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Thoracic and Abdominal Affections in Dromedary Camels: Clinical and Pathological Investigations

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ABSTRACT

This study presents a comprehensive clinical and pathological investigation of thoracic and abdominal affections in dromedary camels in the Qassim region of Saudi Arabia. Sixty clinically affected camels underwent detailed physical and ultrasonographic examinations to identify disorders affecting major thoracoabdominal organs. Additionally, 62 pathological specimens were collected from camels at local slaughterhouses for gross and histopathological evaluation. Clinically diagnosed conditions included renal abscesses, abdominal ascites, hepatic abscesses and cirrhosis, intestinal obstruction and abscesses, paratuberculosis, cystitis, hemoperitoneum, gastrointestinal foreign bodies, and suspected neoplasia. The chi-square test indicates a significant difference among disease frequencies (χ^2 = 33.0, P = 0.00006). This means the diseases are not evenly distributed, with kidney abscesses being the most frequent condition, followed by ascites and liver cirrhosis. Ultrasonography proved to be a valuable diagnostic modality, revealing specific features such as echogenic abscesses, fluid accumulation, and tissue thickening. Pathological evaluation confirmed multiple liver affections—parasitic (e.g., hydatid cysts, fascioliasis, cysticercosis), bacterial (caseous, pyogenic, actinomycotic), fungal (mycotic abscesses), and fibrotic lesions. Lung lesions included pneumoconiosis due to sandstorm exposure, foreign body granulomas, and lymphocytic interstitial pneumonitis. Cardiac affections such as interstitial myocarditis, sarcocystosis, and myocardial degeneration were also documented. The chi-square test shows χ^2 = 178.73 and P<0.001, indicating a highly significant difference in the distribution of lesions across organs. In other words, liver affections occur far more frequently than expected compared to lung, spleen, and cardiac lesions. This study highlights the diagnostic importance of combining clinical and imaging assessments with detailed pathological examination to improve the understanding, diagnosis, and management of thoracoabdominal diseases in camels.

Keywords: Camels, Diagnostic imaging, Diseases, Pathology, Ultrasonography.

INTRODUCTION

In dromedary camels, abdominal disorders are more commonly encountered than those affecting the cardiopulmonary, musculoskeletal, nervous, hepatic, or renal systems (Tharwat 2024). However, due to the camel's broad abdominal girth and the typically mild presentation of abdominal pain—even in severe conditions—many abdominal diseases remain undiagnosed or are only discovered during postmortem examinations (Tharwat 2020a). Ultrasonography has proven to be a valuable diagnostic tool in camel medicine, offering critical insights into various abdominal pathologies (Tharwat 2024). Nonetheless, definitive diagnosis of thoracoabdominal diseases often relies on thorough pathological investigation.

Clinical evaluation of the heart, lungs, and pleura is a vital component of camel healthcare (Tharwat 2024). Both invasive and non-invasive techniques are utilized to assess the pulmonary and pleural structures. Non-invasive approaches include lung auscultation—both at rest and after temporarily obstructing airflow by manually closing the nostrils and mouth—chest wall percussion, pulmonary function testing, radiography, ultrasonography, and endoscopic examination (Tharwat 2021; Tharwat and Tsuka 2024).

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Pathological examination of thoracic and abdominal conditions in camels serves as a definitive diagnostic tool that supports clinical assessments. It also reveals underlying lesions that often go undetected during antemortem evaluations. Furthermore, such investigations contribute significantly to understanding the pathogenesis of these conditions in camels, offering valuable insights for comparative pathology studies. Various pathological conditions have been documented, including renal disorders (Barakat et al. 2017), parasitic infections (38.0%), gastrointestinal diseases (27.6%), dermatological infections (13.1%), respiratory conditions (12.8%), metabolic disorders (7.5%), and mastitis (4.0%) as reported by Alhendi (2000). Additional studies have identified Middle East Respiratory Syndrome infections (Alnaeem et al. 2020) and viral and bacterial causes of neonatal diarrhea in camel calves (Al-Ruwaili et al. 2012). However, comprehensive pathological descriptions of thoracic and abdominal lesions in camels, particularly in the Qassim region, remain scarce.

In dromedaries, abdominal diseases are most frequently observed, followed by thoracic disorders. These conditions often affect vital organs—such as the heart, lungs, liver, and components of the digestive and urinary systems—and can lead to fatal outcomes (Marzok et al. 2025). Due to the often-subtle clinical presentation, these diseases can be challenging to diagnose, resulting in significant mortality and economic loss (Niehaus 2022).

The present study aims to identify clinical findings of thoracic and abdominal disorders in camels through physical examination and ultrasonography. It also seeks to investigate pathological conditions in slaughterhouses, providing a detailed characterization of lesions both grossly and microscopically, and, when possible, determining their etiologies.

MATERIALS AND METHODS

Animals

Sixty dromedary camels were brought to the Veterinary Teaching Hospital at Qassim University, Saudi Arabia, for the evaluation of various clinical ailments. Animals exhibited signs of gastrointestinal disorders, including loss of appetite, abdominal bloating, reduced fecal output, and episodes of colic, which manifested as agitation and rolling behavior. Diseased animals were categorized into nine groups. Each camel underwent a comprehensive clinical assessment, which included evaluation of general demeanor, body condition, and vital signs such as heart rate, respiratory rate, and rectal temperature. Detailed auscultation of the heart and lungs was conducted, along with palpation and auscultation of the forestomach and intestinal areas, to identify signs of impaired motility, gas buildup, or atypical gastrointestinal sounds. In addition to the physical examination, all camels underwent laboratory diagnostics. All procedures were carried out in compliance with the ethical guidelines approved by the Ethics Committee for the Use and Care of Animals at Qassim University, adhering to the standards outlined in the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS 2010).

Thoracic and abdominal ultrasonography

Evaluation of the thoracic organs—specifically the heart, lungs, and pleura—was conducted following previously established methodologies (Tharwat 2021; Tharwat 2025). Similarly, sonographic examination of the abdominal organs, including the gastrointestinal tract, liver, and kidneys, was performed according to protocols described in earlier studies (Abu-Seida 2016; Tharwat 2024; Tharwat et al. 2025a, b, c, d, e; Tharwat and Elmoghazy 2025).

Pathological investigation of the thoracic and abdominal affections in camels

Various instruments and chemicals were used for specimen collection at the slaughterhouse and for tissue preservation and processing. A 10% formaldehyde solution was used in sufficient quantity to fully immerse the tissue samples in sealed containers, ensuring proper preservation.

Gross pathology and sampling

Tissue samples were collected from camels exhibiting thoracic and abdominal lesions, including those affecting the heart, lungs, pleura, bronchial lymph nodes, liver, gastrointestinal tract, regional mesenteric lymph nodes, spleen, and kidneys. Gross pathological changes were carefully documented, noting the location, size, shape, color, consistency, and texture of each lesion. All observed abnormalities were described in detail and photographed. Representative samples of the lesions were collected for subsequent histopathological analysis. Based on the morphological characteristics of the lesions, such as the parasite histomorphology (Saini et al., 2025), bacterial gross and microscopic pathognomonic lesions (Castillo and Manterola 2020), and mycotic hyphal structures (Woods and Walker 1996; Gupta et al. 2009), the histopathological lesions were described, diagnosed, and categorized on a pathological basis and not etiological basis.

Histopathology

Portions of the affected organs were excised and fixed in 10% neutral buffered formalin. Tissue samples, approximately 1cm³ in size, were trimmed to 5mm thickness for processing. This included dehydration by ascending ethanol concentrations, clearing in three changes of xylene, and infiltration with paraffin wax. The tissues were then embedded in molten paraffin at 60°C. Sections were cut at 5µm and stained using the routine hematoxylin and eosin (H&E) method for microscopic examination, as described by Bancroft and Gamble (2013).

Statistical Analysis

Data were presented as percentages, comparing the number of diseased animals within each diseased group with the total number of diseased or pathologic lesions. Chi-Square test was applied using SPSS, version 25 (2017). The significance level was set at $P<0.05$.

