



Superficial swellings in camels (*Camelus dromedarius*): Clinical and ultrasonographic findings

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ABSTRACT. This study describes the clinical and ultrasonographic features of superficial swellings in dromedary camels (*Camelus dromedarius*) and evaluates the role of ultrasonography (US) in diagnosing and surgical planning or making treatment decisions for such swellings. One hundred and twenty-three camels of both sexes were included in this study based on the clinical and US evidence of superficial swellings varying in type, stage, content, and site. Clinical and US evaluation of these superficial swellings resulted in diagnoses of abscess (30.08%), hernia (26.83%), cyst (16.26%), tumor (13.01%), hematoma (6.50%), bursitis (3.25%), aneurysm (2.44%), and grade III muscle strain (1.63%). US yielded a higher sensitivity (91–100%) and specificity (97–100%) than clinical examination (75–91%) in differentiating the superficial swellings. The highest specificity value for US in evaluating the swellings was 100% for hernias, cysts, and tumors, while the lowest specificity values were recorded for hematomas (97%), followed by aneurysms (98%). In conclusion, US is a reliable and accurate tool providing rapid differential diagnosis, thus enabling treatment options for different superficial swellings in camels when clinical examinations are inconclusive.

KEY WORDS: camel, clinical, superficial, swelling, ultrasonography

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Superficial swellings commonly occurring in camels include abscesses, hematomas, cysts, hernias, and neoplasms [2–5, 16, 20, 22, 26, 28]. They distort the esthetic appearance and conformation of the camel body, affecting both the animal's health and market value [4]. Clinical diagnosis of such swellings is usually achieved through inspection, palpation, and centesis or biopsy. However, differential diagnosis of such swellings is challenging for the veterinarian as most of these swellings have similar clinical presentations [27]. Furthermore, the treatment of these swellings differs from one lesion to another.

Ultrasonography (US) can provide accurate details regarding the extent and character of the swelling being examined, distinguish soft from hard contents, and guide fine needles for aspiration or biopsies [10, 23]. Based on the US features of each swelling along with clinical findings, palpable superficial swellings can easily be differentiated from each other, thus enabling a proper surgical judgment regarding the treatment of these swellings [1]. Many reports have described superficial swellings in farm animals [1, 12, 21]. Despite the popularity of camels, to the authors' knowledge, little has been found in the literature concerning the use of US in the diagnosis and treatment of superficial swellings in these animals. Therefore, this study was designed to describe the clinical and US features of such affections in dromedary camels and to evaluate the role of US in their diagnosis and treatment.

MATERIALS AND METHODS

Camels

One hundred and twenty-three dromedary camels (*Camelus dromedarius*) of both sexes (67 males and 56 females) and

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of different breeds aged 1–132 months (mean \pm SD: 98 ± 12 months) weighing 50–870 kg (mean \pm SD: 550 ± 100 kg) were investigated. Throughout the period between January 2017 and January 2019, the camels were admitted to the Veterinary Teaching Hospital of the Faculty of Agriculture and Veterinary Medicine at Qassim University, Saudi Arabia. Camels with clinical and US evidence of superficial swellings in different body sites were included in the study. The study protocol was approved by the Animal Welfare and Ethics Committee of Qassim University and conformed to their laboratory animal control guidelines.

Clinical examination

Upon presentation, the camels were clinically examined in the standing and recumbent positions to evaluate the nature, site, size, and contents of the swellings.

US examination

These swellings were subsequently examined ultrasonographically with the camels placed in the sternal or lateral recumbent position using a 2.5–5.0 MHz convex or 7.5–10.0 MHz linear transducer (SSD-500; Aloka, Tokyo, Japan). The site of the swelling was clipped and shaved. Once the transmission gel was applied, the area was examined to evaluate the US characteristics (echogenicity, size, thickness, stage, and contents) of the swelling. When needed, an ultrasonographically guided aspiration was performed with the camel being lightly sedated via IV administration of xylazine HCl (Seton 2%; Laboratorios Calier, S.A., Barcelona, Spain) at 0.2 mg/kg. To ensure consistency, all investigations were performed by a single investigator, and the US findings were compared with the clinical findings to determine the role of US to the diagnosis of the swellings.

Histopathological examination

Specimens were taken from tumors for histopathological examination. These specimens were routinely fixed in 10% formalin, processed and stained with hematoxylin and eosin stain. Findings were analyzed and reported.

Statistical analysis

Statistical analysis was performed using the GraphPad Prism statistical software, version 5.0 (GraphPad Software, San Diego, CA, USA). A contingency table analysis was performed to compare the efficacy of clinical examinations with that of US examinations in the diagnosis of superficial swellings in camels. The data were presented as sensitivity and specificity values, *P* value, confidence interval, odds ratio, and positive and negative predictive values. *P* values of <0.05 were used to denote statistical significance.

RESULTS

Of the superficial swellings in the 123 camels enrolled to this study, 37 (30.08%) were diagnosed with abscesses, including 8 acute, 11 mature, and 18 chronic; 8 (6.50%) were diagnosed with hematomas, including 3 recent and 5 organized; 3 (2.44%) were diagnosed with aneurysms, including 2 acute and 1 chronic; 2 (1.63%) had grade III muscle strain, including 1 acute and 1 organized; 20 (16.26%) had cysts, including 13 dermoid, 6 branchial, and 1 thyroid; 33 (26.83%) were diagnosed with hernias, including 26 reducible and 7 non-reducible; 4 (3.25%) had bursitis, all of which were chronic; and 16 (13.01%) had tumors (Table 1).

