UNIVERSITI PUTRA MALAYSIA

ULTRASONOGRAPHIC IMAGING STUDY ON ABDOMINAL ORGANS OF GOAT

SITI NORAZIRAN BINTI MUHAMAD

ULTRASONOGRAPHIC IMAGING STUDY ON ABDOMINAL ORGANS OF GOAT

By:

SITI NORAZIRAN BINTI MUHAMAD

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CERTIFICATION

It is hereby certified that we have read this project paper entitled 'Ultrasonographic Imaging Study on Abdominal Organs of Goat', by Siti Noraziran binti Muhamad and in my opinion it is satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the course of VPD 4999- Final Year Project.

_____

PROF. ABD.WAHID HARON,

DVM (UPM), PhD (DUBLIN)

Professor

Department of Veterinary Clinical Studies

Faculty of Veterinary Medicine

Universiti Putra Malaysia

(Supervisor)

_____

DR. SITI ZUBAIDAH RAMANOON,

DVM (UPM), PhD (GUELPH),

Lecturer

Department of Veterinary Clinical Studies

Faculty of Veterinary Medicine

University Putra Malaysia

(Co-Supervisor)

DEDICATIONS

I dedicated this thesis with appreciation and love to:

My parents and husband

Muhamad bin Yusof

Zaiton binti Omar

Tun Mohd Alamin bin Tun Abdul Manan

My Supervisor and Co-supervisor

Prof. Dr. Abd.Wahid.Haron

Dr. Siti Zubaidah Ramanoon

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My siblings

Mohd Zaid bin Muhamad

Mashmaizan binti Muhamad

Siti Zamrah binti Muhamad

Siti Zul Norain

And to all lectures and friends who were involved either directly or indirectly in this project.

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Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada VPD4999-Projek Ilmiah Tahun Akhir

KAJIAN PENGIMEJAN ULTRABUNYI TERHADAP ORGAN-ORGAN ABDOMEN DALAM KAMBING

Oleh

SITI NORAZIRAN BINTI MUHAMAD

2016

Penyelia: Prof. Dr Abd Wahid Haron

Kajian ini merumuskan penemuan imej ultrabunyi terhadap organ-organ abdomen kambing. Lima ekor kambing betina yang kelihatan sihat dipilih untuk kajian ini. Kesemua haiwan tidak dibius dan dikawal dalam posisi berdiri dan kawasan badan yang ingin diperiksa dicukur bulunya sebelum pemeriksaan dijalankan. Rumen, retikulum, omasum, abomasum, hati, hempedu, limpa dan ginjal diperiksa menggunakan pengimbas ultrabunyi (Sonoscape) yang disambung kepada prob dengan frekuensi 4.0-6.0MHz. Pemeriksaan dijalankan menggunakan dua jenis prob iaitu prob linear dan cembung. Keputusan yang diperolehi menunjukkan rumen dan limpa diperiksa pada bahagian kiri manakala organ-organ lain diperiksa di sebelah kanan badan. Dinding rumen diperiksa pada bahagian lambung kiri dan limpa diperiksa pada ruang interkosta yang ke-11 di mana salur darah limpa amat jarang untuk dilihat. Retikulum diperiksa pada kawasan

bawah ruang interkosa yang ke-6, manakala abomasum pula diperiksa pada kawasan bawah ruang interkosta yang ke-7. Omasum pula diperiksa pada ruang interkosta yang ke-8 dan hati diperiksa bermula daripada ruang interkosta yang ke-7 sehingga ruang interkosta yang ke-12, vena portal dan vena hepatik juga dapat dilihat. Ginjal diperiksa pada bahagian belakang tulang rusuk yang terakhir dan hempedu diperiksa pada ruang interkosta yang ke-10. Kesimpulannya, pemeriksaan ultrabunyi adalah lebih mudah untuk diaplikasikan di dalam perubatan ruminan kecil sebagai salah satu kaedah untuk mendiagnosis penyakit dan juga untuk pemeriksaan organ-organ dalaman.

