

MORPHOLOGICAL CLASSIFICATION OF HEPATIC TUMOURS IN ONE-HUMPED CAMEL (*Camelus dromedarius*)

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ABSTRACT

Camels rarely develop hepatic tumours. Forty six livers with tumour lesions from camels that had been slaughtered over a period of 3 years in the biggest abattoirs in Cairo, Egypt, were used in this investigation. The morphological and histological analyses of the hepatic lesions gave rise to a sufficient overview of the possible tumours that could develop in camel livers, whether they were neoplastic or not. Out of 46 cases, 40 cases (87%) had non-neoplastic tumours and six cases (13%) had neoplastic tumours. Out of 40 non-neoplastic tumours, 25 camels with hepatic hydatidosis constituted 54.3% of all hepatic tumours in the examined livers. Chronic hepatitis with hyperplasia or granulomatous lesions (n = 9, 19.5%), abscesses (n = 5, 10.8%) and hepatic lipomatosis (n = 1, 2.2%) were among the other non-neoplastic tumours. Cavernous haemangioma (n = 2, 4.4%), hepatocellular carcinoma (n = 2, 4.4%), cholangiocarcinoma (n = 1, 2.2%) and leiomyoma (n = 1, 2.2%), were among the neoplastic lesions that were noted. In conclusion, the majority of the one-humped camels' hepatic tumours were non-neoplastic. However, there were also reports of neoplastic liver tumours, such as cavernous haemangioma, cholangiocarcinoma, hepatocellular carcinoma and leiomyoma. Lipogranuloma and hepatic lipomatosis in camels have been identified histologically.

Key words: Camel, carcinoma, hepatic tumours, liver

Camels have a significant impact on a number of areas, including the preservation of ecosystems, biodiversity, food security, economic growth, adaptation to climate change and cultural and social aspects (Abu-Seida *et al*, 2024).

A significant amount of camel production is lost due to camel liver disorders, which also result in the condemnation of many livers in slaughterhouses. Although, camel liver can be affected by many different diseases, the most common causes are toxic substances, infectious diseases, parasitic hepatitis, fatty liver and tumours (Belina *et al*, 2015).

Several hepatic tumours have been recorded in camels including osteolipomatous metaplasia (Al-Sadi, 1994), liver abscess (Aljameel *et al*, 2014), benign mesenchymal hepatic tumours like lipoma, cavernous haemangioma and leiomyoma (El-Mahdy *et al*, 1997; Rezaie *et al*, 2015), as well as hydatidosis (Shoulah *et al*, 2023; Tharwat *et al*, 2023). However, the most common neoplastic tumour recorded is cholangiocarcinoma (Birincioglu *et al*, 2008).

In Egypt, a recent study revealed unusual multiple primary hepatic tumours (prevalence 7/988, 0.7%) in dromedary camels. These tumours included one case each of cholangiocarcinoma-leiomyosarcoma, haemangiosarcoma-cholangiocarcinoma-leiomyoma, myelolipoma-osseous metaplasia, lymphosarcoma and 3 cases of leiomyomas (Elmaghraby *et al*, 2023).

Camelids are understudied in scientific studies (Abu-Seida *et al*, 2024). Moreover, neoplasia has been infrequently reported in Old World camelids (Ibrahim *et al*, 2023; Zabady *et al*, 2024). Therefore, this study described the morphological classification of hepatic tumours in 46 dromedary camels in Egypt.

Materials and Methods

This study was carried out on 46 livers obtained from camels that had been slaughtered for human consumption over 3 years in the main Cairo abattoirs (El-Basatin, El-warak and Kerdasa Abattoirs). These livers were thoroughly inspected and any tumour lesion was subjected to thorough

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gross and histological examination. Specimens from the hepatic tumours were preserved in 10% neutral buffered formalin for histopathology examination. The specimens were processed by paraffin embedding technique, sectioned at 4 μ thickness and stained by the routine H&E stain and some histochemical stains according to Bancroft *et al* (2008). Special stains like Ziehl Nilsen and PAS were used to confirm granulomas as well as Van Giesson's stain was applied to confirm hepatic leiomyoma in the examined camels.

