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Original Contribution

COMPARATIVE IMAGING ANATOMIC STUDY OF DOMESTIC RABBIT LIVER (ORYCTOLAGUS CUNICULUS)

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ABSTRACT
Aim: Comparing results from rabbit liver's ultrasonographic, computed tomographic and anatomical topgraphic studies.
Object: Nine healthy New Zealand white rabbits, aged 8 months, weighed 2.8 to 3.2 kg were studied. In the ultrasonographic investigation the animals were positioned in supine recumbency. The approach was transabdominal percutaneous hypochondrial.
The abdominal cavity was transversally and sagittaly scanned by axial computer tomograph. The animals were positioned in supine recumbency.
In the native anatomical investigation topographic rabbit liver's features were compared with its imaging anatomical findings.
Results: The liver echogenicity was heterogeneous and lower than the close soft tissue strucrures. The gall bladder's wall was a hypoechoic finding.Cystic duct was observed in its beginning part.
In the computed tomographic study, the liver was a massive, heterogeneous, normodense soft tissue finding. There wasn't visible border between lateral and medial left hepatic lobe and right hepatic lobe.
In the native anatomical study the left and right hepatic lobes, quadrate lobe and gall bladder's parts were found.
Conclusion: The comparative analysis of rabbit liver's imaging anatomical and native transversal study could be applied in the interpretation and diagnosis of many rabbit liver diseases.

Key words: liver, gall bladder, imaging anatomy, cadaver anatomy, rabbit.

INTRODUCTION

Rabbit liver is situated in the epigastric region, reaching 7th right rib and 9th left rib. It is composed of five lobes. Right hepatic lobe, quadrate and caudate ones are single. Left hepatic lobe is divided in lateral and medial. Its dorsal edge is situated transversally toward the median line, and the left lobes are parallel to the right one. The quadrate lobe is small. Marker about its position is fossa vesicae feleae. The caudate lobe is close to the right kidney. The choledoch duct is formed by the left hepatic and cystic ducts (1).

According to (2) the rabbit liver is caudally situated to diaphragm. It is perpendicularly toward the body longitudinal axis. Left and right lobes are bigger than the other lobes.

Ultrasonography is a popular, non invasive method for many abdominal organs' visualization in the small mammals (3). The same author (4) performs transabdominal ultrasonography of small mammals' liver. He investigates the liver parenchyma's structure in order to diagnose many diseases – hepatomegaly, adipose dystrophy, hepatitis, and diaphragm rupture.

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A lot of authors (5) apply transabdominal ultrasonography about normal liver parameters' study in sheep and goats. They use the intercostal space as an acoustic window. According to (5) the small ruminants' hepatic vessels are anechoic tubular structures. The gall bladder has an elongated to round shape, and its wall is hypoechoic.

By investigaton of (6) transabdominal ultrasonography is a suitable method for investigation the rabbit liver's ultrasonographic anatomy, following sedation and animals' position in supine recumbency.

Ultrasonographic findings of the liver parenchyma, portal and hepatic veins and hepatic arteries are reliable information for indication of cirrhosis, hepatocellular carcinoma and human portal vein's thrombosis (7).

By data of (8) liver parenchyma in the big ruminants is hypoechoic. The gall bladder's shape ultrasonographically is oval to round.

According to (9) the human liver's ultrasonographic structure is homogenous, and its contours are smooth. The gall blader is represented as a low echoic stripe. The biliary ducts are anechoic, thin tubular structures without own walls. The cystic duct is visualized in its beginning part and is parallel to the portal vein. The gall bladder is anatomically consisted of fundus, body, infundibulum and neck. The hepatic veins have interlobar way and the biliary ducts are intrasegmental structures (9, 10).

In 2000 year (11) use the rabbit as an animal model for investigation the normal liver circulatory processes and diagnosis of the human liver fibrosis, via computed tomography.

Canine liver is investigated by computed tomography by (12). As bone markers for right and left hepatic lobes are used the following thoracic (Th) and lumbar (L) vertebra (Th12 - Th 13 and Th13 - L1).

The computed tomography is a quantitative method for studying normal rabbit liver and diagnosing the early necrosis and steatosis (13, 14).

By results of (15) computed tomography is a conventional, non invasive method for investigation the rabbit abdominal organs' topography. The authors perform computed tomographic study of the abdominal organs with scans' thickness 5 mm. The animals are positioned in sternal recumbency, and as bone markers for liver topography are used Th 8 and L3. The authors investigate comparatively the rabbit liver, by computed tomography and transversal native study. They compare the obtained results of the both methods, and prove correlation.