Kata kunci: Ultrabunyi, Ruang interkosta, Prob, Kambing betina, Organ-organ

ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfillment of requirement for the course of VPD 4999- Project

ULTRASONOGRAPHIC IMAGING STUDY ON THE ABDOMINAL ORGANS OF GOAT

By

SITI NORAZIRAN BINTI MUHAMAD

MARCH 2016

Supervisor: Prof. Dr. Abdul Wahid Haron

This study summarizes the ultrasonographic findings of the abdominal organs of goat. Five apparently healthy does were selected in this study. All animals were non-sedated, restrained in standing position and examination area was clipped and shaved prior investigation. Rumen, reticulum, omasum, abomasum, liver, gall bladder, spleen and kidney were examined using SonoScape ultrasound scanner attached to a probe with frequency between 4.0-7.0 MHz. Examination was done using both, linear and convex transabdominal probe. From the result, rumen and spleen were examined on the left side while the other organs were examined on the right side. Rumen wall was examined and identified at the left flank area while spleen was examined at the 11^{th} intercostal space (ICS) and the splenic vessel is rarely can be seen. For the reticulum, its wall was examined at the ventral abdomen at the 6^{th} ICS just caudal to the xiphoid and the abomasum wall was examined at the ventral part of the 7^{th} ICS while for the omasum, it

was examined at the 8th ICS. Liver was examined from the 7th -12th intercostal spaces (ICSs) with hepatic and portal vein can be examined. Kidney was examined just caudal to the last rib while gall bladder was examined on the right side at 10th ICS. In conclusion, ultrasound examination is more convenient to be used in small ruminant medicine as an aid in the diseases diagnosis as well as evaluation of the internal organs.

Keywords **:** Ultrasound, Intercostal space, Probe, Does, Organs

1.0 INTRODUCTION

Ultrasound imaging method is well established in both, human and veterinary medicine as a valuable imaging modality either in normal or clinical studies or cases (Yamaga & Too, 1983). In small ruminants, ultrasonographic examination has been routinely conducted. It was established as a rapid non-invasive technique to obtain information on the normal abdominal organs and an increasing number of abdominal disorders. Ultrasonography provides anatomical information that is not easily obtainable by other means (Goddard,1995). It is occasionally carried out in sheep and goats because of low financial value of these animals. This technique is safe for the assessment of structures and tissue consistency in various organs. However, there is some limitations of this method as it cannot penetrate lung tissue, gas-filled bowel and also bone tissue (Yamaga & Too, 1983)

Ultrasound has been considered as an excellent diagnostic tool for the investigation of the abdominal organs that include liver, gall bladder, spleen and the forestomach structure as well. Indeed, this technique is non-invasive and there are no known side effects that had been reported and it provides images in real time and does not require sedation (Braun, 2009). This technique had been used successfully to evaluate the rumen, reticulum, omasum and abomasum and some portions of the intestines. It provides important

information to clinicians thus avoiding the need of invasive diagnostic procedures (Streeter & Step, 2007; Braun *et al*, 2011). Abdominal ultrasonography enables an examination on the normal anatomical position of the internal organ as well as the evaluation of the organs. It is a safe method with no biological hazard was reported for the patient itself and also for the sonographer. In clinical studies or diagnosis, ultrasonography imaging enables a serial examination to monitor the progression of the condition and the patient's response towards treatment given (Kofler & Hittmair, 2006).

In this study, the examination was carried out using B-mode ultrasonography only with frequency ranging from 4-7MHz. Two types of probes were used which are the linear and also the convex transducer.

1.1 OBJECTIVES

The objectives of this study were:

i. To examine the structure and location of the abdominal organs which are the liver, gall bladder, spleen, kidney, rumen, reticulum, omasum and abomasum of goat using ultrasound scanning method.

ii. To provide information on the normal structure or appearance of each organs.

1.2 HYPOTHESIS

Ultrasonographic imaging technique is a useful modality for the determination of the normal structure and location of the organs as well as the abnormalities of abdominal organs in goats**.**

2.0 LITERATURE REVIEW

Ultrasonography is the modality of choice in ruminants for the abdominal organs examination in sheep and goats since the other diagnostic imaging techniques for detecting diseases of the abdominal organs are not appropriate (Alireza *et al*., 2007; Sarang *et al*., 2008 and Braun *et al*., 2011)

The anatomical location of the organs was determined before the examination was performed. The goat liver appeared nearly a triangular shape with the ventral portion is slightly larger than the dorsal part. It is displaced to the right median plane by the fore stomach that is the rumen. The long axis is dorsoventral 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 liver can be examined from seventh to twelfth intercostal spaces on the right lateral side of the goat (Kandeel *et al*, 2009).

The gall bladder is located within the liver parenchyma just to the right side from the ventral midline. It can be viewed at the lower part of the tenth intercostal spaces with 6-7 MHz linear transducer (Braun & Kruger, 2013). The gall bladder also has a thicker wall when it is contracted. For the rumen, it appeared completely in lateral and ventrodorsal of the left paralumbar fossa. It extended from the eighth rib cranially to the pelvic inlet caudally and from the

vertebral column dorsally to the abdominal floor ventrally. Thus rumen can be viewed at the left paralumbar fossa area with 4-6MHz linear transducer. Reticulum is located just behind the diaphragm at the ventral part of the abdomen. Ultrasound examination of reticulum was done at the area of sixth intercostal spaces just caudal to the xiphoid cartilage with 4-6MHz convex transducer.