Results and Discussion

The recorded non-neoplastic and neoplastic tumours in the examined livers are shown in table 1. Out of 46 hepatic tumours, 40 cases, representing 87% of the total recorded hepatic tumours, had non-neoplastic tumours. However, neoplastic tumours were recorded in 6 cases representing 13% of the total recorded hepatic tumours.

Histopathology findings

Non-neoplastic tumours

In the present study, the most common lesion was hepatic hydatidosis (n=25 cases, 54.3%). Two cases of hydatidosis were associated with neoplastic changes like leiomyoma and cholangiocarcinoma.

Gross examination of hepatic hydatidosis revealed single or multiple cysts superficially or embedded within the hepatic parenchyma. They were unilocular cysts, reaching diameter 3-8 cm and irregular in shape with corrugated surface. It contained little amount of fluid with opaque or transparent capsule. In some cases, calcification resulted in gritting sound on cut section. Histological examination revealed that the hepatic tissue being replaced by cysts that appeared as thick eosinophilic lamellate layer surrounded by mononuclear cells, mostly of lymphocytic type and fibrous connective tissue capsule infiltrated by lymphocytes, macrophages, eosinophils and few plasma cells (Fig 1).

Liver abscesses were recorded in 5 cases. Gross examination revealed the presence of multiple subcapsular nodules elevated beyond the capsular surface of different size and surrounded by fibrous capsule. On cut section, large amount of creamy exudates discharged. Histological examination showed the presence of eosinophilic central necrotic area containing cellular debris with foci of mineralisation surrounded by pyogenic membrane (Fig 2).

Chronic hepatitis was recorded in 9 cases. It showed hepatic fibrosis with prominent biliary hyperplasia (n=6 cases) or granulomatous reaction (n=3 cases). In case of fibrosis, the fibrous connective tissue proliferation began mainly from the portal triads and became insinuated between hepatic lobules or pericellular with bile ductules hyperplasia and mononuclear cells infiltration (Fig 3).

Chronic hepatitis with granulomatous reaction was distinguished in two forms; the first one incited around old hydatid cyst with calcified centre forming calcosphere. Around this centre, there were mononuclear cells and giant cells aggregations (Fig 4). The second one was an eosinophilic granuloma formed of central area of necrosis containing living and died eosinophils surrounded by mononuclear cells, giant cells and eosinophils. Both types of granulomas were negative for Ziehl Nilsen and PAS stains.

One case showed characteristic granulomatous reaction called "lipogranuloma". Grossly, the liver appeared enlarged, pale yellowish in colour. There were several whitish nodules embedded in the parenchyma. Histologically, the liver showed diffuse fatty change. All the hepatocytes appeared vacuolated with fatty cyst formation. The hepatic fatty degeneration incited a granulomatous reaction began with small group of degenerated hepatocytes and appeared vacuolated with pyknotic nuclei and surrounded by macrophages and lymphocytes. A large granuloma formed of central necrosis with foamy centre (Fig 5A). It was surrounded by macrophages, a giant cell, eosinophils and lymphocytes (Fig 5B).

A case of hepatic lipomatosis was detected as a large separated mass over the liver (Fig 6). It composed of 3 compartments connected with each other by connective tissue strands. On cut section, the mass appeared whitish chalky and friable with fibrous tissue in between. Histologically, there was adipose tissue with large areas of necrosis and calcification. Mononuclear cells and foreign body giant cells were infiltrated (Fig 6).

Neoplastic tumours

The neoplastic tumours were reported in 6 cases representing 13% of the total examined livers as shown in table 1.

There were two cases of cavernous haemangiomas among the recorded benign tumours of the liver. Upon gross examination of the hepatic haemangiomas, a single, ovoid, dark brown mass