The US images of the superficial swellings varied depending on their location, infiltration, type, duration, content, and mass effect on the surrounding structures. US was able to accurately differentiate the superficial swellings from one another (sensitivity, 91–100%; specificity, 97–100%; odds ratio, 1.0–8.5). In addition, it enabled each form of the same swelling to be distinguished from other forms. The highest specificity value in the US evaluation of the superficial swellings was 100% for hernias, cysts, and tumors, while the lowest specificity values were recorded for hematomas (97%), followed by aneurysms (98%). The descriptive details of the sensitivity, specificity, odds ratio, and positive and negative predictive values for the superficial swellings included in this study are presented in Table 2.

The US images of the abscesses showed that most were echogenic capsules with hypoechoic to hyperechoic contents. The echogenic capsules were septated and contained large or small amounts of pus, debris, or homogenous contents, as indicated by internal echoes. Based on the site, type, and contents, the echogenicity of the abscesses varied from hypoechoic to hyperechoic. In eight cases, upon palpation, the abscesses were firm, and the contents appeared homogenous and had hypoechoic to echogenic structures within a thick capsule. Such cases were considered acute (unripened) forms, and lancing of these abscesses was delayed until maturation (Fig. 1A and 1B). The mature (ripened) abscesses in 11 camels had soft to doughy contents upon palpation, and the sonographic appearance of the contents was more hypoechoic with some echogenic debris (Fig. 1C and 1D). US-guided needle aspiration was performed for further confirmation, followed by lancing as a routine surgical procedure. However, the chronic abscesses in 18 camels had a firm texture, and US showed that the contents were heterogeneous and hypoechoic to anechoic, with thick internal septa enveloped in a thick echogenic capsule. Surgical excision of this type of abscess as one block mass was considered the best treatment option (Fig. 1E and 1F).

Eight camels with a history of trauma were diagnosed with hematomas. The appearance of the walls of the hematomas resembled that of an abscess capsule, but they were less echogenic, while the contents differed according to duration. Cases with recent hematomas ($n=3$) exhibited hot, inflammatory swellings and pain upon palpation. The sonograms of these cases revealed anechoic to hypoechoic fluid contents, especially at the periphery of the swelling, and the presence of echogenic septa toward the center dividing the swelling into small chambers (Fig. 2A and 2B). Surgical interference was postponed for these cases until the organization of the hematomas. However, clinical examination of the five cases with organized hematomas showed circumscribed

Table 1. Description of the location, duration, and percentage of the superficial swellings assessed in the cohort of camels

Location	Superficial swellings (n=123)																
	Abscess (n=37) (30.08%)			Hematoma (n=8) (6.50%)		Aneurysm (n=3) (2.44%)		Muscle strain III (n=2) (1.63%)		Cyst (n=20) (16.26%)			Hernia (n=33) (26.83%)		Bursitis (n=4) (3.25%)		Tumor (n=16) (13.01%)
	Acute (n=8)	Mature (n=11)	Chronic (n=18)	Recent (n=3)	Organized (n=5)	Acute (n=2)	Chronic (n=1)	Acute (n=1)	Organized (n=1)	Dermoid (n=13)	Branchial (n=6)	Thyroid (n=1)	Reducible (n=26)	Irreducible (n=7)	Acute (n=0)	Chronic (n=4)	
Head (n=10)	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Neck (n=26)	1	4	4	0	0	0	0	0	0	10	6	1	0	0	0	0	0
Chest (n=8)	2	1	2	1	0	0	0	1	0	0	0	0	0	0	0	1	0
Abdomen (n=41)	2	1	0	0	0	0	0	0	1	0	0	0	26	7	0	0	4
Forelimb (n=11)	1	1	3	0	0	2	1	0	0	0	0	0	0	0	0	2	1
Hind limb (n=16)	2	2	5	1	1	0	0	0	0	0	0	0	0	0	0	1	4
Udder (n=3)	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Testes (n=1)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Penis (n=2)	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Prepuce (n=2)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Perineum (n=1)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Umbilicus (n=1)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Eye (n=1)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Table 2. Statistical analysis of both clinical and ultrasonographic discriminations of superficial swellings in dromedary camels

Swelling	Sensitivity (%)		Specificity (%)		Odds ratio		Positive value (%)		Negative value (%)	
	Clinical	US	Clinical	US	Clinical	US	Clinical	US	Clinical	US
Abscess	89	96	93	99	8.5	1.0	89	96	93	99
Hematoma	87	94	86	97	8.2	1.0	87	94	86	97
Aneurysm	88	91	83	98	2.1	6.1	88	91	83	98
Muscle strain III	83	96	91	99	7.8	1.3	83	96	91	99
Cyst	92	100	96	100	6.2	1.7	92	100	96	100
Hernia	94	100	96	100	3.3	3.9	94	100	96	100
Bursitis	75	92	94	99	2.9	6.2	75	89	94	99
Tumors	89	99	97	100	7.9	1.2	89	99	97	100

swelling with false crepitation. US scanning of the organized hematomas before the routine surgical treatment revealed increased echogenicity of the contents, thicker septa, and decreased anechoic fluid contents, with the presence of some echogenic shreds.

Aneurysms were detected in three cases (2.44%) out of the 123 camels included in this study. All lesions were located in the shoulder region of the forelimbs. In both acute and chronic cases, on US, the aneurysms appeared similar to hematomas, except that they had fewer echogenic septa (Fig. 2C and 2D).

Two cases had grade III muscle strain. One was acute and located on the chest wall, and the other was chronic and found on the ventrolateral abdominal wall. Both were due to severe blunt-force trauma that led to the destruction of the superficial layer of the abdominal and thoracic muscles, respectively, which were sloughed away, leaving the debris floating in the accumulated inflammatory fluid. Sonography of the grade III muscle strain cases showed that the inflammatory fluid was extensive, diffuse, and anechoic in the acute case and was hypoechoic with the absence of a capsule and including floating hypoechoic to hyperechoic masses in the chronic case (Fig. 2E and 2F).