The omasum was located at the right side of the abdominal cavity and it can be examined at the eighth intercostal space with 4-6MHz convex transducer. The abomasum is located at the ventral part of the cranial abdomen between the the reticulum cranially and the ventral ruminal sac caudally. Thus, it can be viewed at the seventh intercostal space just to the right from the ventral midline with 4-6MHz convex transducer.

For the kidney, right kidney is more cranial than the left kidney in goat and it is located at the area of the right paralumbar fossa just caudal to the caudal border of the liver. In this study, kidney was examined at the area just caudal to last rib using 4-6MHz convex transducer. Spleen in goat is located at the left side of abdominal cavity. It can be viewed at the eleventh intercostal spaces using 4-6MHz convex transducer.

3.0 MATERIALS AND METHODS

This study was performed on five apparently normal and healthy Boer cross does with the body weight between 27-36kg and aged of 4 years old. The animals were non-sedated and ultrasound examination was done in a standing position on both sides of abdominal cavity. Basic physical examination including taking the temperature, pulse rate and also respiratory rate were carried out prior the examination. The body area to be examined which include both of the right and left sides of the goats was clipped from the sixth rib caudally to the paralumbar fossa area and from the dorsal vertebrae until the area of linea alba. Then, the clipped body area was cleaned using water and paper towel. The ultrasound scanner machine was adjusted according to the instruction prepared in the operating manual. The linear and convex probes were attached at the back side of the scanner. The patient detail was recorded by pressing the 'patient file' button. Ultrasound coupling gel was applied on the surface of the probe to enable a better and clear image of the organs. The organs were examined based on their determined anatomical location respectively. A grayscale, B-mode ultrasonography was used and after the images of the organ was obtained, the image will be captured by pressing the 'Freeze' button on the scanner keyboard. The images will then be recorded in the directory file that was being set initially.

4.0 RESULTS

The results of scanning positions of all abdominal organs were summarized in Table 1.

Organs	Examination area	Type of probe	Frequency
Liver	7^{th} to 12^{th} intercostal spaces (Right side)	Convex	4-6MHz
Gall bladder	10^{th} intercostal spaces (Right side)	Linear	6-7MHz
Spleen	11^{th} intercostal spaces (Left side)	Convex	4-6MHz
Kidney	Area caudal to the last rib (Right side)	Convex	4-6MHz
Reticulum	6^{th} intercostal space (Right side)	Convex	4-6MHz
Rumen	Left paralumbar fossa area (Left side)	Linear	6-7MHz
Omasum	8^{th} intercostal spaces (Right side)	Convex	4-6MHz
Abomasum	7^{th} intercostal spaces (Right side)	Convex	4-6MHz

Table 1: Examination area of each organ

i. Liver

As mentioned in the introduction, the liver was viewed at the 7^{th} to 12^{th} intercostal spaces in the area ventral to the level of the shoulder joint with the pointer was pointed dorsally. A 4-6MHz convex transducer was used to examine the liver. It was found that the best examination area to view the liver were between the 10^{th} and 11^{th} intercostal spaces. The liver was visible ventral to the lung border and its parenchyma appeared as hypoechoic that is homogenously distributed. Hepatic vein can be differentiated from portal vein, as hepatic vein was visible as an anechoic structure with no echogenic border while portal vein was indicated by a thick hyperechoic wall that lining the vessel. The images of hepatic and portal vein were showed in Figure 3. Caudal vena cava was examined as a triangular shape that was also showed in Figure 3.

