

## Anatomical and ultrasonographic study of the stomach and liver in sheep and goats

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### Abstract

This work was conducted on (500) small ruminants, (225) sheep and (275) goats of different weights, ages and sex admitted to the Veterinary Hospital and Surgery Department, Faculty of Veterinary Medicine, Zagazig University. Five goats of this number were used for studying the normal anatomical positions of the abdominal organs through serial cross and sagittal sections. The aim of performing anatomical study in this work was to determine the acoustic window of different abdominal organs in sheep and goats. The others were either normal (300 animal) or clinically affected cases (195 animal) and were examined ultrasonographically. From the results of this study, the liver of sheep and goats can be examined in standing position or with the animal on left lateral recumbency using 3.5/ 5MHz sector transducer. The right 7<sup>th</sup> to 12<sup>th</sup> intercostal spaces were the suitable acoustic window for the liver which appeared as numerous weak echoes homogenously distributed with its blood vessels. The portal vein appeared with an echogenic wall while the hepatic vein had a less echogenic one. The gall bladder was examined in standing or lateral recumbency from the right side at 9<sup>th</sup> and/or 10<sup>th</sup> intercostals spaces using 6/8MHz linear transducer and appeared as elongated oval or circular shape with anechoic content "bile" with smooth and thin echogenic wall. Ultrasonographic examination of the rumen was done by using a 5MHz sector transducer put on the dorsal aspect of the left flank region. The ruminal wall appeared as an echogenic band only, while the ruminal content was appeared as a dark shadow. The reticulum in sheep and goats was examined from the ventral abdominal region just caudal to xiphoid cartilage using a 5MHz sector transducer. Reticular movements were detected through real time scanning in the form of 4-5 biphasic contractions within 4 minutes. The omasum was examined using a 3.5-5MHz sector transducer on the right side at 10<sup>th</sup> intercostal space while the abomasum was imaged using a 3.5-5MHz sector transducer on both ventral midline and right paramedian areas. Cirrhotic liver with cholecystitis and ruminal foreign bodies was detected with the aid of ultrasonography in the examined clinical cases.

**Keywords:** Anatomy, Ultrasonography, Stomach, Liver, Sheep, Goats.

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### دراسة تشريحية وبالموجات فوق الصوتية للكبد والمعدة في الماعز والأغنام

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### الخلاصة

أجريت هذه الدراسة في الفترة من يناير ٢٠٠٣ إلى إبريل ٢٠٠٥ في قسم الجراحة بكلية الطب البيطري جامعة الزقازيق على ٥٠٠ حيوان (٢٢٥ من الأغنام و ٢٧٥ من الماعز) بأوزان وأعمار وأجناس مختلفة. واشتملت هذه الدراسة على دراسة تشريحية ممثلة في عمل قطاعات عرضيه وطوليه لخمس من الماعز المجمدة بغرض توضيح المكان التشريحي المحدد لكل عضو يراد إجراء فحص له بالموجات فوق صوتية. وقد تم فحص الأعضاء الداخلية للبطن بالموجات فوق صوتية وقد أجريت هذه الجزئية على ٣٠٠ من الأغنام والماعز السليمة ظاهرياً. أما باقى الحيوانات وعددها ١٩٥ حيواناً، فقد تم إجراء فحص وتشخيص لبعض الإصابات

الجراحية في البطن باستعمال الموجات فوق الصوتية وقد تمت هذه الدراسة على ١٩٥ من الأغنام والماعز. وقد أظهرت النتائج أنه يمكن فحص كبد الأغنام والماعز في الوضع القائم أو أثناء الرقود الجانبي من الجهة اليمنى عند الفراغ بين الأضلاع الممتد من السابع إلى الفراغ الثاني عشر باستخدام مجس ٣.٥-٥ ميجا هيرتز. وقد ظهرت أنسجة الكبد الطبيعية أثناء الفحص بالموجات فوق الصوتية باللون الرمادي المتناسق (صدى صوتي متوسط) وكذلك أوعيته الدموية حيث ظهر جدار الوريد البايبي ابيض بينما ظهر جدار الوريد الكبدي اقل صدى من الأول (رمادي). كما ظهرت الحويصلة المرارية في الجهة اليمنى في المسافة بين التاسع والعاشر بين الضلوع في الوضع الواقف أو الأيمن الجانبي باستخدام المجس ٦-٨ ميجا هيرتز وقد ظهرت بشكل بيضاوي أو مستدير ذو صدى صوتي منعدم حيث ظهرت باللون الأسود ممثلاً في الصفراء ولها جدار ابيض رقيق (ذو صدى صوتي متوسط). أما الكرش تم فحصه من الجهة اليسرى في الوضع الواقف عند منطقه الخاصرة اليسرى وأسفل البطن باستخدام المجس ٦-٨ ميجا هيرتز وكان جدار الكرش ذو صدى صوتي عالي ابيض بينما ظهر المحتوى الداخلي للكرش بظل اسود فقط. وظهرت الشبيكة في الجزء السفلي للبطن في الوضع الواقف خلف الغضروف السيفي (القص) باستخدام المجس ٣.٥-٥ ميجا هيرتز وظهر الجدار على شكل نصف قمري ابيض اللون ولقد سجلت حركه الشبيكة أثناء الفحص وكانت من ٤-٥ حركات ثنائيه الطور في خلال ٤ دقائق. المعدة الثالثة ذات التلافي ظهرت في الوضع الواقف الأيمن عند المنطقه العاشرة بين الضلوع خلف الكبد باستخدام المجس ٣.٥-٥ ميجا هيرتز وظهر الجدار بصدى صوتي عالي ابيض سميك وظهرت محتوياتها بظل اسود اللون. أما المعدة الحقيقية أو المنفحة أو المعدة الرابعة ظهرت في الوضع الواقف أو الظهري الراقف في المنتصف أسفل البطن أو في الجهة اليمنى باستخدام المجس ٣.٥-٥ ميجا هيرتز والمحتوى الداخلي ظهر متغاير الخواص ابيض اللون. وقد تم تشخيص بعض إصابات الجهاز الهضمي مثل الأجسام الغريبة في الكرش وتم تشخيص تليف الكبد مع التهاب المرارة باستخدام الموجات فوق الصوتية.