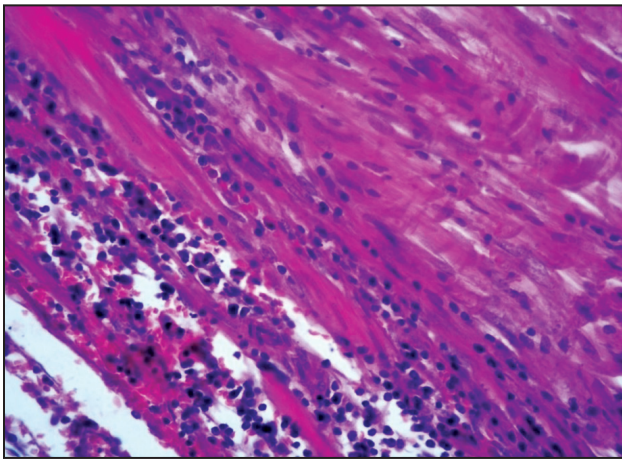


Fig 1. Photomicrograph from liver hydatidosis showing the fibrous capsule of the cyst infiltrated by lymphocytes, macrophages and eosinophils (H & E, X 400).

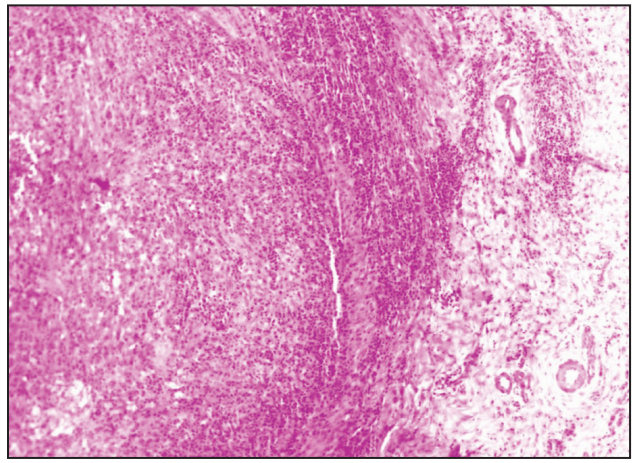


Fig 2. Photomicrograph of a liver abscess showing central liquefactive necrosis and surrounded by pyogenic membrane (H & E, X 100).

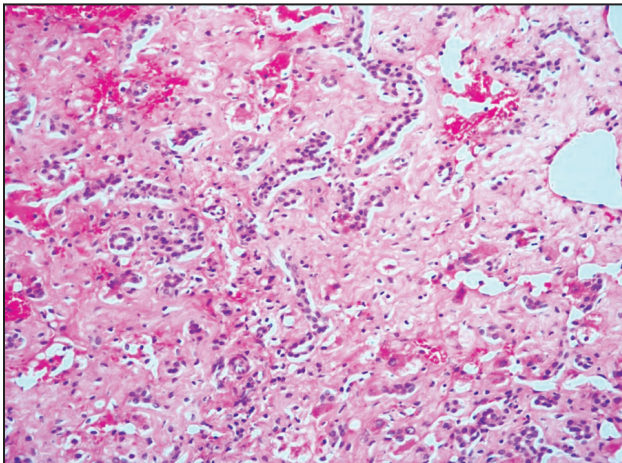


Fig 3. Photomicrograph of biliary hyperplasia showing biliary epithelial proliferation arranged in acini, tubules or branched tubules and in solid masses (H & E, X 400).

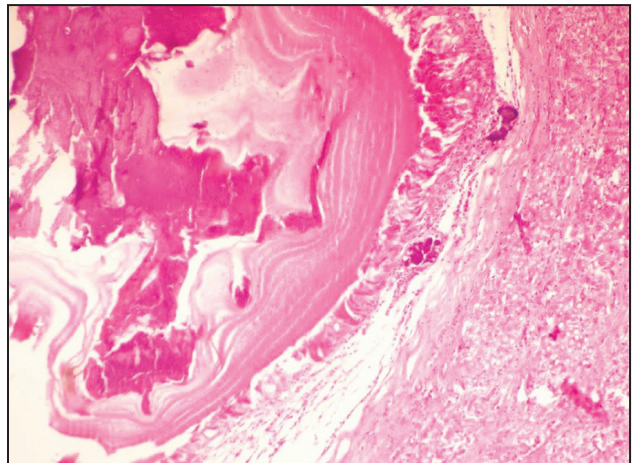


Fig 4. Photomicrograph of chronic hepatitis showing calcified hydatid cyst forming calcosphere. There were mononuclear cells and giant cells aggregation around the centre (H & E, X 200).