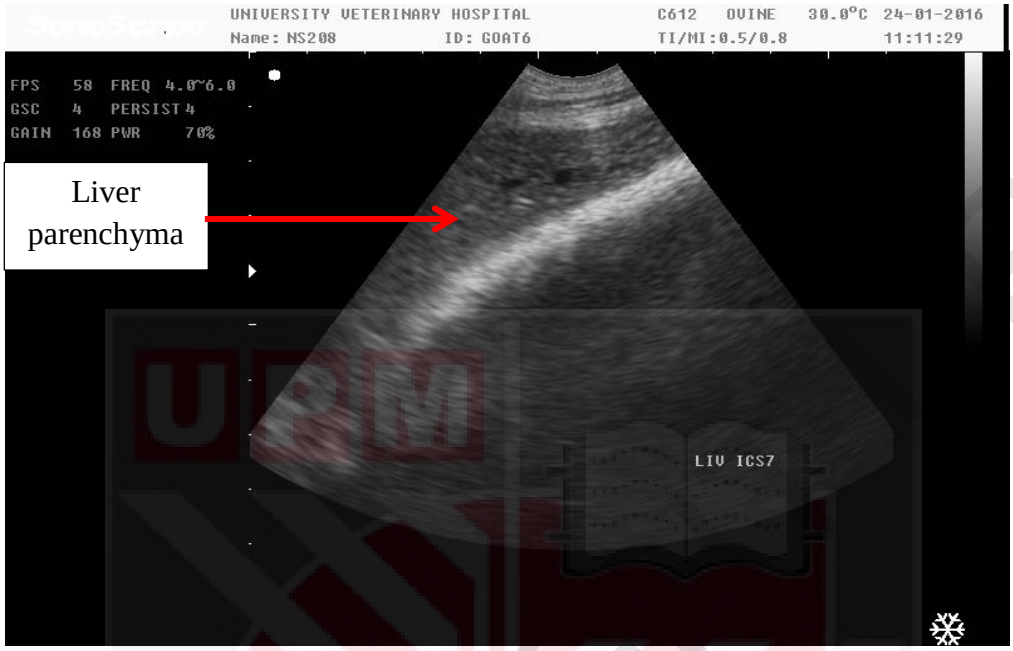

Figure 1: Liver image at the 7th intercostal space

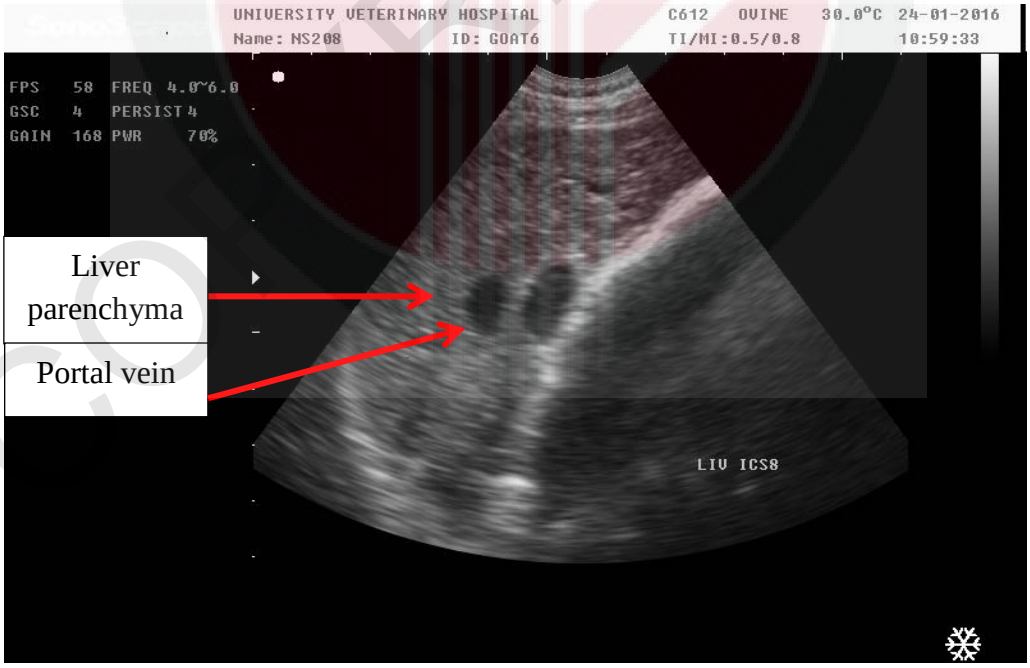

Figure 2: Liver image at the 8th intercostal space

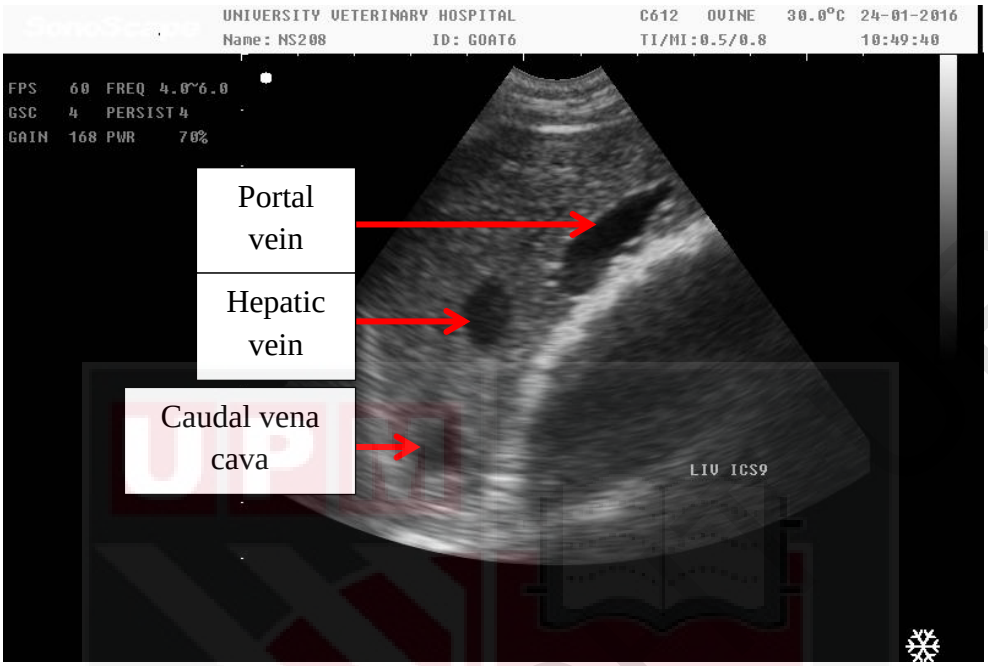

Figure 3: Liver image at the 9th intercostal space

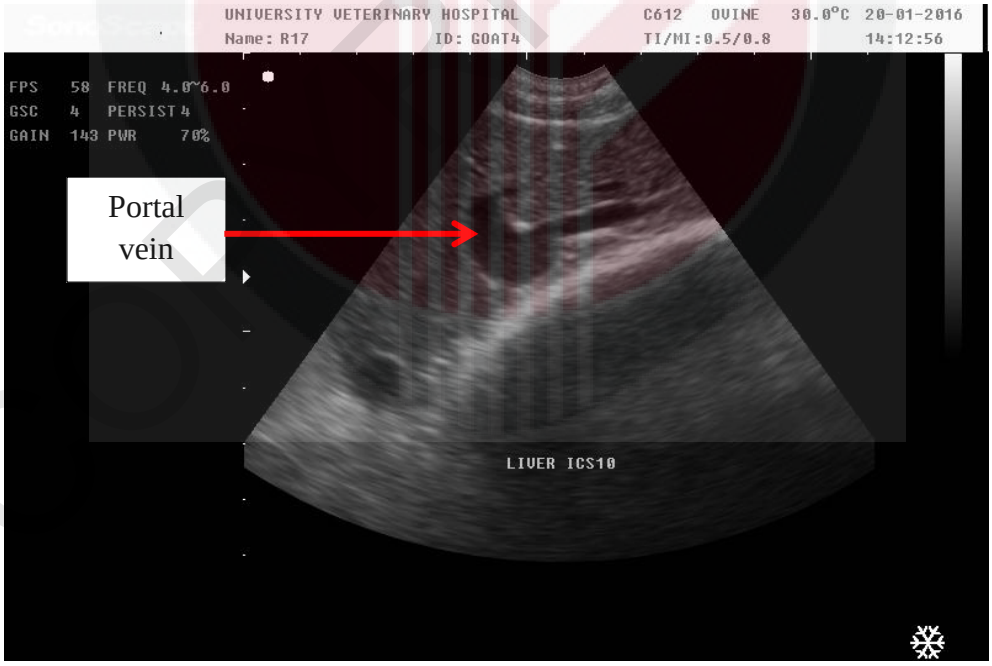