RESULTS

The nine categories of diseased camels examined at the Qassim University Hospital are summarized in Table 1.

The first group presented with renal abscesses. Upon examination, they exhibited symptoms such as reduced

appetite, fatigue, low energy levels, overall weakness, difficulty urinating, and in cases involving larger abscesses, swelling in the flank or lower back area. Ultrasonography revealed a circumscribed lesion that contained either echogenic or hypoechoic pyogenic material (Fig. 1).

Table 1: Different categories of diseased camels were examined at the Qassim University Hospital

Group	Number	%	Disease
1	18	30	Kidney abscesses
2	10	16.6	Ascites
3	9	15	Liver cirrhosis and abscesses
4	8	13.3	Intestinal obstruction
5	4	6.7	Paratuberculosis
6	4	6.7	Cystitis
7	3	5	Hemoperitoneum
8	3	5	Rumen foreign bodies
9	1	1.7	Abdominal neoplasia
Total	**60**	100	

The chi-square test indicates a significant difference among disease frequencies ($\chi^2 = 33.0$, $P = 0.00006$). This means the diseases are not evenly distributed, with kidney abscesses being the most frequent condition, followed by ascites and liver cirrhosis.

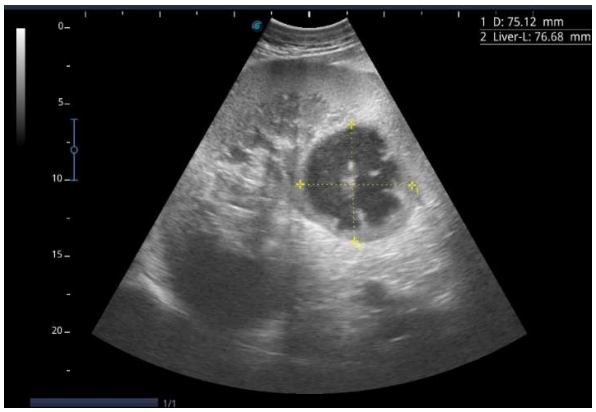

Fig. 1: Ultrasound image showing an abscess affecting the left kidney.

The second group was diagnosed with abdominal ascites. They exhibited signs such as a swollen abdomen, limited mobility, reduced appetite, and shortness of breath. Ultrasound examination confirmed fluid accumulation in the abdominal cavity, accompanied by abnormal abdominal sounds. A massive volume of peritoneal fluid was visualized sonographically, where abdominal viscera were imaged “swimming” in the peritoneal effusions (Fig. 2).

The third group was found to have liver abscesses along with cirrhosis. Clinical indicators of liver abscesses included poor appetite, weight loss, fatigue, and a mild elevation in body temperature. In cases of liver cirrhosis, common signs observed were overall weakness and decreased food consumption. By ultrasonography, multiple calcified echogenic deposits were imaged within the hepatic parenchyma with coarse hepatic echotexture (Fig. 3).

The fourth group was diagnosed with intestinal obstruction. Animals exhibited symptoms including anorexia, abdominal distension, and a noticeable reduction in fecal output. In cases of intestinal abscesses, the main signs observed were loss of appetite and a palpable abdominal mass. Bilateral abdominal distension was evident with symptoms of vomiting. Sonographically, the intestinal abscess was imaged within the intestinal loops (Fig. 4).

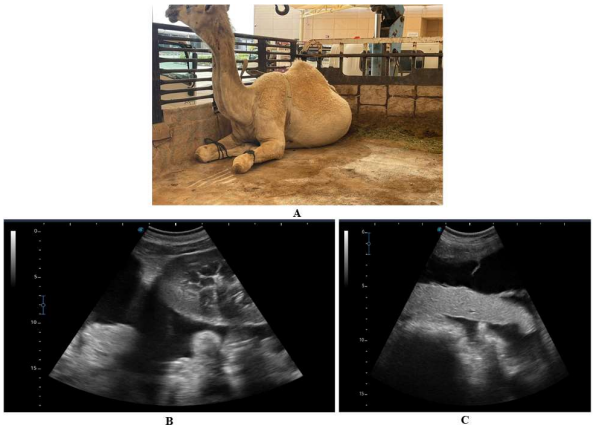

Fig. 2: Ascites in a dromedary camel. Pronounced abdominal distension was apparent (A). Abdominal viscera, including the right kidney and intestines (B) and the spleen (C), were visualized floating in the peritoneal hypoechoic fluid.

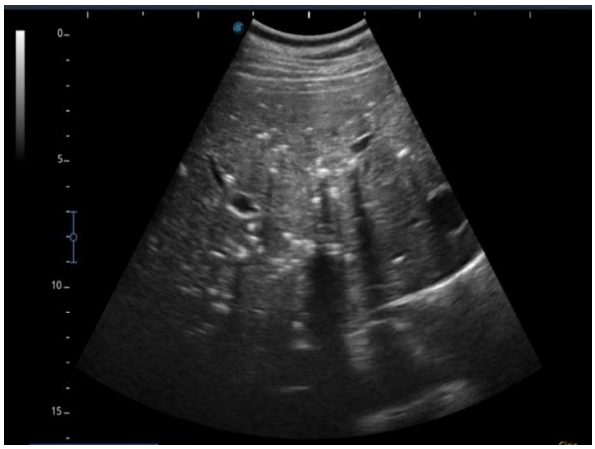

Fig. 3: Hepatic cirrhotic pattern in a dromedary camel. Multiple calcified echogenic deposits were imaged within the hepatic parenchyma with coarse hepatic echotexture.

The fifth group was affected by paratuberculosis (Johne's disease). The animals exhibited clinical signs such as chronic, foul-smelling diarrhea, marked emaciation, progressive loss of body condition, and overall weakness. Ultrasound showed thickened, corrugated intestinal mucosa. The sixth group was diagnosed with cystitis. Clinical signs observed in the affected animals included persistent hematuria lasting approximately two months, noticeable thickening and inflammation of the bladder wall, signs of phosphorus deficiency, frequent urination in small volumes, and evident pain and difficulty during urination. The bladder was thickened and corrugated on ultrasonography (Fig. 5). The seventh group had hemoperitoneum (Fig. 6). Clinical signs observed included abdominal distension, generalized weakness, pale mucous membranes, and noticeable abdominal pain.

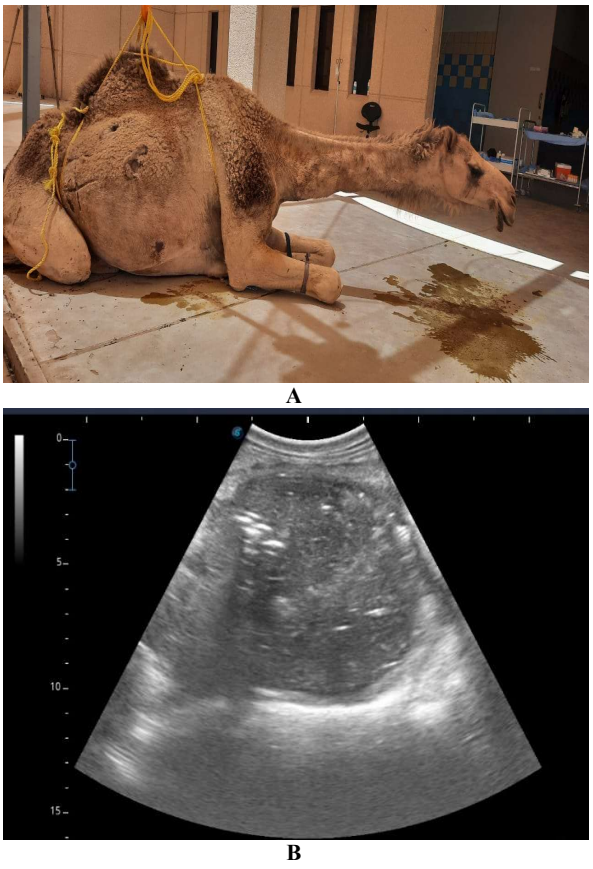

Fig. 4: Intestinal obstruction due to para-mesenteric abscess in a dromedary camel. The animal was presented with repeated vomiting symptoms (A). The lesion was detected sonographically and contained highly echogenic foci (B).