## **Introduction**

The normal liver of sheep appeared as an elongated and somewhat rectangular organ with the ventral portion slightly larger than the dorsal part. It is displaced to the right of the median plane by the stomach. The long axis is dorso-ventral and the caudal border of the liver is represented by a line along the caudal border of the eleventh rib ending about 2.5 cm above the costal arch. The caudate lobe lies dorsally on the visceral surface and has a deep indentation for the right kidney (1). The goat liver has a nearly triangular shape with homogenous soft tissue density (2,3).

In sheep and goats, ultrasound examination of the liver was performed with a real time B-mode scanner with a 3.5 MHz linear array transducer with electronically variable focus (4,5). The liver could be viewed on the right side from 7<sup>th</sup> or 8<sup>th</sup> rib caudally to the 13<sup>th</sup> rib (6,7).

In sheep and goats the parenchymal pattern of the normal liver consisted of numerous weak echoes homogenously distributed over the entire liver. And the liver appeared more echogenic than the renal cortex (6). The normal gall bladder is usually anechoic, smooth margined, thin walled structure within the liver just to the right of midline. The gall bladder also has a thicker wall when it is contracted (8-10).

Regarding some liver abnormalities which could be diagnosed ultrasonographically, most sonographic abnormalities are described in terms of tissue echogenicity (hypoechoic, isoechoic, hyperechoic), distribution (diffuse,

focal, multi focal). The presence of acoustic enhancement or acoustic shadowing and alteration of surface shape or contour, in addition the size and shape of the liver, the gall bladder, the hepatic vasculature and hepatic duct if visible may be evaluated (9,10).

Ultrasonography can be helpful in identifying uncommon mass lesions in the liver such as abscesses, hydatid cysts and rarely neoplasms. When available, ultrasonography can be particularly helpful in performing accurate liver biopsies (4,11-13).

In small animals it is important to know the ultrasound anatomy, so this study aimed to make a comparative view between the normal anatomical and ultrasonographic picture of the stomach and liver in addition to recording any ultrasound abnormalities if present.

## **Material and methods**

The present work was carried out on (500) small ruminants, (225) sheep and (275) goats of different weights, ages and sex as shown in table (1). These animals were admitted to the Veterinary Hospital and Surgery Department, Faculty of Veterinary Medicine, Zagazig University.

Five goats of them were used for the anatomical study and 300 were apparently normal. 195 small ruminants, (95) sheep and (100) goats were sustaining some medicinal and surgical disorders. These animals were thoroughly examined clinically and ultrasonographically.

Table (1): showing the total number, sex, age and weight of the examined normal and affected sheep and goats.

Category	Number		Sex		Age	Weight	
	Sheep	Goat	Female	Male			
I-Normal sonographic images of different abdominal organs in sheep and goats	130	170	210	90	2.5month to 5years	10kg to 50kg	
II-Sonographic images of some surgical affections of the abdomen "clinical cases"	95	100	pregnant	Non pregnant	105	2.5month to 8years	10kg to 50kg
			30	60			

The anatomical study was carried out on five goats; two adults aged 2.5 to 3 years and three kids aged 3 to 6 months. This study was performed on frozen slaughtered goat sagittal and cross sections at different levels; Cross section at the level of 7<sup>th</sup> intercostal space, Cross section at the level of 10<sup>th</sup> intercostal space, Cross section at the level of 12<sup>th</sup> intercostal space, Cross section at mid lumbar "3<sup>rd</sup> lumbar vertebra", Cross section at pelvic region "3<sup>rd</sup> sacral vertebra", Mid line plane passing dorsally at the mid vertebra and ventrally at linea alba, Right paramedian. Passing cranially at the dorsal end of right transverse process of lumbar vertebra and at the ventral aspect of the right hypochondric region till the right inguinal region caudally, Left paramedian. Passing cranially at the dorsal end of left transverse process of lumbar vertebra and at the ventral aspect of the left hypochondric region till the left inguinal region caudally,

The goats were slaughtered with separation of the head and neck. The esophagus was ligated and the two fore limbs were cut to visualize the 1<sup>st</sup> rib. The carcass was then put in a deep freezer in a sternal position or in lateral recumbency.

After complete freezing of the carcass it was transversely sectioned using electrical and manual saws at the designed levels. The cut section was nearly parallel to the ribs in the intercostal spaces, and then photographed from cranial and caudal views.

For sagittal sections, goats were slaughtered and prepared as the same in cross sections except after freezing, the carcass was longitudinally sectioned in the mid line and parallel to it on the right and left passing through the inguinal ring ventrally and at the end of transverse process of the lumbar vertebrae dorsally.