Figure 4: Liver image at the 10th intercostal space

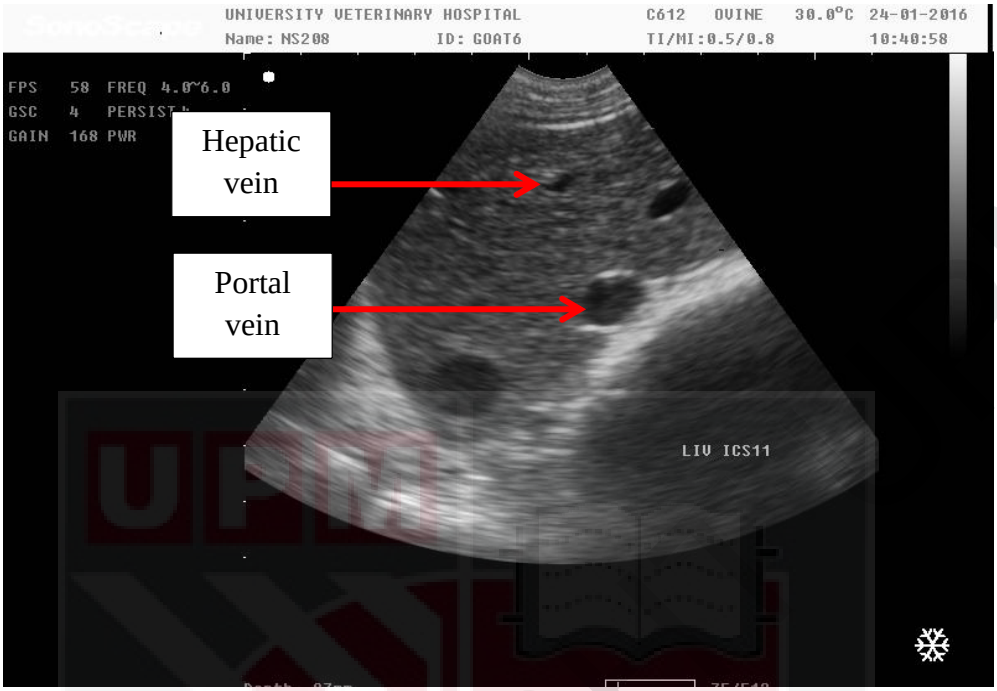

Figure 5: Liver image at the 11th intercostal space

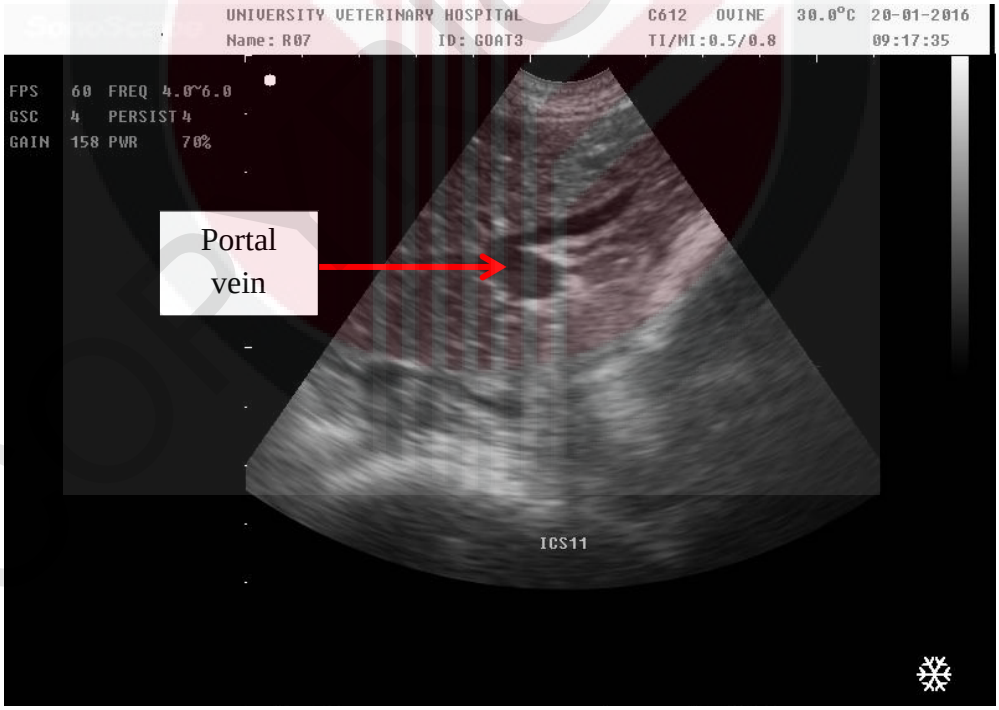

Figure 6: Liver image at the 12th intercostal space

ii. Gall bladder

The gall bladder was examined at the area of 10th intercostal spaces on the right side of the goat abdomen using 6-7MHz linear transducer. It was located within the liver parenchyma and appeared as an elongated circular shape with its content (bile) appeared anechoic (Figure 7). The gall bladder was lined by a thin and smooth echogenic wall.