According to (16, 17) the human liver is a massive soft tissue normodense structure, without visble border between the right and left hepatic lobe. The vascular structures and gall bladder are hypodense. Left to the portal vein is visualized the hepatic artery and right – the biliary ducts, as annular hypodense soft tissue structures.

The comparative analysis from the imaging anatomical and native transversal studies of the rabbit liver can be applied as a norm in the interpretation and diagnosis of many rabbit and human liver diseases.

The aim of study is to comparing results from rabbit liver's ultrasonographic, computed tomographic and anatomical topgraphic studies.

MATERIALS AND METHODS

Object

Nine sexually mature and healthy New Zealand white rabbits aged 8 months with body weight from 2.8 kg to 3.2 kg. The animals were anesthetized with 15 mg/kg Zoletil® 50 (tiletamine hydrochloride 125 mg and zolazepam hydrochloride 125 mg in 5 ml of the solution) Virbac, France.

Transabdominal ultrasonography

The study was performed with Diagnostic Ultrasound System DC-6Vet and micro convex probe with frequency 7 MHz and radius 20 mm. Contact gel (Ecoultragel Pirrone & Cö., Italy) was used for better contact between the skin and probe. The findings were documented with termoprinter device Mitsubishi P93. The animals were positioned in supine recumbency. The approach was transabdominal percutaneous hypochondrial.

Computed tomography

The study was performed with axial computed tomograph Picker Marconi (1995, USA) with table height 395 mm, FOV=180, filter 1, electric current's intensity 125 mA, anode tension 100 kV and scanning time 1.2 sec. We worked in high resolution - 512 and gentry (GT) - 0°. A window (W) - 399 and centre – 53 were used. The animals were positioned in supine recumbency. The abdominal wall was observed transversally from Th 8 (thoracic vertebra) to L 3 (lumbar vertebra) and sagittally from 8th intercostal space to L 7. The scans' thickness was 8 mm. As bone markers for liver topography were used the corresponding vertebra – dorsally, the costal arch – laterally, and as soft tissue markers – the abdominal wall, diaphragm, stomach and right kidney.

Transversal native study

Four animals were euthanized with 150 mg Thiopental® (50 mg/kg, I V) (Thiopental sodium 1000 mg) Biochemie, Austria iv (18). The cadavers were frozen at -18 C°(15). Transversal cuts with thickness 10 mm were obtained from the cranial abdominal region. The manipulation was in accordance with the requirements of the American Veterinary Association for euthanasia. The obtained data were used to compare the liver imaging anatomical features with those of its topography in situ.

The experiments were made in compliance with European convention for vertebrate animals' protection, used for experimental and other scientific purposes (Starsbourg /16th May, 1986), European convention for companion animals' protection (Starsbourg /13th November, 1987) and animal protection's law in Republic of Bulgaria (section IV- Experiments with animals, art. 26, 27 and 28, received on 24th January 2008 and published in Government Gazette, № 13, 2008).

RESULTS

From the ultrasonographic study, it was found that the rabbit liver is an echoic structure with lower echogenicicty than the neighboring soft tissue findings. Its contours were regular and close to the hyperechoic diaphragm. The liver parenchyma demonstrated heterogeneous echogenicity. The gall bladder was visualized as an elongated oval finding, filled with anechoic content. Its walls were hypoechoic. The cystic duct was observed in its beginning part, in order to joint the left hepatic duct. The both structures were elongated oval findings, compared to the others biliary ducts, who were anechoic tubular structures without own walls (**Fig. 1**).