The normal sonographic images of liver and gall bladder were obtained from a total number of (300) apparently healthy sheep and goats during the period from January, 2003 to April, 2005.

For determination of the acoustic window of the liver and stomach, the anatomical pictures of the different sections either cross or sagittal were correlated with the resulted ultrasonographic images. Fasting the animals prior to ultrasonographic examination of the gastrointestinal tract as mentioned by (14) was performed. In some individual cases xylazine (Rompun, Bayer) was given in a dose of

(0.05-0.1) mg/kg body weight intramuscular as a mean of animal tranquilization (15).

The area to be sonographed was clipped and shaved. A coupling gel was applied. Ethyl alcohol was also used in some cases as a coupling agent after (16) and (17). The ultrasound machine used (Pie-Medical 240 Parus) was adjusted according to the instructions in the operating manual. The type of the probe used depends upon the depth of the examined organ. The video printer (SONY UP-885 MD) with its thermal paper (SONY TYPE 1 normal UPP-110S 110mm X 20m) was used.

## Results

The cross section of the goat's trunk at the level of the 7<sup>th</sup> intercostal space revealed dorsally the terminal part of the diaphragmatic lobes of both right and left lung. Between them and ventral to the body of the 8<sup>th</sup> thoracic vertebra, the abdominal aorta, caudal vena cava and esophagus were present. The two lungs were separated from the abdominal contents by the tendinous part of the diaphragm. The right lobe of the liver occupied the dorsal part of the right hypochondriac sub region and related ventrally to the omasum. The left hypochondriac sub region was occupied by dorsal ruminal sac. The later was related ventrally to the reticulum. The central part of the epigastric region was occupied by abomasum (Fig. 1).

The cross section of goat's trunk at the level of the 10<sup>th</sup> intercostal space showed dorsally the 11<sup>th</sup> thoracic vertebra. The dorsal part of right hypochondriac sub region was occupied by the liver (right and caudate lobe). On the visceral surface of this part of the liver, and ventrally the pancreas and duodenum were placed. The most dorsal aspect of the left hypochondriac sub region of this section was occupied by the spleen. The rest of the section was occupied by the dorsal and ventral ruminal sacs which were filled with ingesta and were separated from each other by a ruminal pillar. The greater omentum surrounded the rumen from the right and ventral aspect (Fig. 2).

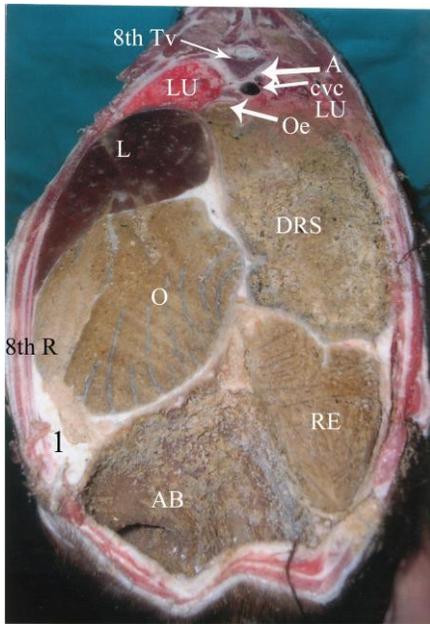


Fig. 1: showing cross section at the level of 7<sup>th</sup> intercostal space in goat: (cranial view) L: liver ; LU: lung; O: omasum; AB: abomasum; l: omentum; RE: reticulum; DRS: dorsal ruminal sac; 8<sup>th</sup> R: 8<sup>th</sup> rib; 8<sup>th</sup> TV: 8<sup>th</sup> thoracic vertebra; Oe: oesophagus; A: aorta; Cvc: caudal vena cava.

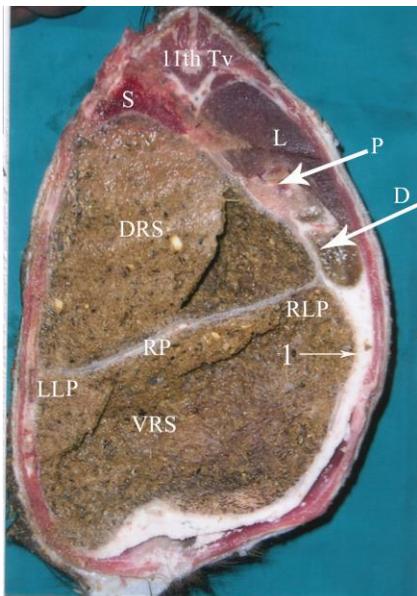


Fig. 2: showing cross section at the level of 10<sup>th</sup> intercostal space in goat (caudal view): S: spleen; L: liver; 11<sup>th</sup>TV: 11<sup>th</sup> thoracic vertebra; P: pancreas; DRS: dorsal ruminal sac; VRS: ventral ruminal sac; D: duodenum; l: greater omentum; RP: ruminal pillar; LLP: left longitudinal pillar; RLP: right longitudinal pillar.

The mid line longitudinal sagittal section of the trunk of goat revealed the vertebral canal which exposed longitudinally and the spinal cord appeared. The cranial part of the section showed the heart cut longitudinally and its apex rested on the sternum and was related dorsally to esophagus and the diaphragmatic lobe of the left lung, while cranially the heart was related to the apical lobe of the left lung. The dome of the diaphragm separated the thoracic and abdominal cavities. The dorsal and ventral ruminal sacs occupied the major part of the abdominal cavity with the presence of several ruminal pillars. The reticulum was located on the cranio-dorsal aspect of the rumen. The abomasum was found ventral to the reticulum and rested on the ventral abdominal floor. The spleen flanked the dorsal aspect of the dorsal ruminal sac. The caudal part of the abdominal cavity was occupied by numerous loops of small and large intestines (Fig. 3).