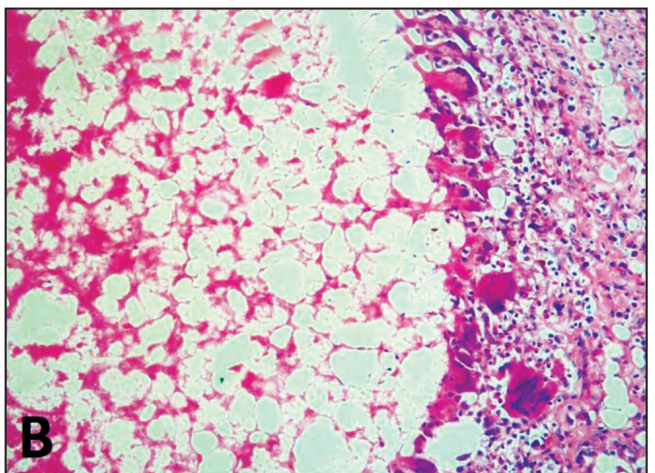
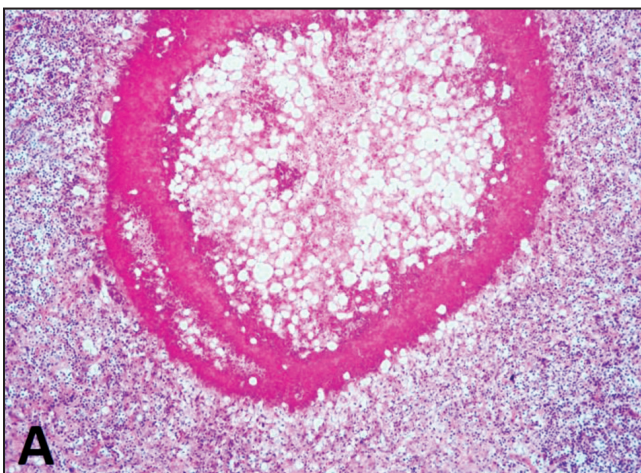


Fig 5. (A) Photomicrograph of lipogranuloma in the liver showing a large granuloma formed of central necrosis with foamy centre (H & E, X 100). (B) Photomicrograph of lipogranuloma in the liver showing foamy centre surrounded by macrophages, giant cells, eosinophils and lymphocytes (H & E, X 400).

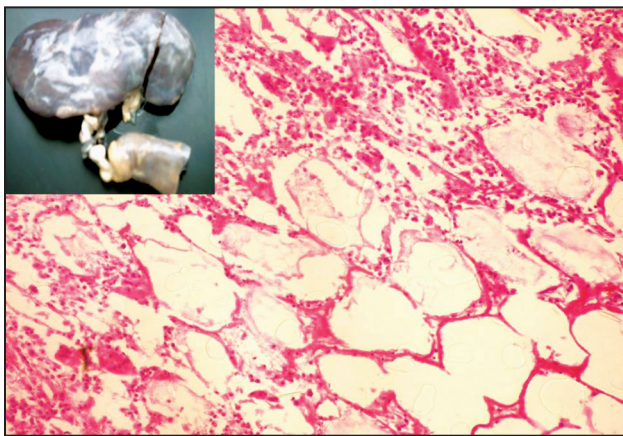


Fig 6. Small box: Photomicrograph of hepatic lipomatosis showing large, hard and separated mass over the liver. Photomicrograph of hepatic lipomatosis showing adipose tissue infiltrated with mononuclear cells and foreign body giant cells infiltration (H & E, X 200).

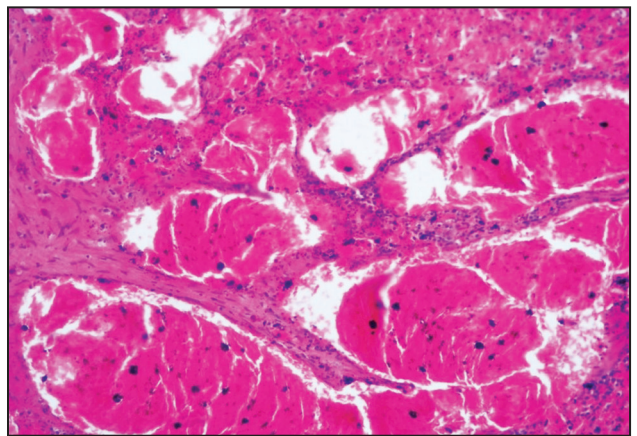


Fig 7. Photomicrograph from hepatic cavernous haemangioma. The tumour showing multiple thick-walled channels lined by flat endothelial cells and filled with blood (H & E, X 400).