Cysts were clinically diagnosed in 20 camels as elliptical or circumscribed swellings, mostly on different sites of the neck, either laterally in the case of a dermoid cyst, more distal on the anterior aspect of neck in the case of a branchial cyst, or distal to the larynx in the case of a unilateral thyroid cyst (Fig. 3A–D). However, two other cases were diagnosed with a rectal cyst (Fig.

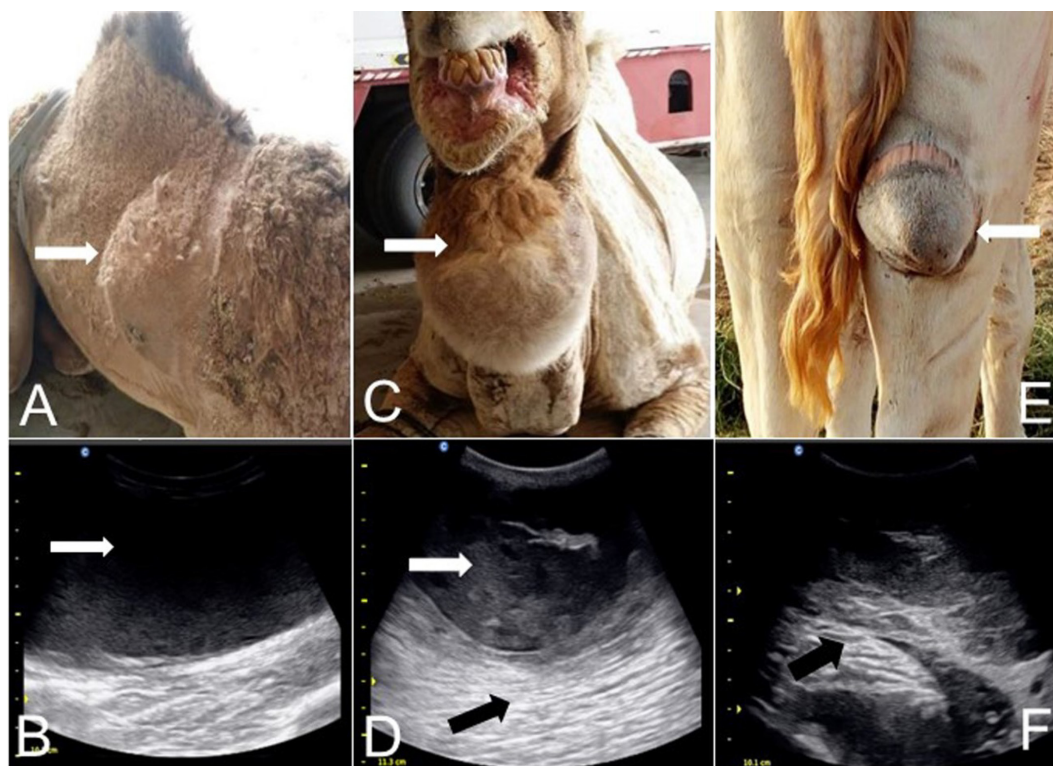


Fig. 1. A. Acute abscess at the lateral aspect of the thoracic wall (arrow). B. The content appeared as homogenous and hypoechoic to echogenic (white arrow) with a thick capsule. C. Mature abscess at the anterior aspect of the upper part of the neck (arrow). D. Sonographically, the contents appeared more hypoechoic (white arrow) with some echogenic debris (black arrow). E. Chronic abscess at the posterior aspect of the thigh region (arrow). F. The contents were heterogeneous and hypoechoic to anechoic with thick internal septa enveloped in a thick echogenic capsule (arrow).

3E) and a dermoid cyst of the eye, respectively. The size of the cysts varied according to the contents. The nature and color of the contents differed for each type. In the dermoid cysts, the contents consisted of a black fluid containing hair (Fig. 3A), whereas in the thyroid cyst, the contents were thick and chocolate-colored (Fig. 3B). In contrast, the contents of the branchial cysts were thick and milky (Fig. 3C), while the rectal cyst contained an odorless, colorless, watery fluid (Fig. 3E). Their sonographic appearance was forward volume transfer constant in all cases, with a thick, well-demarcated echogenic wall enveloping the anechoic fluid contents creating distal acoustic enhancement to hypoechoic fluid contents (Fig. 3F and 3G). However, in the branchial cysts, the contents showed hypoechoic echogenicity, with echoic shreds of hair in some cases. US-guided needle aspiration ensured an accurate diagnosis, which was essential for surgical interference via either lancing or surgical excision of the cyst.

Thirty-three camels were diagnosed with hernias (26 reducible and 7 non-reducible) with diameters varying from 3 cm to 25 cm. The sizes of the herniated swellings ranged from the size of a racket ball to the size of a watermelon (Fig. 4A). In the reducible cases, US examination showed anechoic disruption of the abdominal wall at the site of the defect, with the intestinal loops (Fig. 4B), rumen, or omentum within the hernial sac, according to the site of the hernia. The appearance of the hernial sac differed depending on the herniated organ. A hyperechoic line reflecting the gas cap was a characteristic sonographic feature of the rumen. The intestinal loops within the hernial sac were diagnosed as an echogenic line or circles in the longitudinal or transverse intestinal sections, respectively, with their characteristic peristaltic movement, while the omentum was accurately diagnosed ultrasonographically as a hyperechoic structure varying in thickness. Alternatively, echogenic adhesions between the abdominal wall and a thickened hernial sac were observed in the non-reducible hernias. In addition, the movement of the herniated structure was significantly decreased, with evidence of hypoechoic inflammatory exudates around the intestinal loops and hernial sac. Closed herniorrhaphy was performed to the reducible hernias, whereas non-reducible cases necessitated the open technique for dissection of the hernia contents from varying degrees of adjacent adhesion before reduction.