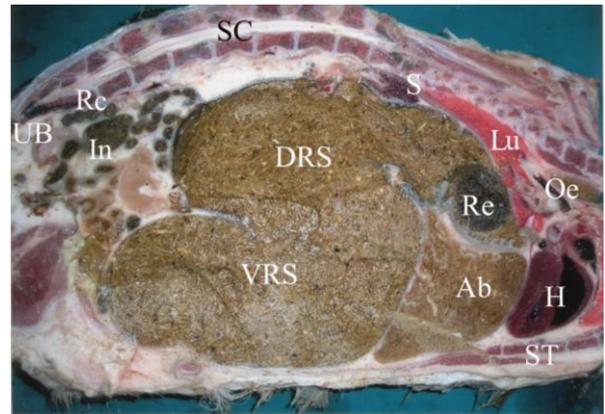
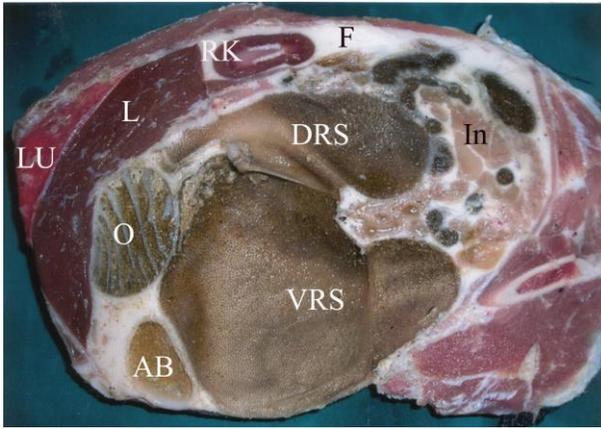


Fig. 3: showing mid line sagittal section in a kid: SC: spinal cord; S: spleen; Lu: left lung; Oe: Esophagus; H: heart; ST: sternum; Re: reticulum; Ab: abomasum; DRS: dorsal ruminal sac; VRS: ventral ruminal sac; In: intestine; Rc: rectum; UB: urinary bladder.

The right para median sagittal section of the trunk revealed at its cranio-dorsal aspect the phrenic lobe of the right lung rested on the diaphragm which demarcated the cranial boundary of the abdominal cavity. The liver was present just caudo-ventral to the diaphragm. The dorsal aspect of the section contained the right kidney which was surrounded by peri-renal fat. The majority of the section was occupied by the dorsal and ventral ruminal sacs with some ruminal pillars. In the space between visceral surface of the liver and the cranial surface of the rumen, omasum and abomasum were placed and surrounded by the fat of greater omentum. The caudo-dorsal aspect of the section was occupied by several intestinal loops (Fig. 4).



(Fig. 4) showing right Para median sagittal section of kid (lateral view): L: liver; LU: right lung; RK: right kidney; O: omasum; AB: abomasum; DRS: dorsal ruminal sac; VRS: ventral ruminal sac; In: intestine; F: peri renal fat.

Para median sagittal section of the left side of the goat's trunk revealed the diaphragmatic lobe of the left lung and the heart present in the cranial aspect followed caudally by the diaphragm. The dorsal part of the section was occupied by the dorsal ruminal sac and the reticulum. The spleen flanked the dorsal aspect of the rumen. The abomasum was deviated cranially under the reticulum. Caudally the left kidney was present. The distal half of the section showed the lateral abdominal wall, the costal arch and costal part of the diaphragm. The caudal part of the section contained loops of the small and large intestine (Fig. 5).

Ultrasonographic examination of the liver in sheep and goats was performed using a 3.5MHz sector transducer from 7<sup>th</sup> to 12<sup>th</sup> intercostal space on the right side (table 2 and 3). The liver parenchyma appeared hypoechoic as numerous weak echoes homogenously distributed and it was more echogenic than the renal cortex. The hepatic vasculature could be recognized as anechoic tubular structure within the parenchyma. Both longitudinal and cross sectional segments of these vessels may be identified.

Hepatic vein could be differentiated from portal vein, as hepatic vein was anechoic structure with thin echogenic wall while portal vein was anechoic structure with hyper echogenic wall. Caudal vena cava could be appeared dorsally and medially to the portal vein. It was triangular on cross sectional view (Figs. 6-8).

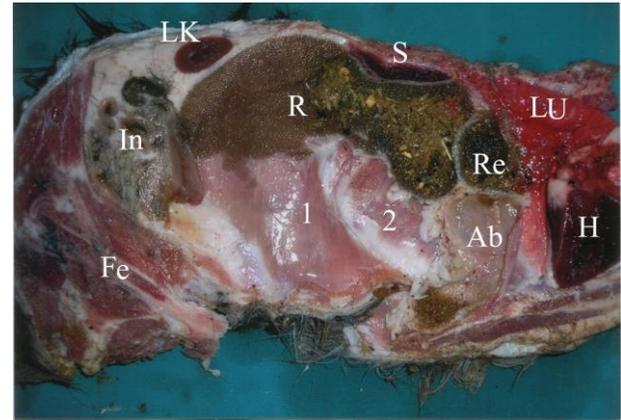


Fig. 5: showing left paramedian sagittal section of kid (lateral view): S: spleen; H: heart; LK: left kidney; R: rumen; In: intestine; LU: left lung; Re: reticulum; Ab: abomasum; 1: costal arch; 2: costal part of diaphragm; Fe: femur.