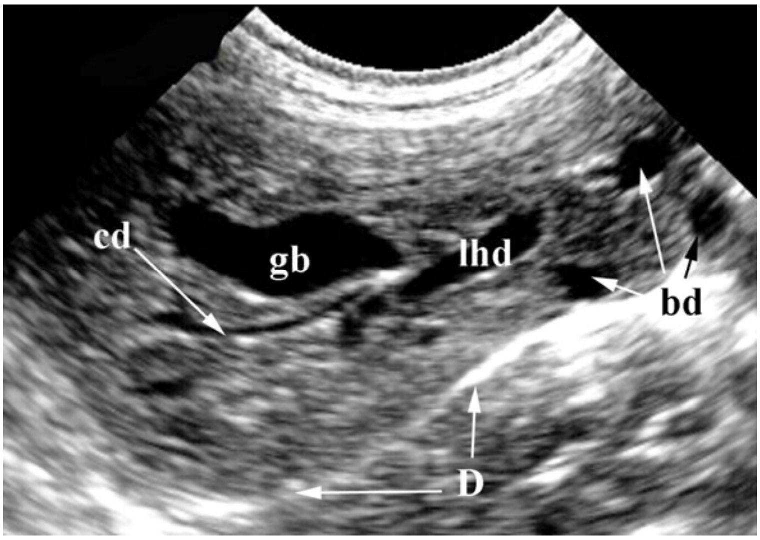

Fig. 1. Transversal ultrasonographic image of rabbit liver: gall bladder (gb), cystic duct's beginning part (cd), left hepatic duct (lhd), biliary ducts (bd) and diaphragm (D).

The ultrasonographic study found the normal gall bladder's anatomical parts. Its body was observed as an oval structure, filled with anechoic content, and its walls were hypoechoic. The infundibulum's and neck's walls were hypoechoic. These two anatomical parts were visualized as elongated structures, passing without sharp boundary in cystic duct. The portal vein was with wide lumen and hyperechoic, well visible walls. Parallel to the vein, cystic duct was observed as a thin tubular structure (**Fig. 2**).

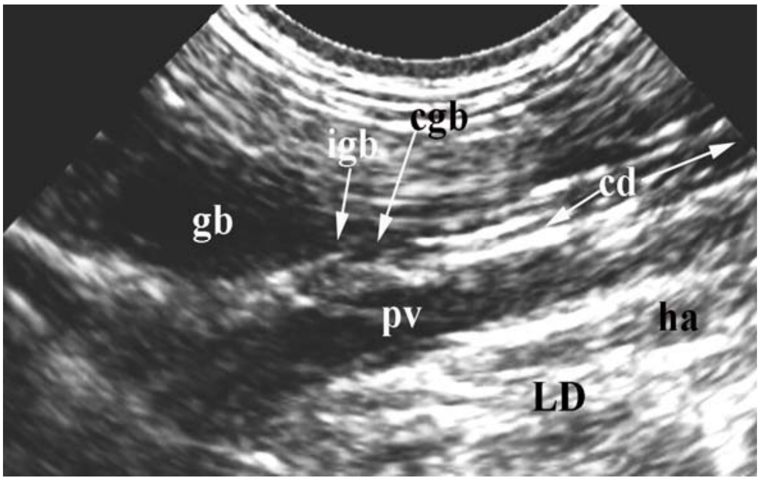

Fig. 2. Transversal ultrasonographic image of rabbit liver: gall bladder's body (gb), infundibulum (igb) and neck (cgb), cystic duct (cd), portal vein (pv), hepatic artery (ha) and right hepatic lobe (LD).

Computed tomographicly the liver was visualized as a massive, heterogeneous, normodense finding with well defined edges. The left lobe was in sharp distinction from the stomach. There wasn't visible boundary between the left and right hepatic lobes. The vascular structures were observed as hypodense findings toward the normodense liver parenchyma. Left to the portal vein was hepatic artery and right – the biliary ducts. Ninth thoracic vertebra was marked dorsally, laterally – the costal arch and ventrally – the abdominal wall (**Fig. 3**).

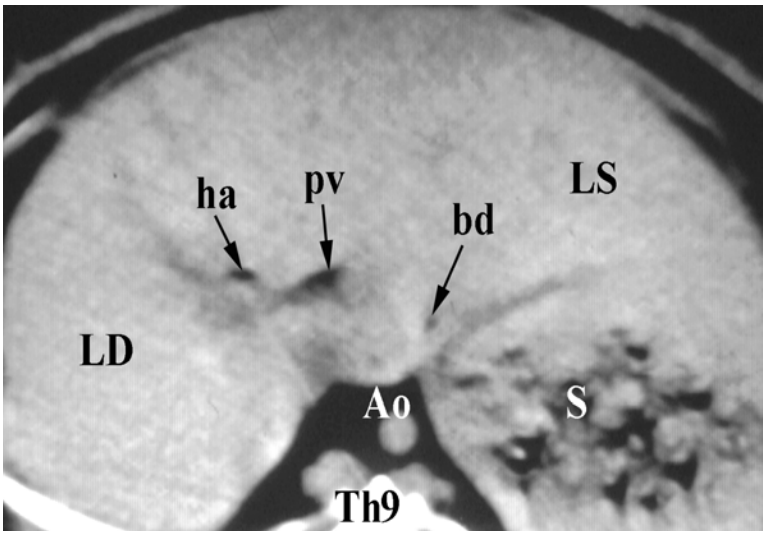

Fig. 3. Transversal computed tomographic scan of rabbit liver: right hepatic lobe (LD), left hepatic lobe (LS), hepatic artery (ha), portal vein (pv), biliary ducts (bd), stomach (S), abdominal aorta (Ao), 9th vertebra's body (Th9).