Four camels were diagnosed with bursitis in different body areas, including olecranon, precarpal (Fig. 4C), prepatellar, and chest pad bursitis. All cases were chronic when admitted to the clinic. Fluid accumulation was palpated only in the stifle joint, and precarpal bursitis was confirmed using diagnostic centesis. According to the presence or absence of fluid, the bursitis was classified as cystic (1 case), serofibrinous (proliferative) (1 case), and fibrous (2 cases). The extent of the bursitis, capsule thickness, and bursa contents were determined using US. The capsule echogenicity varied between hypoechoic in the cystic type and hyperechoic in the fibrous type with a mean capsule thickness of 5.3–11.7 mm. Sonography of the cystic bursitis revealed a thick, hyperechoic capsule (8.7–13.5 mm) surrounding hypoechoic to anechoic fluid contents. However, US scanning of the

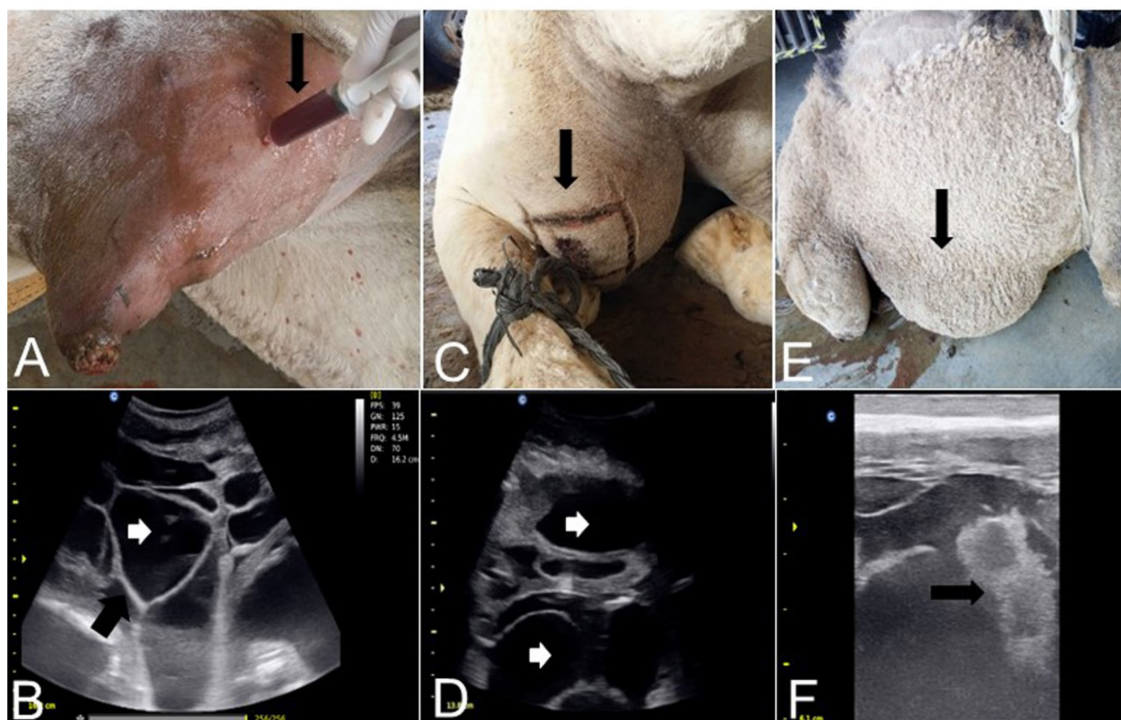


Fig. 2. A. Recent hematoma in the udder tissue of a female Wadheh camel. B. Ultrasonographic examination revealed that the capsule generally resembles an abscess but was less echogenic with hypoechoic to anechoic fluid content (white arrow), especially at the periphery of the swelling with the presence of echogenic septa (black arrow) dividing the swelling into small chambers toward the center. C. An aneurysm at the cranial aspect of the right shoulder region of a male Wadheh camel (arrow). D. Ultrasonographic view of the aneurysm showed hypoechoic fluid contents (arrow) resembling those of a hematoma but with fewer echogenic septa. E. Grade III muscle strain at the ventral abdominal wall in a female Wadheh camel (arrow). F. Ultrasonographic view of the grade III muscle strain showed diffuse anechoic to hypoechoic inflammatory fluids. Please note the absence of a capsule together with floating hypoechoic to hyperechoic masses (arrow).

serofibrinous bursitis showed a thick, echogenic capsule enveloping thick, echogenic fibrous masses within a minute amount of hypoechoic fluid (Fig. 4D). In the US images, the fibrous bursitis appeared as a fibrinous mass with heterogeneous echogenicity. Surgical interference differed according to the type of the bursa. Both drainage and intra-bursal injections were performed in cases with cystic bursitis without fibrin clots, while radical excision was the treatment of choice for fibrous bursitis.

Sixteen tumors were found in different body regions of the camels and included fibrosarcoma at the ventrolateral aspect of the abdomen (Fig. 4E), fibromas at different sites on the body (the limbs [Fig. 4G], abdomen, umbilicus, chest pad, and neck), papilloma in the umbilical region, myxopapilloma on the ventral part of the abdomen, fibropapilloma on the udder, osteosarcoma on the ventral aspect of the mandible, pyogranuloma in the retropharyngeal region, squamous cell carcinomas in the maxilla and neck regions, and lymphosarcoma in the neck region. Clinically, the tumors had mixed consistencies, varying from friable to solid. However, sonographically, they appeared as isoechoic to hyperechoic masses with diameters ranging from approximately 7.2 cm to 13.5 cm (Fig. 4F and 4H). Radical excision was performed in all cases as a treatment option. Histopathological examination was performed to confirm the tumor type; in fibromas, the fibroblasts were arranged in waves and the cells have spindle nuclei (black arrow) and eosinophilic collagen fibrils (white arrow) (Fig. 4I).

