspnea with presence of ulceration, impaction with food, hematoma, gangrene, fibrosis and penetrating wounds. On the other hand protruded dulla was fluctuating and edematous and camels were unable to withdraw the dulaa inside the oral cavity.

In the present study, the duration of the dulla disorders (time elapsed after appearance of clinical symptoms up to the presentation to the clinic), varied in the studied camels from one to five days (the mean time was 2.6 (±1.5). Lacerated and punctured wounds (7 camels) caused by long and sharp teeth especially canines were the most common soft palate injuries in the studied camels. While hematoma was the least common one resulted from sharp trauma of canines and molars leading to submucosal haematoma, followed by necrosis and gangrene, it was reported in one case. Impacted soft palate with feed material was reported in 4 cases, it appeared as a heavy mass and it had difficult exteriorization from the throat region; flushing with warm water proved helpful in the approach of such cases. Protrusion was reported in 3 camels as result of impacted feed material, due to chasing of females for mating or as a result of fighting together with other males. Treatment was established by successful surgical resection of the affected soft palate in all studied camels (Fig. 2A-C).

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Table 1: Clinical findings of soft palate injuries (n=19) in camel.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Breed</th>
<th>Age</th>
<th>Sex</th>
<th>Type of surgical disorder</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-</td>
<td>Wadeh</td>
<td>6 Yrs</td>
<td>Male</td>
<td>Lacerated wound</td>
<td>3 Days</td>
</tr>
<tr>
<td>2-</td>
<td>Wadeh</td>
<td>10 Yrs</td>
<td>Male</td>
<td>Impaction with feed material</td>
<td>4 Days</td>
</tr>
<tr>
<td>3-</td>
<td>Asfar</td>
<td>9 Yrs</td>
<td>Male</td>
<td>Protrusion</td>
<td>One Day</td>
</tr>
<tr>
<td>4-</td>
<td>Ashaal</td>
<td>8 Yrs</td>
<td>Male</td>
<td>Lacerated wound</td>
<td>3 Days</td>
</tr>
<tr>
<td>5-</td>
<td>Wadeh</td>
<td>7 Yrs</td>
<td>Male</td>
<td>Lacerated wound</td>
<td>5 Days</td>
</tr>
<tr>
<td>6-</td>
<td>Wadeh</td>
<td>8 Yrs</td>
<td>Male</td>
<td>Punctured wound by canine</td>
<td>2 Days</td>
</tr>
<tr>
<td>7-</td>
<td>Wadeh</td>
<td>9 Yrs</td>
<td>Male</td>
<td>Gangrene</td>
<td>5 Days</td>
</tr>
<tr>
<td>8-</td>
<td>Asfar</td>
<td>8 Yrs</td>
<td>Male</td>
<td>Protrusion</td>
<td>2 Days</td>
</tr>
<tr>
<td>9-</td>
<td>Mejhem</td>
<td>6 Yrs</td>
<td>Male</td>
<td>Protrusion</td>
<td>2 Days</td>
</tr>
<tr>
<td>10-</td>
<td>Wadeh</td>
<td>5 Yrs</td>
<td>Male</td>
<td>Hematoma</td>
<td>2 Days</td>
</tr>
<tr>
<td>11-</td>
<td>Wadeh</td>
<td>7 Yrs</td>
<td>Male</td>
<td>Punctured wound by canine</td>
<td>One Day</td>
</tr>
</tbody>
</table>

3.2. Treatment outcomes

There was an association between the time elapsed after injury and the health state of the entrapped or protruded dulla; early diagnoses and treatment as much as possible as well as thorough post-operative care revealed good treatment outcomes. Follow up of the cases was done by contacting camel owners for a period of 6 months with special reference to the effect of amputation on eating and swallowing, before and after operation. Also, they were asked about discharge from the surgical site, and final functional results of the surgery. All treated camels were completely recovered 6 months post-operatively.
Table 2: Ratio of incidence of soft palate injuries in different camel breeds (n=19) in camel.

<table>
<thead>
<tr>
<th>Type of surgical disorder</th>
<th>Wadheh</th>
<th>Asfar</th>
<th>Mejhem</th>
<th>Ashaal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of camels</td>
<td>Incidence (%)</td>
<td>No. of camels</td>
<td>Incidence (%)</td>
</tr>
<tr>
<td>lacerated wound</td>
<td>4</td>
<td>21.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>impaction with feed materials</td>
<td>2</td>
<td>10.5</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>punctured wound by the canine</td>
<td>3</td>
<td>15.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>protrusion</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td>gangrene</td>
<td>1</td>
<td>5.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>hematoma</td>
<td>1</td>
<td>5.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>57.9</td>
<td>3</td>
<td>15.8</td>
</tr>
</tbody>
</table>

4. Discussion

Soft palate injury is a common serious affection in camels. It frequently required surgical interference to overcome their complications in such animals [5, 9]. Because of the limited knowledge about soft palate injuries in camel and its incidence in the available literature. Therefore, the present study was to describe the clinical presentation of dulla disorders and to evaluate the efficacy of surgical resection in repair of such affection in dromedary camels.

Occurrence of soft palate injury in different breeds of the camel was reported in the present study. Wadeh camels represent the highest prevalence in comparison to other studied breeds (11 vs 8). This may be contributed to the high number of Wadeh camels among other camel breeds in the Kingdom of Saudi Arabia in relation to their productive and reproductive and economical values [1, 9].

Case history and physical examination are routinely performed for the diagnosis of soft palate injuries in camels. Surgical exteriorization of entrapped dulla could be used for confirmation of diagnosis of varieties of dulla disorders in such animals, especially when case history do not provide an accurate and conclusive clinical decision. In the present study, the clinical finding of dulla injuries varied according to their type and duration. These findings were in coinciding with Gahlot, 2000 [3], and Reece and Chawla, 2001 [10].

Dulla (Gulla) is the oro-ventral projection of the soft palate in camels [2, 5]. In this study, various types of dulla injuries were precisely diagnosed; lacerated wound, impaction with feed materials, protrusion, punctured wound by the canine, gangrene, and hematoma. Entrapped dulla in studied camels exhibited signs of dysphagia and mild dyspnea, while protruded one appeared as heavy edematous mass hanged out on either side and camels were unable to retract it into mouth cavity. On the other hand, dysphagia and dyspnea have been reported as a characteristic signs seen in cases of soft palate injuries. Similar results were reported by Gahlot, 2007 [4], Gharu et al., 2016 [5] and Ramadan, 2016 [9].

In this study, dulla injury is common surgical disorders mostly caused by sharp trauma such as by long sharp teeth, impacted feed material and during chasing of females for mating or as a result of fighting together with other males. Successful surgical resection was performed in all examined camels. These findings were in coinciding with Sobayil and Ahmed, 2011 [2], Jena and Sahoo, 2014 [6], Gharu et al., 2016 [5] and Ramadan, 2016 [9]. Our results revealed that, male camels had higher incidence (100%, n=19) of dulla injuries; this could be attributed due to well developed status of dulla in male than female. Similar findings were reported by Sobayil and Ahmed, 2011 [2], Gharu et al., 2016 [5], Kumar et al., 2017 [8].
Conclusion
Case history, clinical findings and surgical exteriorization of dulla provide diagnosis and subsequent surgical decision of various types of dulla injuries in dromedary camels. Moreover, successful surgical resection of the dulaa could be used as curative treatment of such disorders in camels. Therefore, our results advice practioners to permit resection of the dulla as a routine prophylactic procedure.

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Conflict of Interest
(No conflict of interest).

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