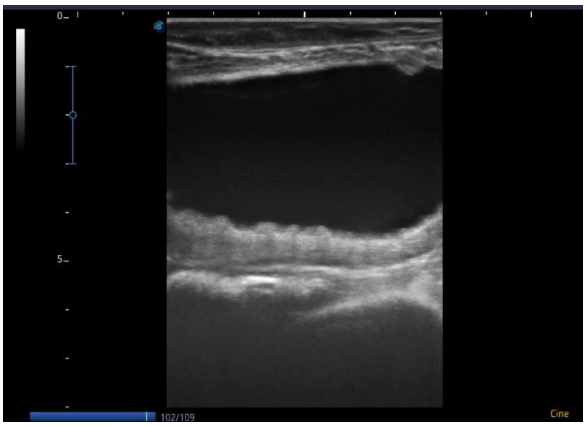

Fig. 5: Cystitis in a dromedary camel. The bladder was thickened and corrugated.

The eighth group was found to have rumen foreign bodies, accompanied by severe thickening of the intestinal wall. Affected animals showed signs of emaciation, general weakness, and a tendency to lie consistently on the right side for an extended period. Interestingly, laboratory test results remained within normal ranges. The ninth group was diagnosed with abdominal cancerous tumors. The condition involved multiple neoplastic locations, including an internal mass in the abdominal cavity. Unfortunately, the tumors were not confirmed histologically.

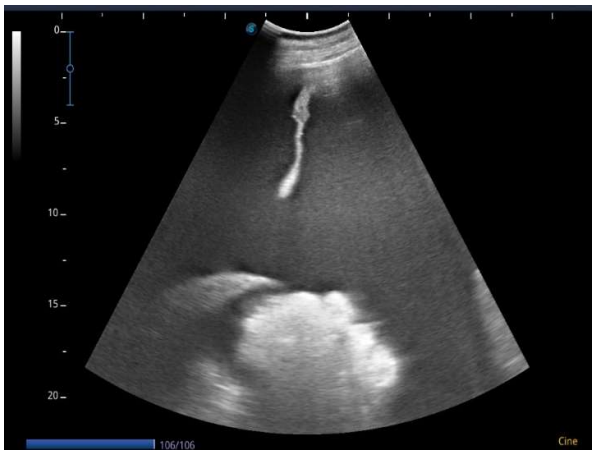

Fig. 6: Hemoperitoneum in a dromedary camel. The abdomen contained highly echogenic effusions that contained echogenic deposits consisting of fibrin threads.

Pathological affections of the thoraco-abdominal organs in camels

Of the 62 grossly abnormal cases, 62 were collected from the Buraydah slaughterhouse in the Qassim region. Fifty samples from the liver revealed parasitic infection in 19 cases, bacterial infection in 21 cases, and 10 instances revealed liver fibrosis. Out of 6 cases of lung affections, 2 were sand particle inhalation, two foreign body granuloma, and 2 were lymphocytic interstitial pneumonitis. Spleen revealed incidental hematoma and age-related changes in one case each. Heart lesions revealed pericardial hemorrhagic suffusion, myocardial sarcocystosis, interstitial inflammation and degeneration and atrophy in one case each (Table 2).

Liver affections

Parasitic affections of the liver

Liver cysticercoids (cestode)

Several tiny circular or oval whitish structures ranging in size from 2 to 4 mm were observed under the hepatic capsule (Fig. 7A) as well as deep within the liver tissue, either elevated or depressed. The structures were either cloudy and degenerated or intact, containing clear liquid. Microscopical examination revealed a membranous structure with a serrated surface and a conspicuous, deep invaginated canal, which was interpreted as a developing scolex, and 4 hooklets were observed (Fig. 7B, C). The parasite's cross-section was encircled by vital liver tissue and a host-derived capsule composed of fibroplasia, myofibroblasts, and mononuclear cell infiltration. These observations suggested that metacestode larvae *(Cysticercus tenuicollis*) were responsible for the observed hepatic alterations.

Liver cysts (hydatid cyst)

A bladder cyst parasite of a hydatid cyst grows in the peritoneal cavity, attached to the visceral peritoneum and the liver capsule. These cysts are parasitic larvae that develop into larger cysts (Fig. 7D). The degenerated hydatid cyst was surrounded by concentrically arranged mature fibrous tissue or early reactive fibroplasias (Fig. 8A). The liver of a camel showed multilocular alveolar cysts filled with eosinophilic homogenous fluid and

Table 2: Distribution of pathological lesions in organs collected from abnormal cases at Buraydah Slaughterhouse, Qassim region

Lesions	Distribution of pathological lesions	
	No.	%
Liver affections:	50	80.64
1. Parasitic affections	19	30.65
• Liver cysticercoids	6	
• Liver cysts (hydatid cyst)	7	
• Liver trematode (Fasciola) tunnels	5	
• Non-parasitic cysts	1	
2. Bacterial abscesses	21	33.87
o Disseminated hepatic abscesses as part of caseous lymphadenitis.	9	
o Pyogranulomatous lesion (may be due to actinomycosis)		
o Pyogenic abscess (liquid abscess).	2	
o Mycotic abscess		
3. liver fibrosis	9	
	1	
	10	16.66
Lung affections	6	9.67
✓ Sandstorm particulate matter:	2	
✓ Foreign body granuloma:	2	
✓ Lymphoid interstitial pneumonitis	2	
Spleen affection:	2	3.2
▪ Incidental localized splenic hematoma:	1	
▪ Age-related changes in the spleen of older camels:	1	
Cardiac affections:	4	6.45
❖ Interstitial myocarditis:	1	
❖ Hemorrhagic suffusion	1	
❖ Myocardial degeneration and atrophy:	1	
❖ Myocardial sarcocystosis:	1	

The chi-square test shows $\chi^2 = 178.73$; $P<0.001$, indicating a highly significant difference in lesion distribution among organs. In other words, liver affections occur far more frequently than expected compared to lung, spleen, and cardiac lesions.

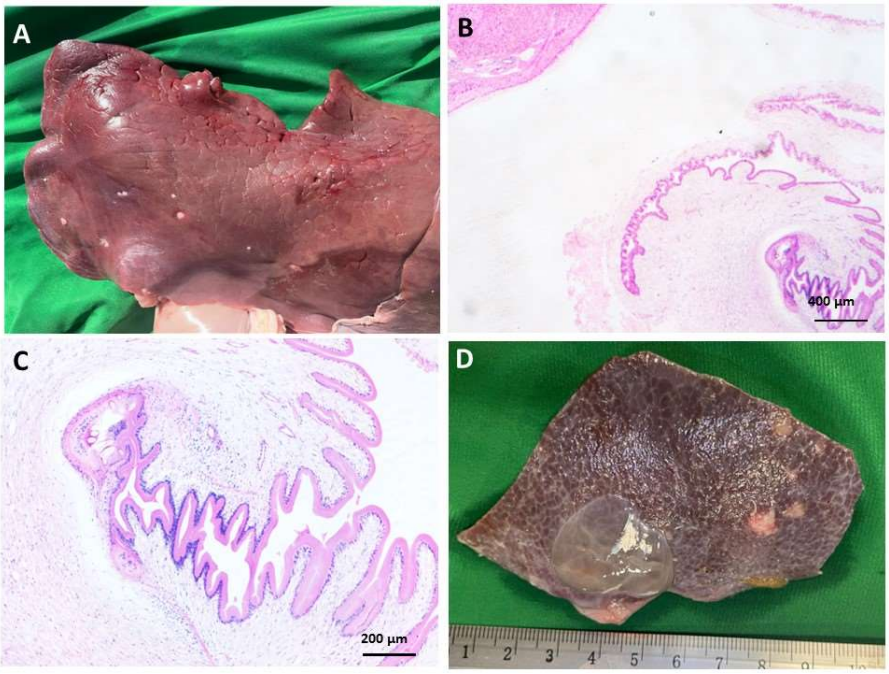

Fig. 7: A) Case 20 of cysticercosis in the liver of camels appeared as several tiny circular or oval whitish structures ranging in size from 2 to 4 mm under the hepatic capsule, and B) microscopically characterized by rostellum and convoluted spiral canal (thin arrow), vestibule, and thin wall of the cyst attached to hepatic tissue (H&E, bar = 400µm). C) Higher magnification of B (H&E, bar = 200µm). D) Bladder cysts in the visceral peritoneum and the capsule of the liver.

communicated with each other. Hydatid cyst filled with homogenous caseated material intermixed with degenerated scolexes and surrounded by fibrous capsule and mononuclear inflammatory cells (Fig. 8B-D).