DISCUSSION

The early and accurate diagnosis of superficial swellings in camels is an essential step toward achieving successful treatment that ensures that the affected animals regain normal functions. Diagnosing superficial swellings in camels through case history and clinical examination alone can be inconclusive; this may be because camels have thick skins and exhibit fewer signs of pain than other domestic animals. Thus, diagnostic imaging techniques such as US are needed to confirm the primary diagnosis and improve the planning of surgical interference for such swellings in camels.

US is a relatively unique imaging modality for soft tissues of the animal body [13]. In addition to providing animal comfort under field conditions, US is a noninvasive, safe, quick, simple, and reliable imaging technique for differential diagnosis of different superficial swellings [1]. Moreover, US detects the nature of the contents and enables precisely guided needle biopsy of the swellings, which can improve the ability of the camel practitioner to differentiate several superficial swellings [25]. According to the available literature, the use of US in diagnosing superficial swellings in camels is limited. Therefore, this study can be

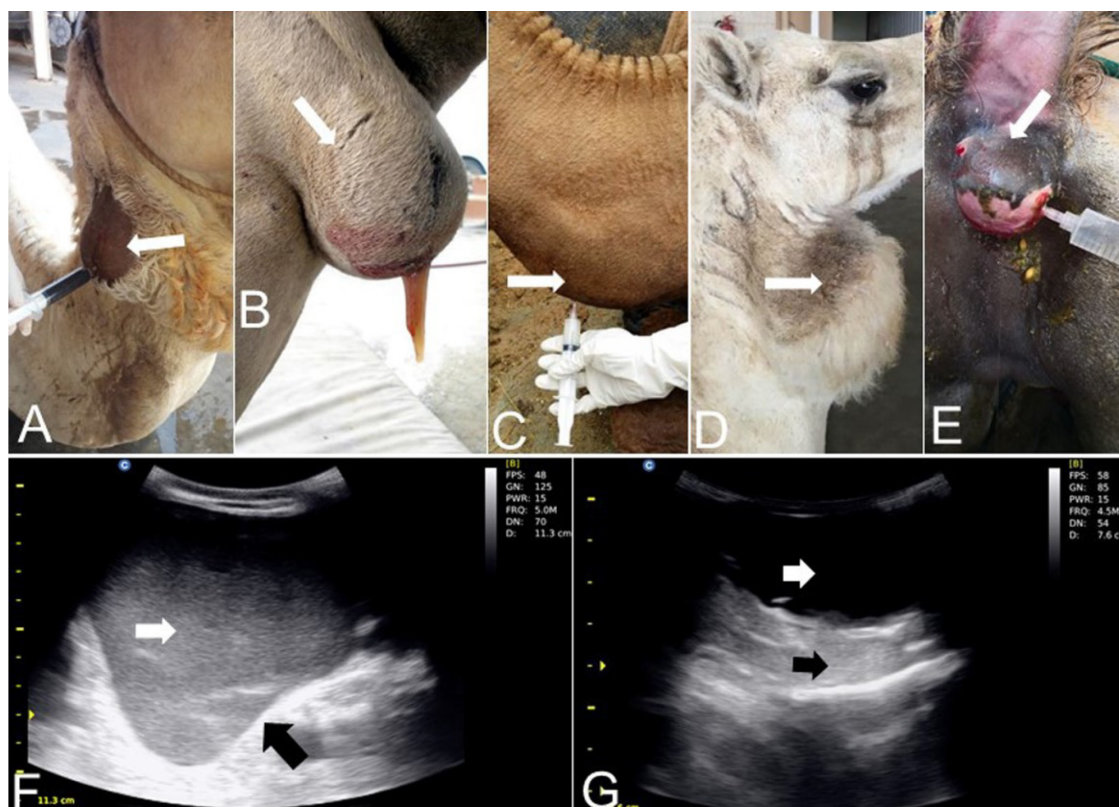


Fig. 3. Cysts: A. A lateral dermoid cyst on the neck containing black fluid with hair. B. A thyroid cyst with thick chocolate-colored contents. C. A branchial cyst in the lower part of the neck with thick milky contents. D. A unilateral thyroid cyst distal to the larynx. E. A rectal cyst distal to the tail containing odorless, colorless watery fluid. Forward volume transfers constant sonographic appearance: F. A thick, well-demarcated echogenic wall (black arrows) enveloping hypoechoic fluid (white arrows). G. Clear anechoic fluid contents (white arrows) creating distal acoustic enhancement (black arrows).

considered the first inclusive study of the application of US in differentially diagnosing superficial swellings in camels.

Cutaneous abscesses are a common affection in dromedary camels causing superficial swellings in all parts of the body, especially the skin, subcutaneous tissue, and lymph nodes [4]. Abscesses are harmful to camels and result in great economic losses in meat, hide, and wool production [3, 28]. Abscesses were the most prevalent (30.08%) superficial swellings found in the camels included in this study. The most frequently affected sites were the neck (n=9), hind limbs (n=9), forelimbs (n=5), and chest region (n=5). Chronic abscesses in camels are usually associated with necrosis, fibrosis, and calcification, which may make clinically diagnosing tumors difficult. The findings of this study conformed to those of the studies by Ali *et al.* [4] and Mohammed [15].