The gall bladder in sheep and goats was scanned between the hepatic parenchyma dorsally and the wall of small intestine ventro medially in the right side of the abdominal cavity in the last 2 to 3 intercostal spaces deep to the costal arch by about 2-3 cm using 3.5 MHz sector transducer or 6 MHz linear array transducer, it appeared as elongated oval or circular shaped structure in both longitudinal and transverse views respectively with an echoic content "bile" and smooth thin echogenic wall. Deep to the gall bladder there was an area of distal enhancement (Figs 9 and 10).

Table (2): showing the position of the animal and the acoustic windows during ultrasonographic examination of the liver and stomach:

Organ	Position of animal	(Site of the organ) Acoustic window
Liver	Standing or lateral recumbency	Right side from 7 <sup>th</sup> to 12 <sup>th</sup> intercostal space.
Gall bladder	Standing or lateral recumbency	Right side at 9 <sup>th</sup> or 10 <sup>th</sup> intercostal or both.
Reticulum	Standing	Ventral mid line behind xiphoid cartilage (xiphoid region).
Rumen	Standing	Lateral left flank and ventral abdominal region.
Omasum	Standing	Right side at 10 <sup>th</sup> intercostal space behind the liver.
Abomasum	Standing or dorsal recumbency	Ventral mid line or right para median.

Table (3): showing the suitable transducer used for the liver and stomach.

organ	Transducer	
	3.5/ 5MHz convex sector array	6/8MHz linear array
Liver	+++	+
Gall bladder	+	++
Reticulum	++	+
Rumen	+	++
Omasum	++	+
Abomasum	++	+

+++ Widely used, ++ Moderately used, + Less used.

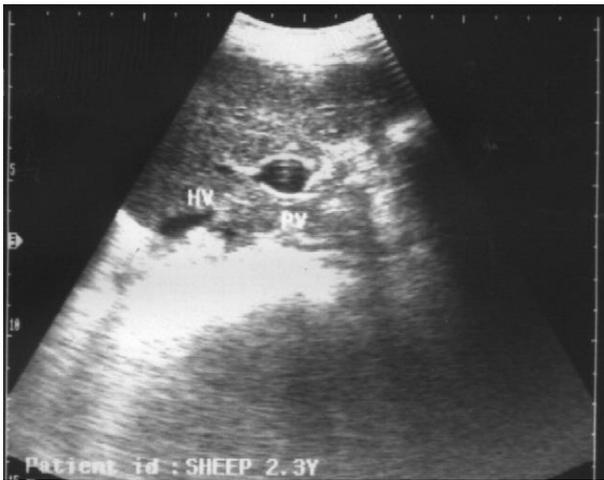
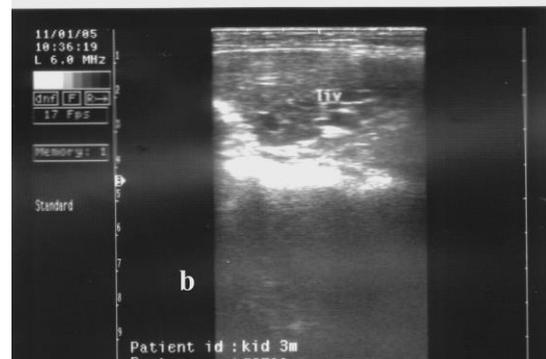


Fig. 6: Trans abdominal scanning of normal liver in 2.3 year old sheep using 3.5MHz sector transducer showing: hypo echoic liver parenchyma, hepatic vein with undetectable wall (HV), portal vein with echogenic wall (PV).

Concerning the ultrasonographic examination of the clinical cases, five sheep were admitted with a history of long period of indigestion. Ultrasonographic examination revealed presence of hyperechoic liver parenchyma. The gall bladder wall was thick and echogenic (Figs. 11).

Ultrasonographic examination of the rumen was done by using a 5MHz sector transducer put on the dorsal aspect of the left flank region. The ruminal wall appeared as an echogenic band only, while the ruminal content was appeared as a dark shadow. (Fig. 12).

The reticulum in sheep and goats was examined from the ventral abdominal region just caudal to xiphoid cartilage using a 5MHz sector transducer. The reticular wall appeared as a thick echogenic half moon shape band (Fig. 13). Reticular movements were detected through real time scanning in the form of 4-5 biphasic contractions within 4 minutes.



Figs. 7: Trans abdominal scanning of the liver of adult and young goat using 6 MHz linear transducer showing hepatic vein (HV) longitudinal section and portal vein (PV) cross section with echogenic wall.



Fig. 8: Trans abdominal scanning of goat liver using 6MHz linear transducer showing very prominent caudal vena cava (CVC) with an echogenic center and thin echogenic wall (arrow).



Fig. 9: Trans abdominal scanning of the liver (L) of goat using 6 MHz linear array transducer showing an echoic elongated or circular structure with thin echogenic wall representing the gall bladder (GB) (arrow).