In the sagittal scanning the liver was visualized as a massive soft tissue finding, positioned cranially to the stomach, dorsally to the abdominal wall, in the abdominal cavity's intrathoracal part. This organ was observed from 8th intercostal space to L1. The right kidney was close to the caudate lobe (**Fig. 4**).

In the native transversal anatomical topographic cuts, the gall bladder's parts were found – body, infundibulum and neck. There were intrasegmaental findings in the liver parenchyma – biliary ducts and intersegmental structures – hepatic veins (**Fig. 5**).

There wasn't visible border between the left and right hepatic lobes. After removal of the gall bladder the well defined fossa vesicae feleae served as a marker for tight and small in volume lobus quadrate (**Fig. 6**).

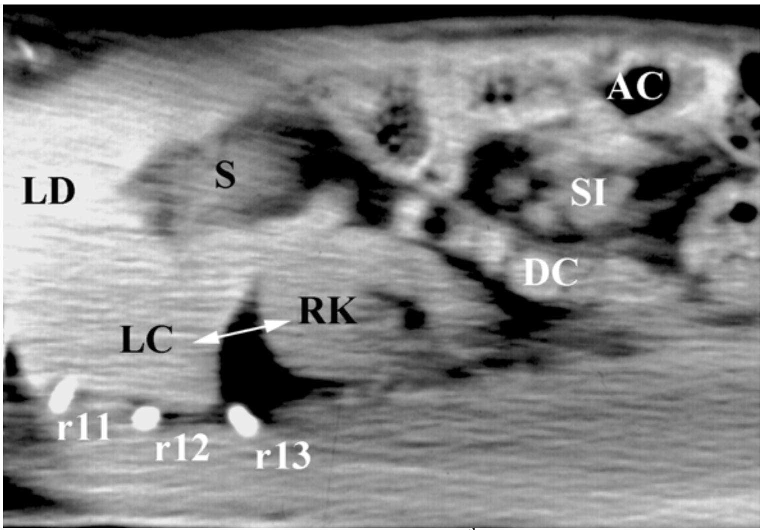

Fig. 4. Sagittal computed tomographic scan of rabbit liver: 11th intercostal space (r11), 12th intercostal space (r12), 13th intercostal space (r13), right hepatic lobe (LD), caudate lobe (LC), right kidney (RK), stomach (S), descending part of colon (DC), ascending part of colon (AC), small intestine (SI).

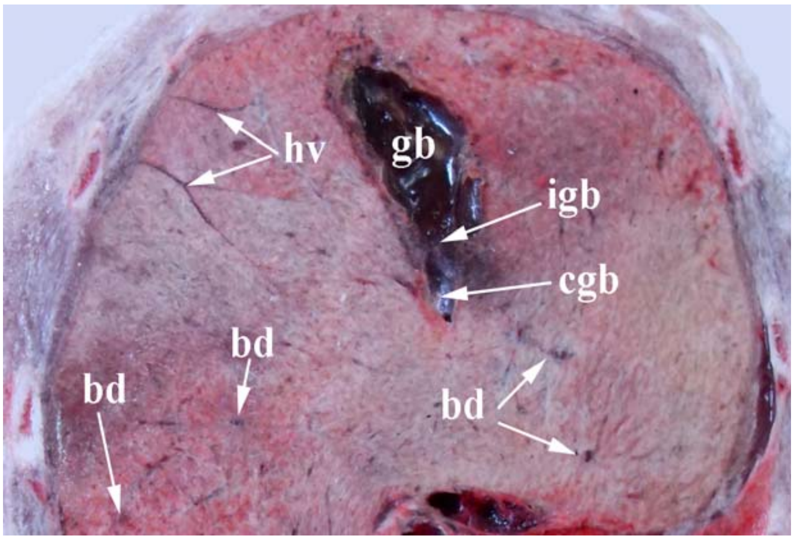

Fig. 5. Transversal anatomical topographic cut of rabbit liver: gall bladder's body (gb), infundibulum (igb) and neck (cgb), biliary ducts (bd), hepatic veins (hv).