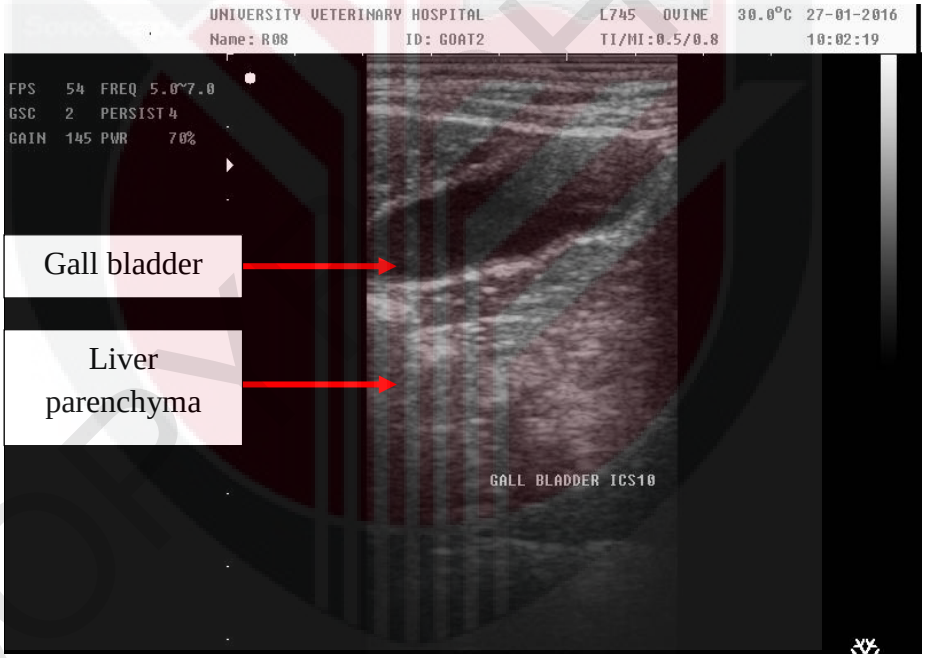

Figure 7: Gall bladder image at 10th intercostal space

iii. Spleen

The spleen was examined at the 11th intercostal spaces on the left side with 4-6MHz convex transducer. Its parenchyma was appeared similar with liver, which is consisted of numerous weak echoes homogenously distributed over the entire organ with splenic vessel is rarely can be seen. Splenic vessel usually appeared as elongated hypoechoic structure as indicated in Figure 8. However, spleen is more hyperechoic than the liver.

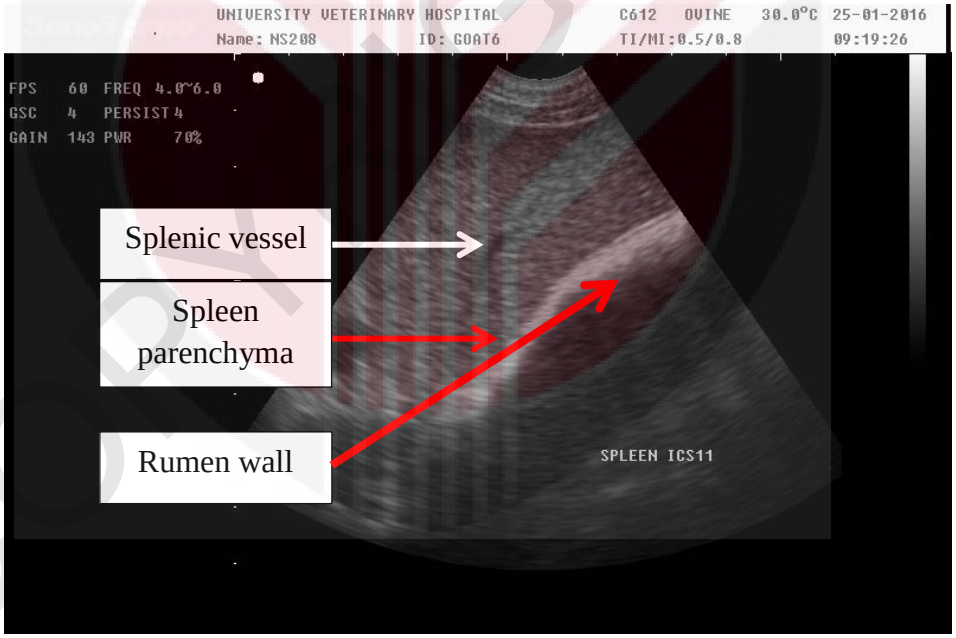

Figure 8: White arrow showing the splenic vessel and the red arrow is showing the spleen and ruminal wall

iv. Kidney

The right kidney was examined at the area just caudal to the last rib at the right side using 4-6MHz convex transducer. The echo pattern of the kidney is different indicating its structure which is the cortex and the medulla. The renal cortex is more echogenic than the medulla as shown in Figure 9, and kidney parenchyma is less echogenic than the liver . The left kidney was not seen during the examination in this study.