Liver trematode (Fasciola) tunnels

Fasciola migrating tunnels appear on gross examination as hemorrhagic tracts on the liver surface and appear as serpentine areas. Multifocal pinpoint necrotic foci appeared as white spots spreading throughout the surface and parenchyma of liver (Fig. 9A). Histologically, these tunnels appeared as multiple eosinophilic necrotic lesions characterized by central necrotic tunnel extensively infiltrated with eosinophils (Fig. 9B, C) and associated with extensive eosinophilic infiltration in the surrounding hepatic tissue (Fig. 9D). Tunnels are filled with blood, fibrin, and cellular debris, including disintegrated hepatocytes and eosinophils, surrounded by necrotic tissue and an inflammatory response of eosinophils, neutrophils, macrophages, and lymphocytes.

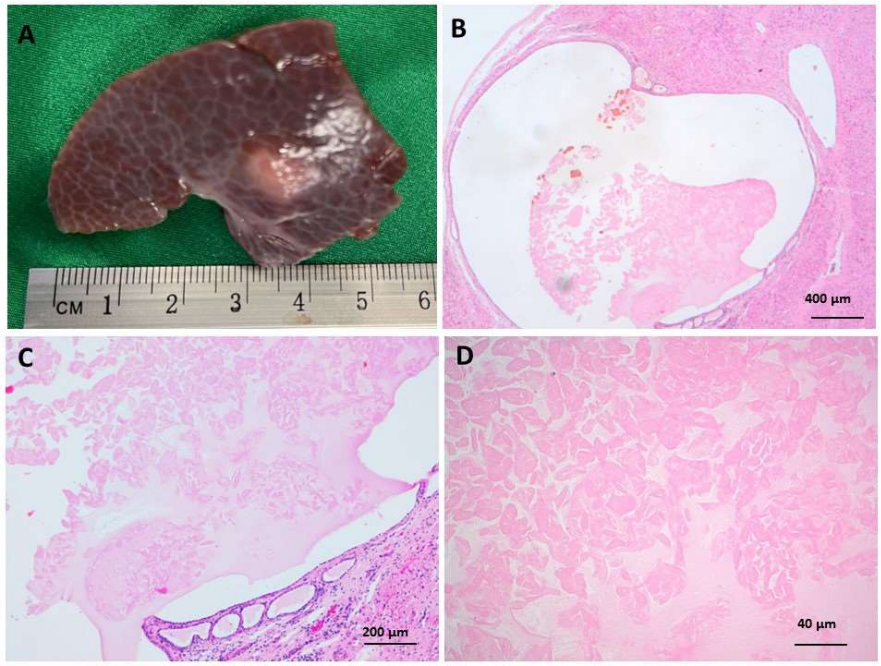

Fig. 8: A) A degenerated hydatid cyst appeared grossly as a focal, cloudy, hard, indurated mass under the hepatic capsule, B) The cyst is surrounded by concentrically arranged mature fibrous tissue or early reactive fibroplasias (H&E, bar = 400µm), C) Liver of a camel showing multilocular alveolar cysts that communicate with each other (H&E, bar = 200µm), and D)the cyst was filled with eosinophilic homogenous fluid and degenerated scolices (H&E, bar = 40µm).

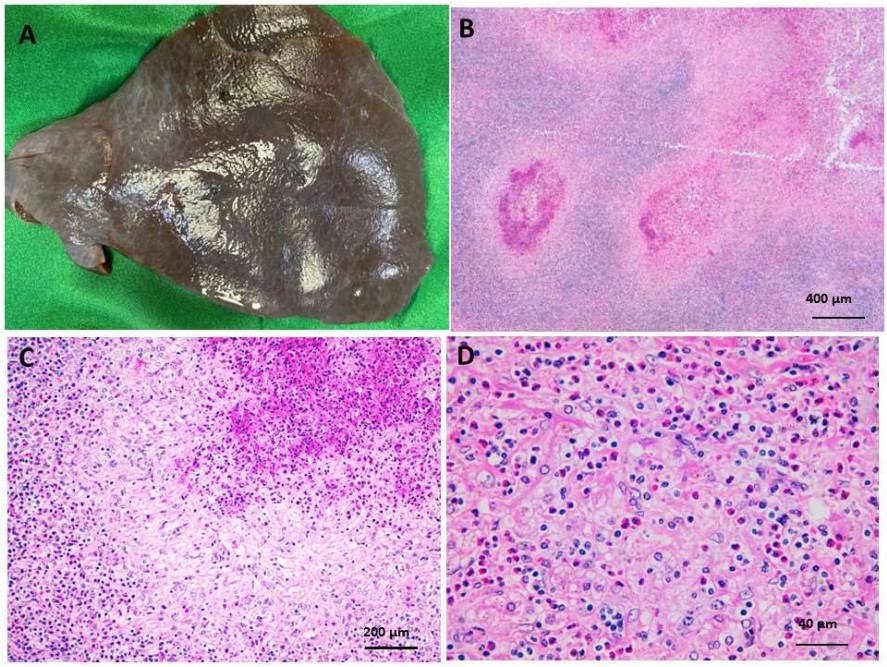

Fig. 9: A) Multifocal pinpoint necrotic foci appeared as white spots spreading throughout the surface and parenchyma of the liver, B) Multiple eosinophilic necrotic lesions characterized by central necrotic tunnel extensively infiltrated with eosinophils (H&E, bar = 400µm), C) The necrotic lesions are associated with extensive eosinophilic infiltration in the surrounding hepatic tissue suggesting migrating tunnels of trematode larvae (H&E, bar = 200µm) and D) A higher magnification of the surrounding tissue revealed eosinophilic infiltration (H&E, bar = 40µm).

Non-parasitic cysts

The macroscopic and microscopic appearance of hepatic cysts in camels has been described. The cysts had thin walls and protruded from the liver surface. They contained no parasites or scolices. The cyst wall was lined by flattened or low cuboidal epithelium, and no definite structures suggestive of parasitic infection could be detected (Fig. 10A, B).

Bacterial abscesses in the liver

Disseminated lamellated hepatic abscesses (Suggestive of caseous lymphadenitis)

Grossly: an encapsulated abscess containing thick, dry, greenish-yellow to white cheesy caseous pus without offensive odor. The pus is dry, pasty, and tenacious. The abscesses were multi-layered ("onion-like" appearance), with a thick fibrous capsule surrounding the central, cheesy material.

Histopathologically, the liver abscess revealed numerous concentric layers with central caseous necrosis. A thin layer of polymorphonuclear neutrophils surrounds the periphery of caseous necrosis, with a further outer layer of caseous necrosis containing polymorphonuclear neutrophils migrating through it at adjacent densities, forming a pyogenic membrane. The outermost layer was a layer of immature fibrosis containing mononuclear inflammatory cells, followed by a thick layer of mature fibrosis outlining the lesion's extent. The caseous necrosis was separated from active, immature fibrosis, with borders containing mononuclear inflammatory cells and migrating polymorphonuclear neutrophils.