Abscesses may be confused with cysts, hematomas, tumors, and hernias because palpation alone cannot detect the different stages in their maturation. In addition, the thick skin of the camel may make a proper interpretation difficult [17, 27]. However, US used to determine the consistency of the abscess contents through either their echogenicity or after ultrasonographically guided needle aspiration is valuable in detecting the degree of maturation and in selecting the line of surgical treatment.

Muscular trauma followed by hematomas and abscesses are the most common affections seen in camels [4]. The clinical presentation of hematomas and abscesses is usually similar, although the sudden occurrence of a hematoma differs from the gradual formation of an abscess. However, in deserts, the open grazing nature of camels makes close inspection problematic; thus, owners are often unsure whether the swellings appeared suddenly or gradually. In such instances, US has proven to be the most reliable tool for differentially diagnosing such swellings based on the nature of the contents.

Furthermore, aneurysms and grade III muscle strains were among the superficial swellings reported in this study. Blood vessel wall weakness was the main cause of aneurysms, while muscle strains occurred as a result of severe blunt-force trauma. This led to the destruction of the superficial layer of the abdominal and thoracic muscles, which were sloughed away, leaving the debris floating in the accumulated inflammatory fluid. Similar findings were reported by Kofler [10] and Draghi *et al.* [6].

In this study, the US features of the aneurysms resembled those of the hematomas in both acute and chronic cases, except that the septa were less echogenic. However, grade III muscle strains were accurately diagnosed using US as largely diffuse and anechoic in the acute cases, whereas in the chronic cases, they were diagnosed using US based on the hypoechoic inflammatory fluid and the absence of a capsule, in addition to the floating hypoechoic to hyperechoic masses. This could be attributed to the damaged muscle layer and accumulated inflammatory fluids in the surrounding tissues. These findings were in accordance with those of the study by Draghi *et al.* [6].

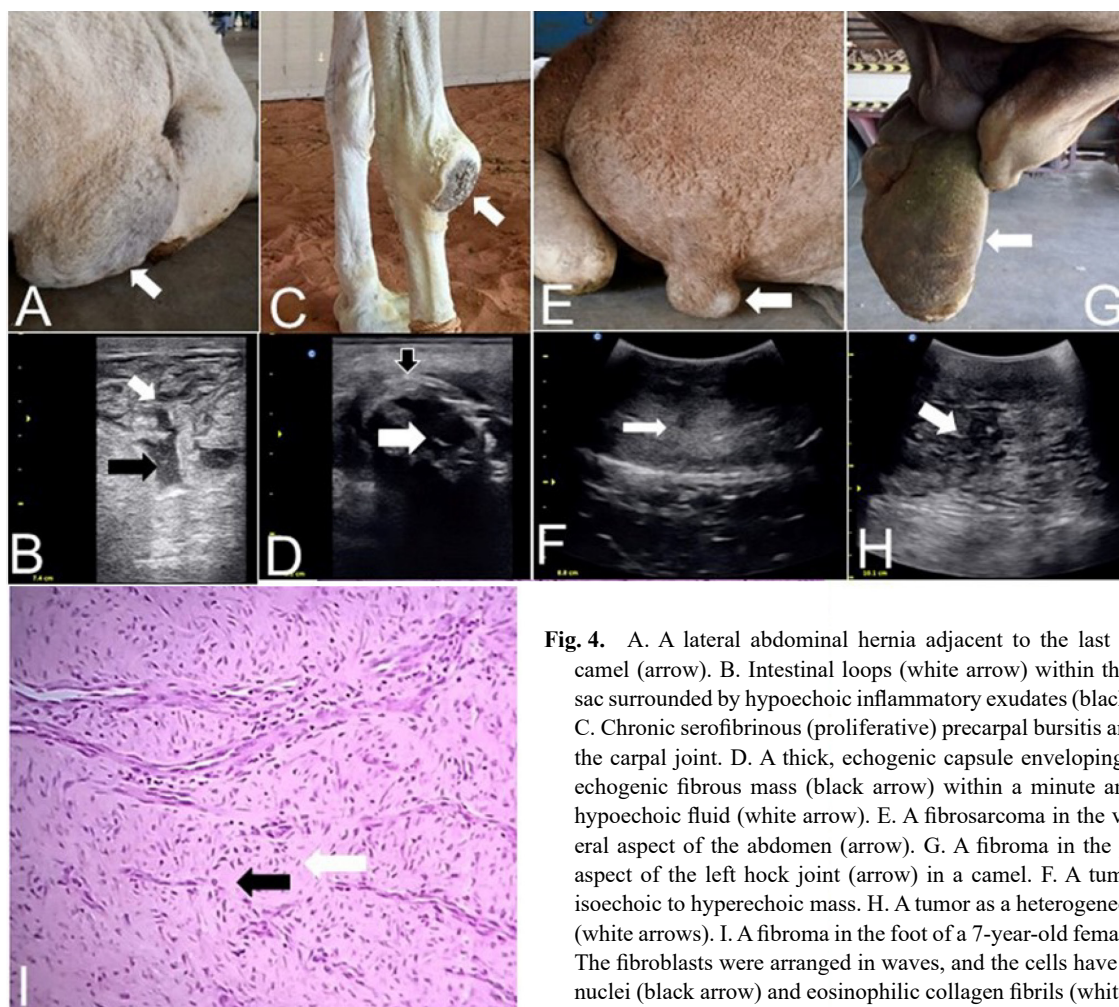


Fig. 4. A. A lateral abdominal hernia adjacent to the last ribs in a camel (arrow). B. Intestinal loops (white arrow) within the hernial sac surrounded by hypoechoic inflammatory exudates (black arrow). C. Chronic serofibrinous (proliferative) precarpal bursitis anterior to the carpal joint. D. A thick, echogenic capsule enveloping a thick, echogenic fibrous mass (black arrow) within a minute amount of hypoechoic fluid (white arrow). E. A fibrosarcoma in the ventrolateral aspect of the abdomen (arrow). G. A fibroma in the posterior aspect of the left hock joint (arrow) in a camel. F. A tumor as an isoechoic to hyperechoic mass. H. A tumor as a heterogeneous mass (white arrows). I. A fibroma in the foot of a 7-year-old female camel. The fibroblasts were arranged in waves, and the cells have spindle nuclei (black arrow) and eosinophilic collagen fibrils (white arrow).