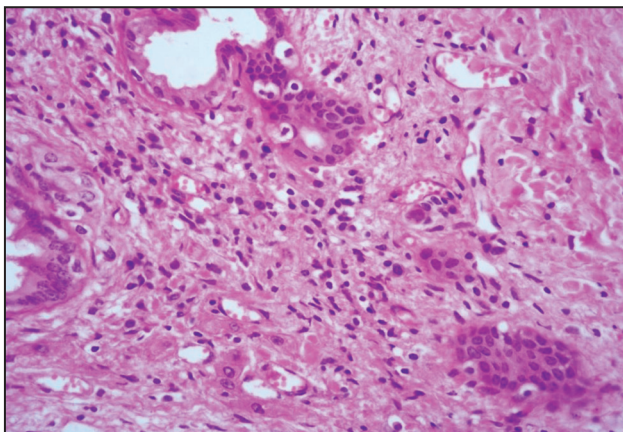


Fig 8. Photomicrograph from cholangiocarcinoma showing neoplastic cells invading the surrounding connective tissue stroma (H & E, X 400)

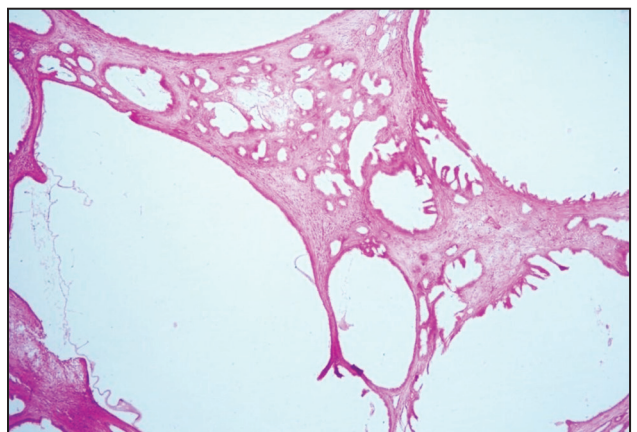


Fig 9. Photomicrograph of cystic cholangiocarcinoma showing cysts of variable sizes with papillary projections into the lumen (H & E, X 100).

was visible. Its diameter varied from 4 to 5 cm and its consistency was semi-hard. It was positioned

Table 1. Types of non-neoplastic and neoplastic hepatic tumours in the examined camels (n=46).

	Hepatic tumours in camels		
		No	%
Non-neoplastic hepatic tumours	Hydatid cyst	25	54.3
	Chronic hepatitis with hyperplasia or granulomatous reaction	9	19.5
	Abscess	5	10.8
	Lipomatosis	1	2.2
Neoplastic hepatic tumours	Haemangioma	2	4.4
	Cholangiocarcinoma	2	4.4
	Hepatocellular carcinoma	1	2.2
	Leiomyoma	1	2.2
Total		46	100

above the liver's surface. Blood seeped from the slashed ends of the section. The histological features included numerous blood-filled channels that were bordered by flat endothelial cells of different sizes (Fig 7). Hemosiderin pigment was also observed in conjunction with a sizable area of bleeding.

The malignant hepatic tumours comprise 2 types, Cholangiocarcinoma and hepatocellular carcinoma. Cholangiocarcinoma was recorded in 2 cases. The liver was grossly enlarged, solid and showed several nodules deep in the parenchyma and on the serosal surface, all of which were grayish white and centrally depressed. According to histology, the tumour was made up of acini, which have varying-sized lumens and sometimes form papillae. With numerous mitotic figures and enlarged hyperchromatic nuclei, the neoplastic cells displayed