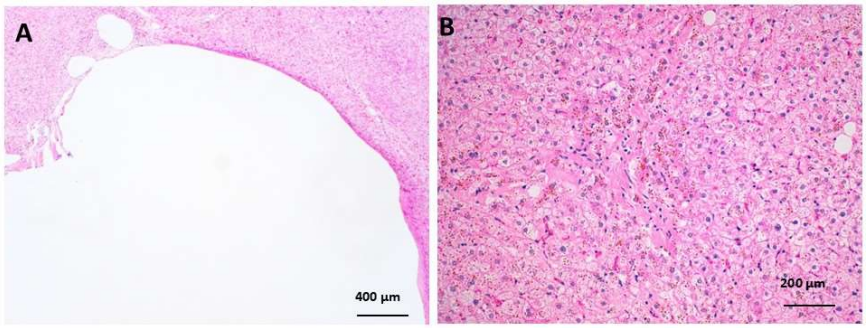

Fig. 10: A) Non-parasitic cyst lined by flattened or low cuboidal epithelium, and no definite structures suggestive of parasitic infection (H&E, bar = 400µm and B) The cyst is associated with lipofuscin pigments in hepatocytes (H&E, bar = 200µm).

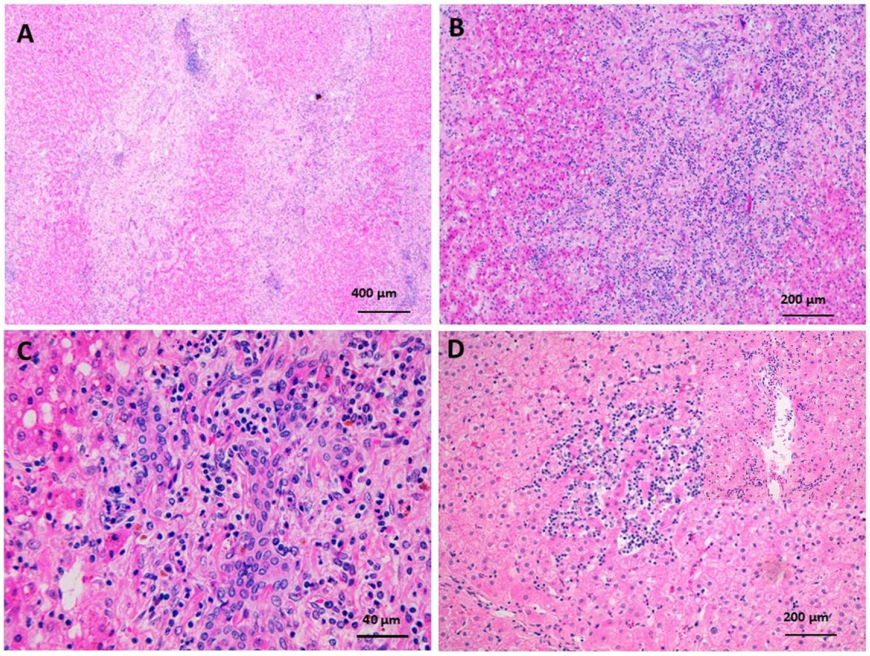

Fig. 11: Case 16 revealed biliary cirrhosis characterized by extensive fibrosis with diffuse lymphocytic and neutrophilic infiltration and biliary hyperplasia (A, B, C; H&E, bar = 400µm, 200µm and 40µm, respectively) and D) Focal areas of neutrophilic and lymphocytic infiltration in hepatic lobules observed as well as central fibrosis (inset), (H&E, bar = 200µm).

Pyogranulomatous lesion

A yellow-gray to brown, firm, indurated abscess with rigid, fibrous walls and soft central areas containing pus or granules. "Sulphur granules".

A mixed suppurative and granulomatous inflammatory reaction, connective-tissue proliferation, sulfur granules, and filamentous raylike bacilli. The granules were clumps of filamentous bacterial microcolonies surrounded by polymorphonuclear neutrophils. Sulphur granules are often pathognomonic of actinomycosis.

Pyogenic abscess

Grossly, multiple small white foci containing whitish, liquefactive, creamy pus and a thick capsule, along with congestion and hemorrhages of surrounding tissue, were observed (Fig. 12A).

Microscopically, a large local area of liquefactive necrosis enclosed by a thick capsule, along with a pyogenic membrane composed mainly of polymorphonuclear leucocytic infiltration, was seen (Fig. 12B).

Mycotic abscess in the liver

Embolic mycotic pyogranulomas in the liver of camels revealed whitish circumscribed foci that were shallowly depressed on the surface of the liver. Multiple embolic eosinophilic mycotic granulomas composed of an eosinophilic necrotic center and surrounded by giant cells. Hyphae of fungi could be observed. The surrounding necrotic tissue exhibited a dense inflammatory infiltrate composed predominantly of mononuclear cells and foreign-body giant cells, intermingled with polymorphonuclear leukocytes.

1) Liver fibrosis

Histopathological examination revealed portal and bridging fibrosis, biliary hyperplasia, hepatocellular atrophy, Kupffer cell hyperplasia, and inflammatory infiltration. The fibrosis of the liver was observed around the central vein, biliary areas, and the portal triad.

Central fibrosis: the fibrosis was observed mainly around the central vein.

Biliary fibrosis: hyperplasia of the biliary ductulus was accompanied by severe, extensive fibrosis, and widening of the portal area, which extended into the surrounding hepatic parenchyma and was associated with hepatocellular atrophy and neutrophilic infiltration (Fig. 11).

Portal fibrosis: The portal regions showed vascular and biliary wall thickening with perivascular and peri-ductal fibrosis, fibroblast hyperplasia in the portal triad, and infiltration by lymphocytes, neutrophils, and pigment-laden macrophages (Fig. 12C).

Post-necrotic fibrosis: occurred after and around liquefactive necrosis (abscesses), which usually extend to the portal area, leaving portal fibrosis with diffuse neutrophilic chronic hepatitis (Fig. 12B).

Lung affections

Sandstorm particulate matter: Dust particles, especially very small (2.5 to 10microns), were deposited, penetrated, and accumulated in lung tissue and the Interlobular septa around bronchioles. The particles are also dispersed in the alveolar tissue. Proliferation of alveolar macrophages, as well as epithelialization of some alveolar spaces, was observed. Pulmonary fibrosis was limited. Lungs of camels mottled with blackish discoloration related to sandstorm dust particles (Fig. 13A). Emphysematous alveoli revealed thickening of the interalveolar septa with fibroblasts. They were lined with cuboidal cells (Fig. 13B). Dust particles in the interlobular septa and around bronchioles were associated with local fibrosis and mononuclear cell infiltration (Fig. 13C). The particles were also dispersed in alveolar tissue. Proliferation of alveolar macrophages as well as epithelialization of some alveolar spaces (Fig. 13D).

Foreign body granuloma: dust particle inhalation causes pneumoconiosis (silicosis), which is associated with macrophage cell proliferation. Voluminous lungs in affected camels that failed to collapse with tiny translucent microfoci (Fig. 14A). Dust particles pneumoconiosis (silicosis) caused foreign body granuloma associated with macrophage cell proliferation (Fig. 14B and 14C). Focal aggregation of alveolar macrophages with thickening of alveolar septa was observed in relation to dust granuloma (Fig. 14D).