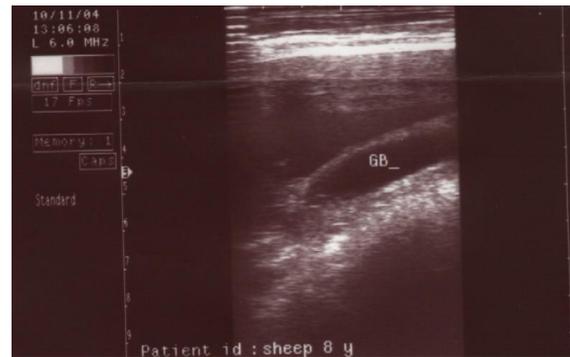
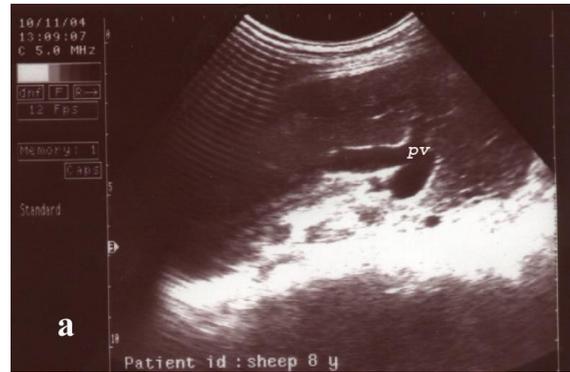


Fig. 11: (a) Trans abdominal scanning of the liver of 8 years old sheep using 5MHz sector transducer showing portal vein (PV) and more echogenic liver parenchyma representing liver cirrhosis. (b) Trans abdominal scanning of the gall bladder of the same case showing thick echogenic gall bladder wall with distal enhancement, representing cholecystitis.

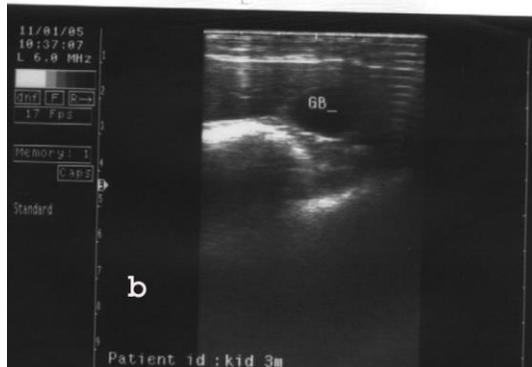


Fig. 10: (a) Trans abdominal scanning of the liver of sheep using 6MHz linear array transducer showing an echoic elongated or circular structure with thin echogenic wall representing the gall bladder (GB). (b) Trans abdominal scanning of the liver of 3 month kid.

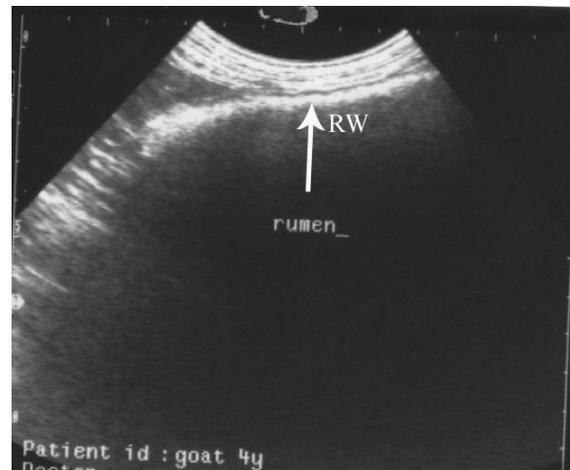


Fig. 12: Trans abdominal scanning of the rumen of 4 years old goat using 5MHz sector transducer showing thick echogenic wall (RW) (arrow) with anechoic shadow representing ruminal contents.

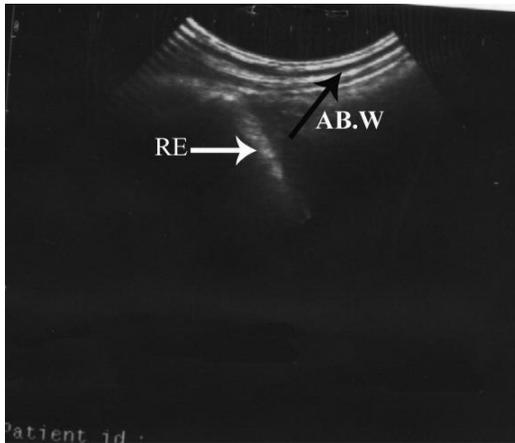


Fig. 13: Trans abdominal scanning of the reticulum in goat using 5MHz sector transducer showing reticulum as thick echogenic half moon shape band. Reticular wall (RE) white arrow. Abdominal wall (AB.W) black arrow.

These biphasic contractions appeared as movement of the rumino reticular fold in cranial direction followed by a contraction of reticular floor and lastly the cranial reticular wall. The reticular floor is elevated in dorsal direction for a short period. The reticular floor remained in its elevated position. Then the reticulum relaxed symmetrically resulting in a downward movement of the reticular floor which appeared in the sonographic picture as echogenic half moon shape band. Then the second contraction starts that made a dark anechoic field.

The omasum was examined using a 3.5MHz sector transducer on the right side at 10<sup>th</sup> intercostal space and the omasum appeared behind the liver as a thick circular echogenic band. The omasal contents appeared as a dark shadow (Fig. 14).