Cysts were recorded in 16.26% of all swellings included in this study. In addition, dermoid cysts were the most common type (65%). On US, the dermoid cyst was presented with a fluctuating and enlarging elliptical mass, painless, and varying in size, located on the proximal part of the neck. It was filled with hair tufts in a brownish or coffee-colored, odorless, greasy mass with glandular secretions. These findings conform to those of the studies by Jubb *et al.* [9], Ahmed and Hassanein [2], and Zidan *et al.* [28].

To the authors' knowledge, branchial and thyroid cysts have not been reported previously in dromedary camels. In this study, branchial cysts (n=6) were detected on the lateral aspect and the cervical and mediastinal regions of the neck. In dogs, both thymic and mediastinal branchial cysts have frequently been reported, mainly affecting the lungs, with risks of developing tumors and metastasis [11, 19, 29].

Only one case out of 20 camels exhibiting cyst formation had a unilateral thyroid cyst. Thyroid cysts have been recorded in hyperthyroid and euthyroid cats with benign and malignant thyroid tumors with treatment methods varying between surgical excision and radiation therapy [14]. The fluid contents of the feline cysts were reddish-brown or serosanguinous and cytologically compatible with hemorrhage or non-septic inflammation [8, 18]. In contrast, in camels, the fluid contents of the cyst were found to be thick and chocolate-colored. The feline cysts were characterized by thin-walled cavitations of the thyroid gland with anechoic fluid, mobile echoic debris, or both [14]. However, the cyst in camels was characterized by a thick, well-demarcated echogenic wall enveloping anechoic to hypoechoic fluid contents, creating distal acoustic enhancement. The thick walls of the cysts in the camel compared to the thin walls of the feline cysts may have been due to the chronicity of the lesion and, unlike cats, to the camel's ability to adapt to harsh desert conditions.

Because of the similar clinical signs and history of acute onset, an inflammatory abdominal wall swelling might be confused with an abdominal hernia. US was effective in differentiating hernias from other swellings. Moreover, the stress of casting, with a high probability of self-inflicted injury to the camel, was avoided [20]. In this study, the discrimination of the hernial sac and its contents was easily achieved using US. Upon US examination, the presence of varying amounts of hypoechoic inflammatory exudates in recent hernias, especially those of the acquired origin, might have been similar to that of an abscess. However, the marked characteristics of the contents of either the rumen or the intestine inside the hernia were valuable for differential diagnosis. This concurred with the findings of Abouelnasr *et al.* [1] and Sadan *et al.* [20]. In addition, monitoring of the intensity of intestinal

and ruminal motility and the presence of adhesions between the hernial sac and surrounding structures critically affected the decision on the surgical intervention performed through either open or closed herniorrhaphy.

To our knowledge, the clinical and sonographic appearances of bursitis in camels have not been previously reported in the literature. US enabled the accurate evaluation of the thickness and contents of the bursitis capsule and the involvement of the surrounding tissue, all of which are important in deciding the best treatment for bursitis. Four camels had bursitis, including one cystic, one serofibrinous, and two fibrous. These were treated using either aspiration and injection of an irritant antiseptic into the cystic case or radical excision. These findings conform to those of Abouelnasr *et al.* [1], Fathy and Radad [7], and Seyrek-Intas *et al.* [24].

In this study, different types of tumors were detected in 13.01% of the camels, including fibrosarcoma, fibroma, papilloma, myxopapilloma, fibropapilloma, pyogranuloma, and lymphosarcoma. Some of these tumors may be confused clinically with other superficial swellings, thus making the diagnosis of the cases challenging. Moreover, inaccurate diagnosis of tumors may result in inappropriate interference, causing progressively more complications. Sonographically, the tumors appeared as isoechoic to hyperechoic masses. Thus, US is an especially important diagnostic tool in discriminating tumors from other swellings affecting camels. In conclusion, US provides an accurate, noninvasive, and rapid method for evaluating and differentiating various superficial swellings in camels and allows the correct decision making regarding treatment when clinical examinations are inconclusive.