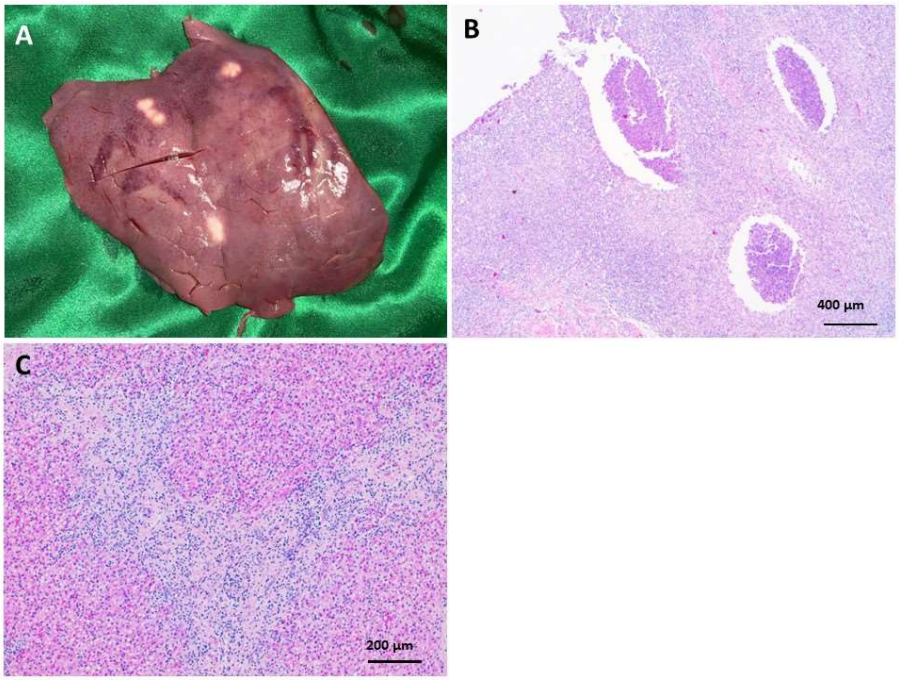

Fig. 12: (A) 24 Liver abscesses appeared as yellowish nodular structure with semifluid content and the surrounding hepatic tissue appeared pale and firm. (B) The abscesses had central liquefactive necrosis and surrounded with suppurative hepatitis (H&E, bar = 400µm). (C) Liver cirrhosis was prominent in the surrounding hepatic tissue (H&E, bar = 200µm).

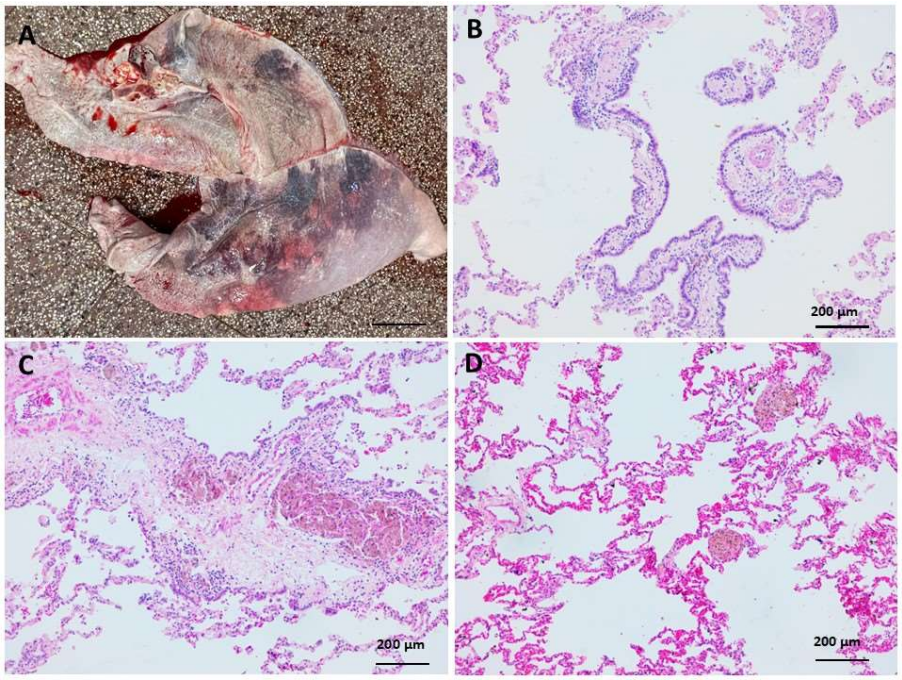

Fig. 13: A) Lungs of camels mottled with blackish discoloration related to sandstorm dust particles, B) Emphysematous alveoli revealed thickening of the interalveolar septa with fibroblasts and lined with cuboidal cells (H&E, bar = 200µm), C) Dust particles in the interlobular septa and around bronchioles associated with local fibrosis and mononuclear cell infiltration (H&E, bar = 200µm) and D)The particles also dispersed in alveolar tissue and proliferation of alveolar macrophages as well as epithelialization of some alveolar spaces (H&E, bar = 200µm).

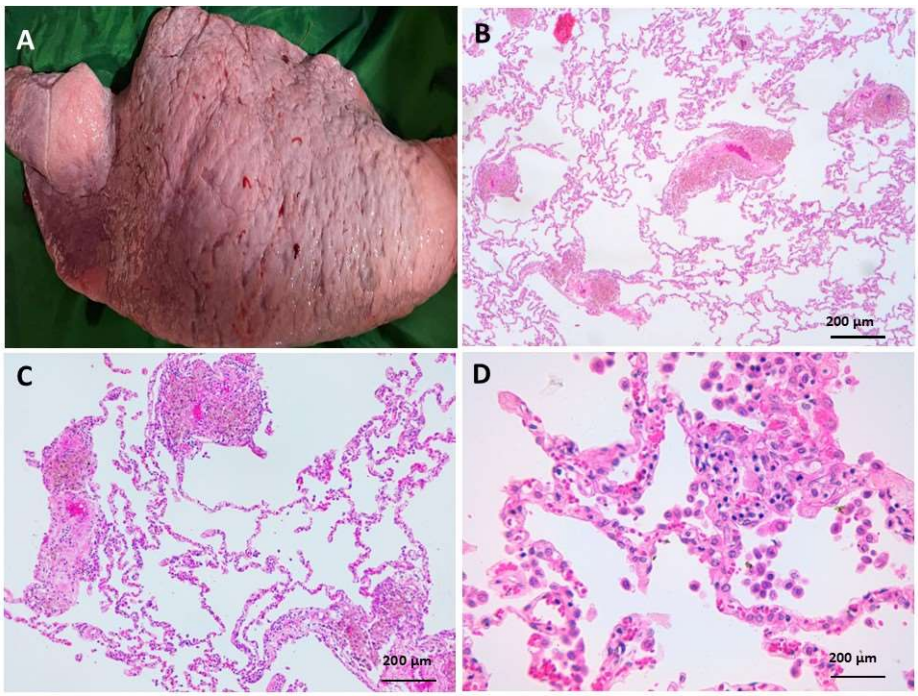

Fig. 14: A) Case 38 revealed voluminous lungs that failed to collapse with tiny translucent microfoci, B & C) Dust particles pneumoconiosis (silicosis) causing foreign body granuloma associated with macrophage cell proliferation (H&E, bar = 200µm) and D) Focal aggregation of alveolar macrophages with thickening of alveolar septa was observed in relation to dust granuloma (H&E, bar = 200µm).

Lymphoid interstitial pneumonitis revealed proliferation of bronchial-associated lymphoid tissue and alveolar inflammation.

Spleen affection

Incidental localized splenic hematoma: There was a hematoma, 1 cm in diameter, on the splenic surface of a camel (Fig. 15A). Microscopically, the hematoma was composed of a lake of blood and fibrin strands between trabeculae, and the splenic tissue appeared devoid of lymphoid structure (Fig. 15B).

Age-related changes in the spleen of older camel: The spleen appeared with a thin mass and wrinkled capsule (Fig. 15C). A look-like atrophy of lymphoid follicles and widening of red pulp at the expense of white pulp. Fibrosis was a prominent finding (Fig. 15D).

Cardiac affections

Interstitial myocarditis

The cardiac muscles revealed whitish streaks and spots (Fig. 16A). Histologically, mild interstitial myocarditis was observed. Edema is distributed between muscle bundles, and cardiac muscle degeneration is observed. The interstitial was widened and interspersed with muscle bundles—muscular tissue infiltrated with inflammatory cells (Fig. 16B).

Hemorrhagic suffusion on the pericardial surface (Fig. 16C). In histopathology, cardiac muscles are normal.

Myocardial degeneration and atrophy: The cardiac muscles appeared pale and flabby. Widening between muscle bundles due to exhaustion and degeneration of cardiac muscles. The muscle bundles appeared smaller and contained many nuclei. Muscular tissue infiltrated with inflammatory cells.