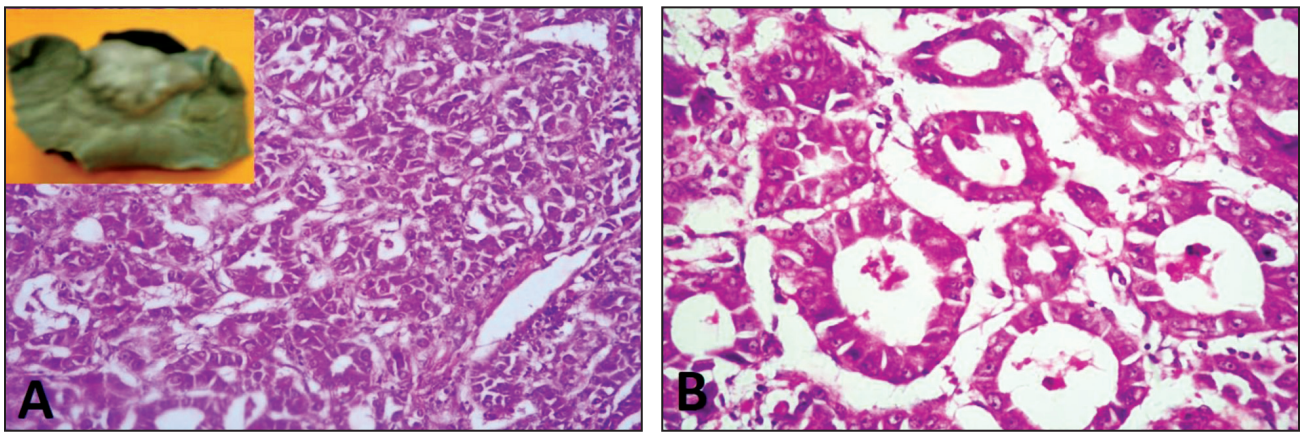


Fig 10. Small box: Photomacrograph of hepatocellular carcinoma showing multiple nodular overgrowths elevated on the hepatic surface. (A) The hepatocellular carcinoma photomicrograph. While some tumour cells formed irregular clusters, the majority of the tumour cells were grouped in acini and trabeculae (H & E, X 200). (B) Hepatocellular carcinoma: photomicrograph displaying significant pleomorphism. The nuclei showed vesicular appearance, hyperchromaticity and enlargement, with chromatin margination containing one or more conspicuous nucleoli (H & E, X 400).

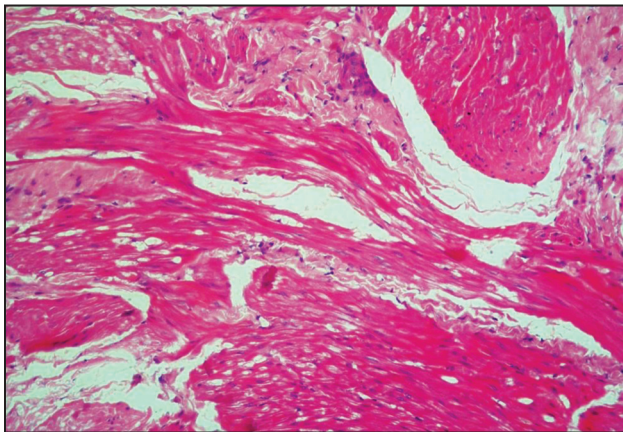


Fig 11. Photomicrograph from leiomyoma in liver. The tumour showing interlacing fibres and strands of spindle shaped smooth muscle cells (H & E, X 400).

remarkable pleomorphism. A portion of the cancerous cells were grouped together without lumens. Typically, fibrous connective tissues infiltrated with mononuclear cells separates the neoplasm's epithelial components (Fig 8). The second case demonstrated cystic cholangiocarcinoma, which was characterised by variable-volume cysts bordered with one to several layers of malignant biliary epithelium (Fig 9).

Hepatocellular carcinoma was recorded in one case. In terms of gross anatomy, the liver displayed a massive overgrowth with an uneven form that was partially immersed in the parenchyma and partially elevated on the hepatic surface (Fig 10). It was pale brown and the overgrowth on the area that had been sliced had the liver's texture. Different histological patterns were often present in the tumour. According to Fig 10A, the 3 main diagnostic groups were solid, adenoid and

trabecular. The most prevalent histological type of the tumour, with the neoplastic cells arranged in plates of varying thickness, was called the trabecular pattern. The acini's lumens varied in size in the adenoid form of the tumour and some of them included proteinaceous material. Malignancy criteria were prevalent. A thin capsule of connective tissue enclosed the tumour (Fig 10B).