REFERENCES

1. Abouelnasr, K., El-Shafaey, S., Mosbah, E. and El-Khodery, S. 2016. Utility of ultrasonography for diagnosis of superficial swellings in buffalo (*Bubalus bubalis*). *J. Vet. Med. Sci.* **78**: 1303–1309. [Medline] [CrossRef]
2. Ahmed, A. F. and Hassanein, K. M. 2012. Ovine and caprine cutaneous and ocular neoplasms. *Small Rumin. Res.* **106**: 189–200. [CrossRef]
3. Alharbi, K. B. and Mahmoud, O. M. 2012. Abscess disease of sheep and goats: A disease of major concern in Saudi Arabia that urges production of an effective vaccine. *J. Agric. Vet. Sci.* **5**.
4. Ali, H. S., Murad, I. M. and Thabet, A. E. 2001. Clinical and bacteriological investigation of cutaneous abscesses in camel in Assiut Governorate, Egypt. *Assiut Vet. Med. J.* **45**: 256–263.
5. Awadin, W. and Mosbah, E. 2013. Histopathology of tumor and tumor-like lesions in twelve female water buffaloes. *J. Vet. Sci. Med. Diagn.* **2**: 2–5.
6. Draghi, F., Zacchino, M., Canepari, M., Nucci, P. and Alessandrino, F. 2013. Muscle injuries: ultrasound evaluation in the acute phase. *J. Ultrasound* **16**: 209–214. [Medline] [CrossRef]
7. Fathy, A. and Radad, K. 2006. Surgical treatment and histopathology of different forms of olecranon and presternal bursitis in cattle and buffalo. *J. Vet. Sci.* **7**: 287–291. [Medline] [CrossRef]
8. Hofmeister, E., Kippenes, H., Mealey, K. L., Cantor, G. H. and Löhr, C. V. 2001. Functional cystic thyroid adenoma in a cat. *J. Am. Vet. Med. Assoc.* **219**: 190–193. [Medline] [CrossRef]
9. Jubb, K. V. F., Kennedy, P. C. and Palmer, N. 2007. Pathology of Domestic Animals, 5th ed., pp. 592–593, Academic, New York.
10. Kofler, J. 2009. Ultrasonography as a diagnostic aid in bovine musculoskeletal disorders. *Vet. Clin. North Am. Food Anim. Pract.* **25**: 687–731. [Medline] [CrossRef]
11. Levien, A. S., Summers, B. A., Szladovits, B., Benigni, L. and Baines, S. J. 2010. Transformation of a thymic branchial cyst to a carcinoma with pulmonary metastasis in a dog. *J. Small Anim. Pract.* **51**: 604–608. [Medline] [CrossRef]
12. Magda, M. A. and Abd El-Hakim, M. H. 2012. Ultrasonographic differential diagnosis of superficial swellings in farm animals. *J. Adv. Vet. Res.* **2**: 292–298.
13. Magda, M. A. 2006. Diagnosis of obstructive urolithiasis in cattle and Buffalo by ultrasonography. *Online J. Vet. Res.* **10**: 26–30.
14. Miller, M. L., Peterson, M. E., Randolph, J. F., Broome, M. R., Norsworthy, G. D. and Rishniw, M. 2017. Thyroid cysts in cats: a retrospective study of 40 cases. *J. Vet. Intern. Med.* **31**: 723–729. [Medline] [CrossRef]
15. Mohammed, A. M. 2010. Camel abscesses in the red sea state of the Sudan. [PhD thesis], University of Khartoum.
16. Mosbah, E. and El-Naggar, A. 2012. Surgical management of caudal rectal tumors in buffaloes. *Res. J. Dairy. Sci.* **6**: 1–4.
17. O'Conner, J. J. 2005. Veterinary Surgery, 4th ed. p. 770. CBS Publishers & Distributors, New Delhi.
18. Phillips, D. E., Radlinsky, M. G., Fischer, J. R. and Biller, D. S. 2003. Cystic thyroid and parathyroid lesions in cats. *J. Am. Anim. Hosp. Assoc.* **39**: 349–354. [Medline] [CrossRef]
19. Rickman, B. H. and Gurfield, N. 2009. Thymic cystic degeneration, pseudoepitheliomatous hyperplasia, and hemorrhage in a dog with brodifacoum toxicosis. *Vet. Pathol.* **46**: 449–452. [Medline] [CrossRef]
20. Sadan, M., El-Shafaey, E. S. and El-Khodery, S. 2019. Abdominal hernias in camel (*Camelus dromedaries*): Clinical findings and treatment outcomes. *J. Vet. Med. Sci.* **81**: 675–681. [Medline] [CrossRef]
21. Sadan, M. 2019. Superficial swellings in sheep (*Ovis aries*) and goats (*Capra hircus*): Clinical and ultrasonographic findings. *J. Vet. Med. Sci.* **81**: 1326–1333. [Medline] [CrossRef]
22. Sahoo, S. and Ganguly, S. 2015. Surgical management of abscess in camel: A case report. *World J. Biol. Med. Science.* **2**: 32–34.
23. Scott, P. R. 2012. Applications of diagnostic ultrasonography in small ruminant reproductive management. *Anim. Reprod. Sci.* **130**: 184–186. [Medline] [CrossRef]
24. Seyrek-Intas, D., Celimli, N., Gorgul, O. S. and Cecen, G. 2005. Comparison of clinical, ultrasonographic, and postoperative macroscopic findings in cows with bursitis. *Vet. Radiol. Ultrasound* **46**: 143–145. [Medline] [CrossRef]
25. Mohamed, T. and Oikawa, S. 2008. Efficacy and safety of ultrasound-guided percutaneous biopsy of the right kidney in cattle. *J. Vet. Med. Sci.* **70**: 175–179. [Medline] [CrossRef]
26. Thompson, K. 2007. Osteosarcoma. pp. 112–118. In: Jubb, Kennedy, and Palmer's Pathology of Domestic Animals. 5th ed. (Maxie, G. M. ed.), Saunders Elsevier, Edinburgh.
27. Tyagi, R. P. and Singh, J. 2006. Ruminant Surgery. 11th ed., pp. 167–174. CBS Publishers and Distributors Pvt., New Delhi.
28. Zidan, K. H., Mazloun, K., Saran, M. A. and Hatem, M. E. 2013. Abscesses in dromedary camels, sheep, and goats, etiology and pathology. 1st International Scientific conference of Pathology Department, Faculty of Veterinary Medicine. 47–59, Cairo University, Cairo.
29. Zitz, J. C., Birchard, S. J., Couto, G. C., Samii, V. F., Weisbrode, S. E. and Young, G. S. 2008. Results of excision of thymoma in cats and dogs: 20 cases (1984–2005). *J. Am. Vet. Med. Assoc.* **232**: 1186–1192. [Medline] [CrossRef]