Myocardial sarcocystosis: Sarcocystis cysts within cardiac muscle fibers typically appear as circular, elongated, or spindle-shaped structures. These cysts had thin walls and contained numerous crescent-shaped bradyzoites (Fig. 16D). Chronic inflammatory cells, including focal lymphocytic infiltration in cardiac muscle, were observed.

DISCUSSION

Although renal abscesses and pyelonephritis are common in ruminants like cattle, their occurrence in dromedary camels is rare and not extensively documented. In cattle, *Corynebacterium renale*, which usually inhabits the lower urinary tract, is widely recognized as the principal causative organism of pyelonephritis (Al-Ani 2004; Karmveer et al. 2015). Other bacteria, such as *Escherichia coli* and *Trueperella (Arcanobacterium) pyogenes*, have occasionally been identified in urine cultures from affected animals (Rosenbaum et al. 2005; Yeruham et al. 2006). Renal abscesses have been increasingly diagnosed in dromedary camels in recent observations (Tharwat et al. 2025a). In that investigation, bacteriological analysis revealed that 10 coagulase-negative samples yielded pure cultures of *Staphylococcus lugdunensis*, 5 coagulase-positive samples contained *Staphylococcus aureus*, and two isolates were identified as unidentified *Staphylococcus* species. Ultrasound imaging has proven to be a valuable, non-invasive diagnostic tool for identifying kidney pathologies in camels as reported earlier (Tharwat 2020b; Tharwat 2021; Tharwat et al. 2025a; Tharwat and Elmoghazy 2025). In the current study, ultrasound of the kidneys revealed complex, one- or multichambered structures with dense, echogenic contents, which were confirmed by ultrasound-guided aspiration of pus.

The presence of ascites—free fluid accumulation within the abdominal cavity—is a relatively frequent clinical observation in camels. This condition can arise from multiple underlying causes, including infections like trypanosomiasis, congestive heart failure, significant protein-losing conditions, as well as hepatic or renal

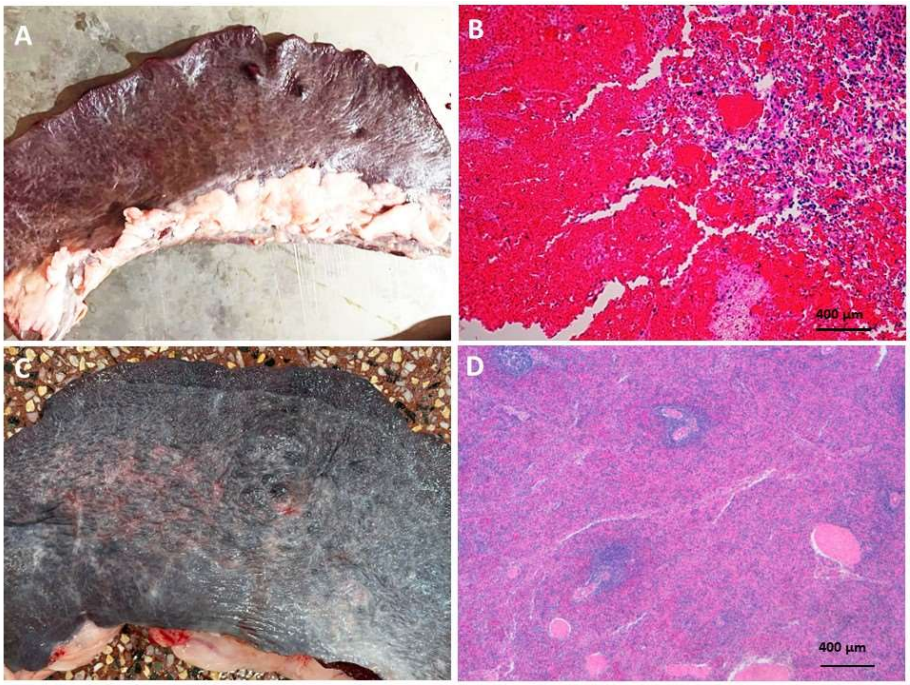

Fig. 15: A)Incidental localized splenic hematoma in case No. 57, B) Incidental hematoma composed of a lake of blood between trabeculae and splenic tissue appeared devoid of lymphoid structure (H&E, bar = 400µm), C) The spleen of case No. 58 appeared smaller, darker, with a wrinkled capsule, suggesting aging-related atrophy and D) Atrophy of lymphoid follicles and widening of red pulp on the expenses of white pulp. Fibrosis is the prominent finding (H&E, bar = 400µm).

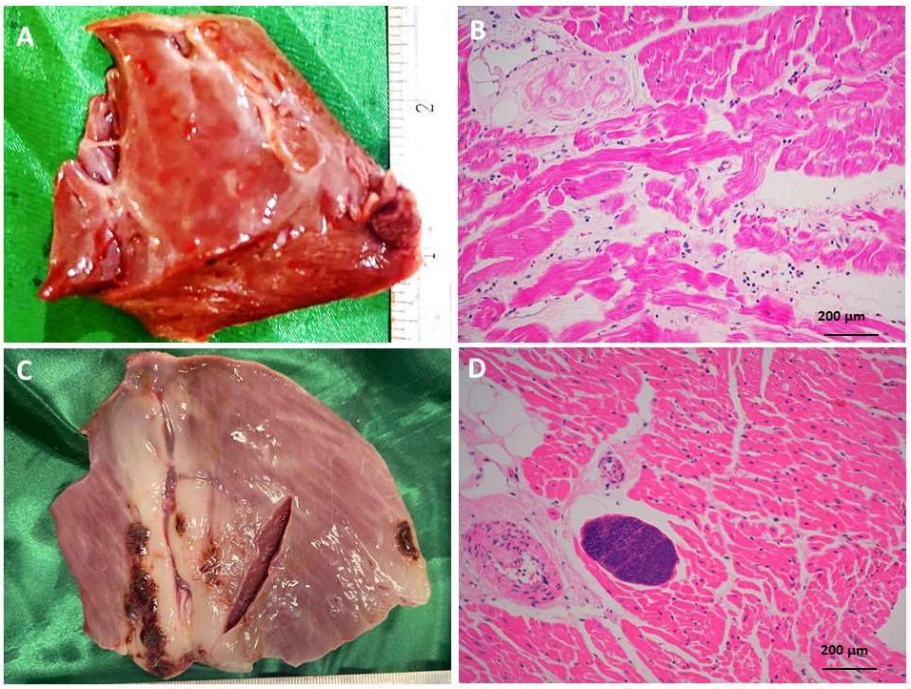

Fig. 16: A) The cardiac muscles appeared pale with white spots and streaks, and B) Edema dispersed between muscle bundles and degeneration of cardiac muscles. The interstitial was widened and interspersed with muscle bundles. Muscular tissue infiltrated with inflammatory cells (H&E, bar = 200µm), C) Hemorrhagic effusions were observed sub-epicardium in the coronary area of the heart, and D) Sarcocystis schizont was observed in muscle bundles (H&E, bar = 200µm).

dysfunction, generalized malignancies, or septic peritonitis. In cases of trypanosomiasis, transabdominal ultrasonography typically reveals clear, anechoic fluid filling the abdominal space. Conversely, when ascites is linked to non-infectious, chronic conditions such as heart disease or liver failure, the fluid appears similarly anechoic. However, it is usually associated with long-standing systemic compromise (Tharwat 2013). In septic peritonitis, ultrasonographic imaging often detects echogenic fibrin strands suspended in a brighter, hyperechoic fluid. As the condition progresses, sonographic findings may include a complex mixture of echogenic and anechoic material distributed around major abdominal organs, including the liver, spleen, rumen, and intestines. This combination of fibrin deposits and fluid accumulation results in a distinct "floating organ" pattern, a hallmark of advanced peritoneal inflammation (Tharwat 2019). In the present study, a large volume of peritoneal fluid was imaged, and abdominal organs were visualized floating in it.