The leiomyoma case manifested as bounded regions that were firm and pale pink. Under histological examination, the fibres were arranged in bundles that ran in different directions; some showed a circular arrangement, while others showed longitudinal and oblique directions. The examination revealed interlacing fibres and strands of spindle-shaped smooth muscle fibres with an elliptically shaped nucleus (Fig 11). Van Giesson's stain verified the tumour.

Hepatic tumours in dromedary camels are rarely recorded in the veterinary literature (El-Mahdy *et al*, 1997; Birincioğlu *et al*, 2008; Klopfleisch *et al*, 2009; Elmaghraby *et al*, 2023). Therefore, this study recorded the common hepatic tumours in 46 one-humped camels. Nevertheless, there are numerous reports of neoplasia in South American camelids, including lymphoma (Cebra *et al*, 1995; Irwin, 2001; Sartin *et al*, 2004), oral neoplasia (McCauley *et al*, 2000; Step *et al*, 2003), malignant gastrointestinal neoplasia (Sartin *et al*, 1997), congenital hepatic neoplasia (Watt *et al*, 2001), cutaneous and mucocutaneous neoplasia (Rogers *et al*, 1997; Schulman *et al*, 2003), pulmonary neoplasia (Ramos-Vara and Miller, 2002; Ramos-Vara *et al*, 2004) and intraocular neoplasia (Hendrix *et al*, 2000).

Regarding hepatic non-neoplastic tumours, the incidence of such lesions was higher than the neoplastic one. Similar finding was previously reported by Al-Ani *et al* (1998).

Hepatic hydatidosis was the most common non-neoplastic tumour recorded in the present study. Similar result was reported in several studies (Al-Ani *et al*, 1998; Lotfi *et al*, 1994).

The second most common hepatic non-neoplastic tumour was chronic hepatitis which was reported in 9 cases. Such lesions were mainly associated with biliary hyperplasia. The hyperplastic biliary change was attributed to the blockage of large bile duct or to the effect of unidentified hepatotoxic agent (Hamir and Smith, 2002).

In the present study, hepatic lipomatosis was recorded in one case. This finding was in close resemblance to that described in cattle around the intestinal wall (Aydin and Gulbahar, 1995) and in llama around the liver (Klopfleisch *et al*, 2009).

Interestingly, hepatic lipogranuloma was recorded, for the first time, in one of the examined livers. Nevertheless, lipogranuloma was recorded in human with hepatitis C and fatty liver disease (Zhu *et al*, 2010) and in dogs with portosystemic shunt (Isobe *et al*, 2008).

Although, cavernous haemangioma is considered a hamartoma, it was diagnosed in two cases in our study. While cavernous haemangioma was reported previously in a higher incidence than that recorded in this study (El-Mahdy *et al*, 1997). In cows, the incidence of cavernous haemangioma was higher and reached to 3% (Betini and Marcato, 1991).

In the current study, cholangiocarcinoma was detected in two cases. The tumour was composed of cells that retained a resemblance to biliary epithelium. Similar findings were recorded in an earlier study (Cullen and Popp, 2002).

Hepatocellular carcinoma was recorded in one liver. To the best of our knowledge, no previous record of such tumour was reported in camels.

Among the neoplastic tumours detected in this study, hepatic leiomyoma that was recognised in only one case. In contrast, higher incidence of hepatic leiomyoma was recorded in a previous study (El-Mahdy *et al*, 1997). This could be attributed to the difference in number of examined livers.

In conclusion, the majority of the one-humped camels' hepatic tumours were non-neoplastic. However, there were also reports of neoplastic liver tumours, such as cavernous haemangioma,

cholangiocarcinoma, hepatocellular carcinoma and leiomyoma. It's interesting to note that the majority of hepatic neoplasms diagnosed in cases of hepatic hydatidosis may provide insight into how long-term irritation affects the development of neoplasms in camels.

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