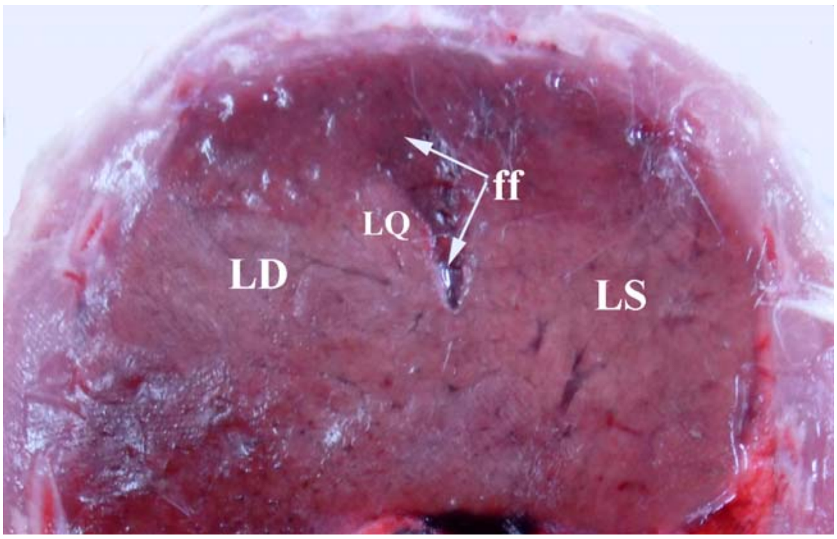

Fig. 6. Transversal anatomical topographic cut of rabbit liver: right hepatic lobe (LD), left hepatic lobe (LS), quadrate lobe (LQ), fossa vesicae feleae (ff).

DISCUSSION

The results of the imaging anatomical and native studies of the rabbit liver confirmed the data of (1) and (2) about its localization and separation in lobes.

The obtained data add the attitude of (4) about the use and opportunities of the ultrasonography in the imaging anatomical studies of many small mammals' abdominal organs.

Our results add those of (3) about the effect of transabdominal ultrasonography's application in some rabbit liver's morphological characteristics, in order to diagnose many diseases as hepatomegaly, adipose dystrophy, hepatitis and diaphragm rupture.

Contrary to the studies of (5) about the small ruminants' liver, in the ultrasonographic study of the same organ in the rabbit, the animals were positioned in supine recumbency, and the approach was transabdominal, percutaneous, hypochondrial.

As (7) we consider that the rabbit liver parenchyma's normal ultrasonographic findings are applicable in the indication of many pathological alterations.

Established by us ultrasonographic features of the liver parenchyma and gallbladder, and the presence of findings of thin anechoic biliary ducts, devoid of its own walls corresponded to the data (8) of the liver in cattle and (5) and (9), for the same organ in small ruminants and humans.

Like (11) we suggest that the rabbit could be used as an animal model in the computed tomographic diagnosis of many human fibrous pathological alterations.

The obtained data confirmed the opinion of many authors (13, 14, 15) on the computer tomography's application and opportunities in liver anatomical topographic characteristics, in relation with some diseases of this rabbit organ as necrosis and liver steatosis.

Our results corresponded with the study of (15) about the animals' position in the computed tomographic investigation of the rabbit liver and the use of bone markers to determine the topography of the investigated organ. Contrary to (15) the obtained scans were thicker - 8 mm. Compared to the data of (12) for canine liver, the rabbit one was visualized in wider ranges – from Th8 to L1.

The rabbit liver demonstrated soft tissue characteristic, as the results of (16, 17) for the human liver and there weren't visible borders between its lobes. The biliary ducts were annular hypodense soft tissue structures.

The native transversal cuts, obtained from the cranial abdominal region, following freezing, corresponded with the data of (15). Their thickness was 10 mm, and the animals were positioned in sternal recumbency, as the investigation of (15).

The results from the rabbit liver's native study corresponded with the data (9) and (10) for hepatic veins' intersegmental way and the presence of gall bladder's anatomical parts – body, infundibulum and neck.

The comparative analysis of the data from imaging anatomical and native transversal anatomical study of the rabbit liver can be use as a norm in the interpretation and diagnosis of many diseases in this animal.

The results of our investigation motivate us to conclude, that the rabbit is a suitable experimental model for liver morphological study, in connection with the study of many animal and human liver pathologies.

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