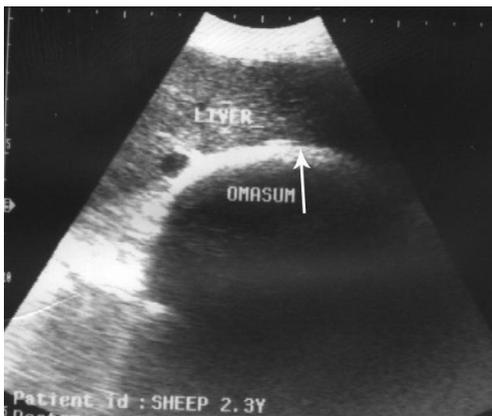


Fig. 14: Trans abdominal scanning of the omasum in 2.3 years old sheep using 3.5MHz transducer. Showing circular echogenic band (white arrow) distally to the liver.

Ultrasonographic examination of the abomasum in sheep and goats was carried out using a 3.5MHz sector transducer on both ventral midline and right paramedian areas. The contents appeared as heterogenous moderately echogenic structure. The abomasal folds were occasionally seen as echogenic structures within the contents (Fig. 15).

Plastic foreign bodies in the rumen of goats were recorded in two cases. Ultrasonographic examination of the rumen revealed presence of hyperechoic areas "foreign bodies" (Fig. 16 a). Diagnosis was ensured by exploratory rumenotomy. Ultrasonographic examination was performed one month post operatively which proved absence of hyperechoic areas inside the rumen (Fig. 16 b).



Fig. 15: Trans abdominal scanning of the abomasum in 4 years old goat using 5 MHz sector transducer. The hypoechoic abomasal content appear with presence of abomasal fold as sickle shape echogenic structure (AB.F).

## Discussion

The aim of performing anatomical study in this work was to determine the acoustic window of different abdominal organs in sheep and goats. The liver was detected in cross sections at the level of the 7<sup>th</sup> intercostal space where it occupied the dorsal part of the right hypochondriac sub region and related ventrally to the omasum. The liver continued to 10<sup>th</sup> intercostal space where the right and caudate lobes occupied the dorsal part of the right hypochondriac sub region, while in the right paramedian sagittal sections, it was also detected cranially just caudoventral to the diaphragm these results were also reported by (1) and (18). This ensured that the liver could be detected ultrasonographically from the right lateral thoracic wall from the 7<sup>th</sup> or 8<sup>th</sup> rib caudally to the 13<sup>th</sup> rib, that is in agreement with that recorded by (6) and (7). While, in calves, the liver could be imaged from the right 7<sup>th</sup> to 12<sup>th</sup> intercostal spaces as mentioned by (19). In

contrast, dogs and cats' liver could be reached and examined from the ventral abdominal wall as mentioned by (20) and (21).

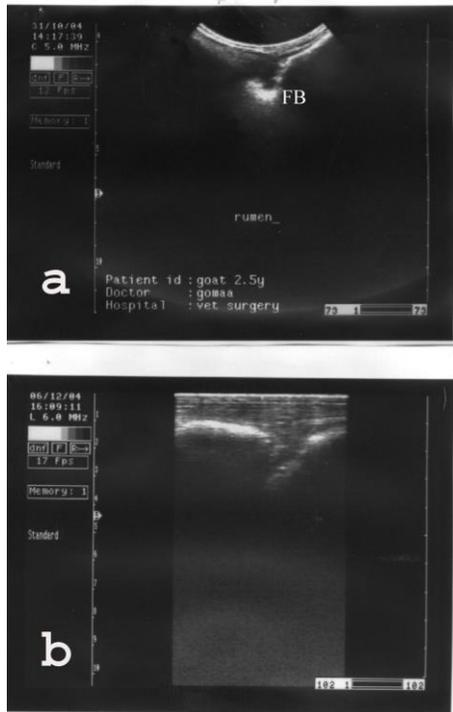


Fig. 16: (a) Trans abdominal scanning of 2.5 years old goat rumen using 5MHz transducer showing anechoic ruminal content "fluid" with hyperechoic material representing foreign body (FB). (b) Trans abdominal scanning of the same case using 6MHz linear transducer after rumenotomy with absence of any echogenicity inside the rumen.

Gall bladder was observed at the end of the right 9<sup>th</sup> costal cartilage and opposite the 9<sup>th</sup> or 11<sup>th</sup> ribs. These results were agreed with (1). Although in comparison with calves, the gall bladder could usually be visualized in only one intercostal space, the middle third of the 10<sup>th</sup> intercostal space at the as mentioned by (19).

The dorsal ruminal sac was present in cross sections at the level of the 7<sup>th</sup> intercostal space at the left hypochondriac sub region and appeared in the 10<sup>th</sup> intercostal space and the 3<sup>rd</sup> lumbar cross sections together with the ventral ruminal sac. The greater omentum was seen surrounding the rumen from the right and ventral aspects. The rumen was found in the mid line, right and left paramedian sagittal sections. So, the rumen could be detected sonographically on the left lateral side from the level of the 7<sup>th</sup> intercostal space to the level of the 3<sup>rd</sup> lumbar vertebra. This was in agreement with (2) and (22) in goats and (19) in calves.

The reticulum was found in cross sections at the level of the 7<sup>th</sup> intercostal space where it was present ventrally to the dorsal ruminal sac and was present in the mid line sagittal sections on the cranio dorsal aspect of the rumen. In the left paramedian sagittal sections it occupied its dorsal part. So, the reticulum could be imaged from ventral abdominal region just caudal to the xiphoid cartilage that was in agreement with (22) in goats; (19), (23) and (24) in calves and cows.