In camels with intestinal obstruction, ultrasonographic findings associated with both partial and complete intestinal blockages in dromedary camels typically include enlarged small intestinal loops and notably decreased or absent peristalsis. Accumulated fluid is frequently detected between these loops, and retained ingesta may be observed in the third stomach compartment (Tharwat et al. 2024a). A noticeable increase in abdominal size is commonly reported during both physical and ultrasound evaluations. Because

the origin of mechanical obstruction might lie beyond the depth limits of ultrasound, the decision to proceed with surgical exploration should be based on clinical presentation, laboratory diagnostics, and the economic value of the camel. Ultrasound imaging is a vital diagnostic modality for early recognition of gastrointestinal blockages in camels, often providing clarity in cases with nonspecific symptoms (Tharwat 2024). Ultrasound scan in the present investigation showed echogenic fibrin strands suspended in a bright, hyperechoic fluid and freely floating intestinal loops. In addition, abdominocentesis yielded reddish fluid that, upon centrifugation, formed a sediment layer.

Camels are susceptible to a variety of hepatic disorders, with the most prevalent causes including infections, toxic exposures, hepatic lipidosis, parasitic inflammation, and neoplastic growths (Belina et al. 2015; Tharwat 2020c). A survey of 822 slaughtered camels found liver abscesses in 13.5% of the animals. Microbiological analysis of these abscesses identified *Staphylococcus* species (41.1%) as the leading pathogens, followed by *Corynebacterium* (17.9%) and *Streptococcus* species (13.3%) (Aljameel et al. 2014). These abscesses are frequently undetected during life due to the absence of distinct clinical symptoms. An investigation conducted in South Darfur between 2009 and 2011 found hepatic abscesses in 111 of 822 camels, primarily in those younger than 7 years. Of the 90 bacterial isolates, the majority were Gram-positive cocci (57.8%), followed by Gram-positive rods (22.2%), and Gram-negative rods (20%). *Staphylococcus* species were identified as the dominant infectious agents (Aljameel et al. 2014). Ultrasound imaging is a valuable diagnostic tool for detecting hepatic abscesses (Tharwat 2020c). These lesions appeared in the present study as hypoechoic or hyperechoic regions, depending on the abscess's chronicity and composition. Four types of liver abscesses were observed: lamellated abscesses corresponding to *C. pseudotuberculosis*, solid abscesses containing sulfur granules corresponding to actinomycosis infection, liquifactive (semi-liquid) abscesses corresponding to pyogenic bacterial infection, and those of fungi revealed hyphae of fungi in histopathology (Abubakr et al. 1999; Al Hizab 2014; Terab et al. 2021).

Paratuberculosis, also known as Johne's disease, is a chronic and progressively debilitating illness in camels that ultimately leads to death. It is mainly marked by prolonged diarrhea and significant weight loss (Elsohaby et al. 2021; Selim et al. 2022). The disease is caused by the bacterium *Mycobacterium avium* subspecies *paratuberculosis*, which has also been suggested to have a role in Crohn's disease in humans (Tharwat et al. 2025c). Consequently, prompt detection and rigorous control of infected camels are essential. Ultrasonography is a useful diagnostic tool for screening suspected cases while awaiting definitive tests such as PCR. In camels suffering from this disease, ultrasound typically reveals thickening and irregularity of the small intestinal walls, as observed in the present study. A prominent feature often noted is enlargement of the mesenteric lymph nodes, which may present with internal echoes ranging from echogenic to anechoic or mixed. Additionally, clusters of echogenic material interspersed with fluid collections can sometimes be observed between intestinal segments (Tharwat et al. 2012).

Camels affected by gastrointestinal blockage due to foreign bodies often exhibit a gradual decline in body weight, unusual eating behaviors such as pica, decreased fecal production, and occasionally, episodes of regurgitation. Pica, characterized by the ingestion of non-nutritive substances, is a notable behavioral disorder in dromedaries and contributes significantly to gastrointestinal obstruction, resulting in a substantial economic impact (Tharwat et al. 2024b). Ultrasonographic examination commonly identifies foreign objects that cause partial or complete intestinal obstruction (Tharwat et al. 2024b). However, in the present study, the presence of gas within the rumen obscured the visualization of foreign bodies in that compartment via ultrasound. A variety of tumor types have been identified in dromedary camels, with the most commonly diagnosed including squamous cell carcinoma, fibroma, adenocarcinoma, fibromyxosarcoma, leiomyoma, angiosarcoma, schwannoma, lipoma, microcystic adnexal carcinoma, renal cell carcinoma, Sertoli-Leydig cell tumors, and granulosa cell tumors (Al-Sobayil et al. 2018; Ali et al. 2018). In the present study, unfortunately, the presence of multiple abdominal masses resembling neoplasia was not confirmed histologically.

Cystic echinococcosis (hydatid disease) is a zoonotic infection caused by tapeworms of the *Echinococcus granulosus* complex (Maksimov et al. 2020). The lifecycle typically includes dogs as definitive hosts and various ungulates, such as sheep, goats, cattle, and camels, as intermediate hosts. Animals become infected by ingesting vegetation contaminated with tapeworm eggs. The cycle is completed when infected organs containing hydatid cysts are consumed by dogs (Bosco et al. 2021). In the present study, hydatid cysts were observed in the livers of camels and were composed of degenerated hydatid sand and a thick fibrous wall (El Saftawy et al. 2021). Non-parasitic cysts in the liver of camels contained no parasitic elements and appeared as a space (Gameel and Bakhsh 2002). Hepatic cysticercosis, containing cross-sections of the larval stage (intermediate host of the cestode), was scarcely recorded previously in camels (Schuster et al. 2015, 2019).

Portal and bridging fibrosis, biliary hyperplasia, hepatocellular atrophy, Kupffer cell hyperplasia, and inflammatory infiltration were observed in camels with hepatic fibrosis (Tharwat et al. 2025b). In the present study, various histological fibrotic types were observed, including portal, biliary, central, and post-necrotic fibrosis. Chronic hepatitis in dogs is the leading cause of liver fibrosis (Cullen 2009; Eulenberg and Lidbury 2018). Hepatic lipidosis is the main predisposing factor for liver fibrosis in dairy cattle (Zhang et al. 2023). The pathogenesis, causes, and predisposing factors for hepatic fibrosis in camels have not been elucidated yet

Lungs containing sand due to a dust storm in desert areas were previously reported in humans in Saudi Arabia (Samarkandi et al. 2017). Four cases of multilobar lung infiltrates after exposure to a dust storm (so-called Haboob Lung Syndrome) in the USA (Panikkath et al. 2013; Cao et al. 2018). In camels, the usual environment for production is the desert; this is the first time dust storm particles have been recorded in the lungs of 4 camels. Sometimes these lesions were associated with interstitial lymphocytic

pneumonitis (El Nagar et al. 2024). Carbon particles were seen as fine black granules extracellularly or intracellularly. This exogenous pigment was localised in interstitial tissue, predominantly in peribronchial and peribronchiolar areas, in 15 camels in Iran (Khodakaram-Tafti and Mansourian, 2010). Spleen hematomas are common in dogs; about 124 cases were reported in one study (Prymak et al. 1988). In camels, splenic hematoma was not recorded; it was incidentally observed in slaughterhouse material.

Conclusion

Thoracic and abdominal diseases in dromedary camels often present with subtle clinical signs, which complicates early diagnosis and timely treatment. Ultrasonography significantly enhances the clinical evaluation of internal pathologies, enabling the identification of lesions that would otherwise be challenging to detect. Pathological examination, especially postmortem, remains a cornerstone in confirming diagnoses, identifying underlying causes, and understanding the pathogenesis of these diseases. The present study revealed a broad spectrum of thoracoabdominal conditions, including parasitic, bacterial, fungal, neoplastic, and degenerative disorders affecting vital organs such as the liver, lungs, kidneys, intestines, heart, and spleen. Notably, this study is among the first to report sandstorm-related pneumoconiosis in camels and provides rare documentation of splenic hematoma. These findings underscore the need for improved clinical vigilance, regular use of diagnostic imaging, and further research into the epidemiology and pathology of camel diseases—especially in regions where camels are economically and culturally important. A better understanding of these conditions can help reduce camel morbidity and mortality, thereby improving animal welfare and productivity.

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