The omasum was detected in cross sections at the level of the 7<sup>th</sup> intercostal space on the visceral surface of the liver ventrally and continued caudally till it disappeared at the level of the 10<sup>th</sup> intercostal space. It was also detected in the right para median sagittal section in the interspace between the visceral surface of the liver and cranial surface of the rumen surrounded by the fat of greater omentum. So, the omasum could be detected ultrasonographically from the right lateral thoracic wall from the 7<sup>th</sup> to 9<sup>th</sup> intercostal spaces. This result was in agreement with (2) in goats. However, in cows, the omasum was visualized from the 10<sup>th</sup> to 12<sup>th</sup> intercostal space as mentioned by (25).

The abomasum was present in cross sections at the level of 7<sup>th</sup> intercostal space at the ventral part of the epigastric region. It was visualized in the mid line and at the left paramedian sagittal sections ventral to the reticulum and rested on the ventral abdominal floor. Small part of the abomasum was found inbetween the visceral surface of the liver and the cranial surface of the rumen at the right para median sagittal sections. This ensured that the abomasum could be detected ventrally at the mid line, right and left paramedian. This finding was in agreement with that recorded by (2) in goats; (19), (26), (27), (28), (29) and (30) in calves and cows.

The acoustic window of each organ was determined according to the previous anatomical study. The sound frequencies for different organs were in the range of 3.5-5, 5- 7.5 and 6-8 MHz. The type of the transducer used depended upon the depth of the examined organ, as the depth to which the sound beam penetrated into soft tissues was reversely related to the frequency employed. These results were similar to the findings of (21), (31), (32), (33) and (34).

Using adequate amount of coupling gel in the present work was necessary in ultrasound examination of sheep and goats to avoid the occurrence of reverberations as mentioned by (20), (21) and (35).

Ethyl alcohol was also used in this work in some cases of sheep and goats and gave results as gel. This was in agreement with that mentioned by (16) and (17).

However (35) preferred the use of viscous preparations as it yielded a more satisfactory results and requiring less frequent reapplication.

The liver was easily examined with its hepatic vasculature. The liver parenchyma appeared as numerous

weak echoes homogeneously distributed and it was more echogenic than renal cortex. These findings coincided with (6) and (7) in sheep and goats.

The hepatic vasculatures were recognized as anechoic tubular structures within the liver parenchyma in both longitudinal and cross sectional segments of these vessels. Hepatic vein appeared as thin echogenic wall while the portal vein appeared as thick echogenic wall, as well as caudal vena cava appeared as triangular anechoic structure in cross section. Similar findings were recorded by (6) and (7) in small ruminants.

The gall bladder was examined from the right side between the hepatic parenchyma dorsally and the wall of small intestine medially at the level of the last 2 to 3 intercostal spaces (10- 12 ICS). It appeared as elongated oval or circular anechoic sac in both longitudinal and transverse views respectively, with thin echogenic wall and presence of distal acoustic enhancement. This result was in agreement with (6) in sheep.

The rumen of sheep and goats in the present work appeared sonographically as thick echogenic wall while the ruminal contents appeared as a dark shadow due to presence of gases. These results were in agreement with (19) who reported such observations in calves. The present study showed that examination of the rumen was only for its wall, but detection of ruminal contents were difficult unless fluid was administered per- os as mentioned by (14) who recorded such results in stomach of dogs.

The reticulum of sheep and goats appeared sonographically as thick echogenic half moon shape band as that observed by (23) and (36). The reticular movements were determined through real time scanning as 4-5 biphasic contractions within 4 minutes in sheep and goats. This result coincided with that detected by (23), (24) and (36) in sheep, goats and cattle.

The omasum of sheep and goats appeared as thick circular echogenic band wall and the omasal contents appeared as a dark shadow. This result coincided with (2) in goats and (25) in cows.

The abomasum of sheep and goats appeared as echogenic line representing the wall and heterogeneous moderately echogenic contents, while the abomasal folds appeared as echogenic spiral folds within the contents. These results were similar to that mentioned by (27), (28) and (29) in cattle; (19) in calves and (30) in cattle.

In the present work ultrasonographic examination of the clinical cases admitted to the surgery clinic, the liver in sheep and goats revealed normal texture and echogenicity. In three non pregnant ewes of 5 -8 years old suffering from indigestion, sonographic examination revealed more echogenic liver parenchyma than normal. This echo accompanied liver cirrhosis or fatty infiltration as mentioned by (3), (9), (10), (20), (21) and (37).

Gall bladder in two old aged ewes, 5-8 years, appeared as elongated anechoic sac with thick echogenic wall. The gall bladder wall appeared sonographically thick, echogenic and nodular due to presence of mucinous hyperplasia. Old age changes and may be due to cholecystitis. These results were in agreement with (3) and (8) in cats and dogs.

Normally the ruminal contents could not be imaged sonographically due to presence of gases that made shadows as mentioned by (19) in calves. Nevertheless, 1.5 liter of water was given per os to the examined goats to facilitate imaging the contents. This approach was applied in suspected foreign bodies inside the rumen in goats, which showed hyperechoic shadows. Rumenotomy operation was performed after sonographic examination. The foreign bodies obtained from the rumen after the operation were, plastic objects and ropes. These results were in agreement with (22) in sheep and goat.

It could be concluded from the present study that the liver and omasum of sheep and goats can be scanned on the right side while the rumen can be scanned from the left. The reticulum and abomasum were imaged at the ventral midline. On the other hand, examination of the liver parenchyma with its blood vessels sonographically is now important additional diagnostic method for assessing normal liver structures as well as abnormal changes.

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