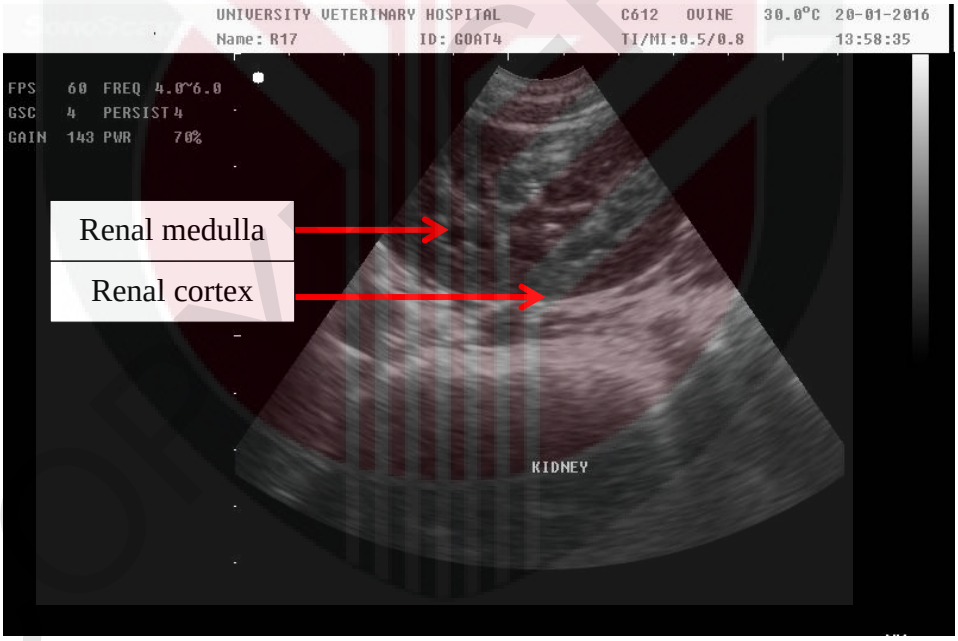

Figure 9: Kidney image at the area just caudal to the last rib

v. Reticulum

Reticulum was examined at the 6th intercostal space at the area of the ventral abdominal region just caudal to the xiphoid cartilage with 4-6MHz convex transducer. Only the reticular wall that appeared as a half-moon shaped as shown in Figure 10, that can be seen during the examination while the different layers of the reticular wall could not be imaged as well as the honeycomb like structure of its mucosa also cannot be examined.

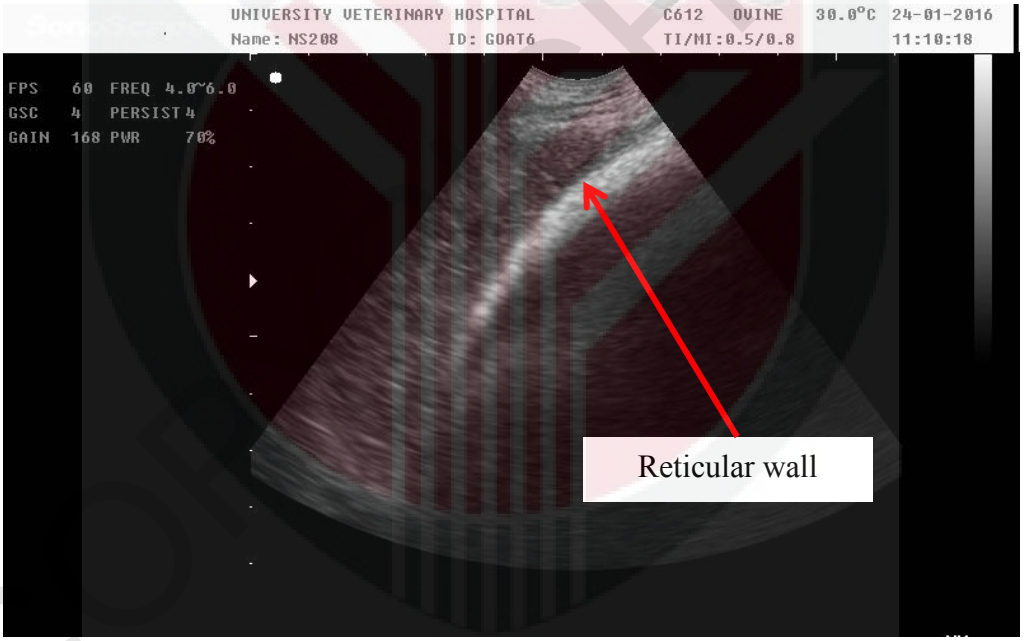

Figure 10: Reticulum image at the ventral pat of 6th intercostal space

vi. Rumen

The rumen was examined at the area of the left flank or paralumbar fossa using 6.5-7.5MHz linear transducer. The ruminal wall appeared as a thick smooth echogenic line while its content was appeared anechoic as shown in Figure 11.

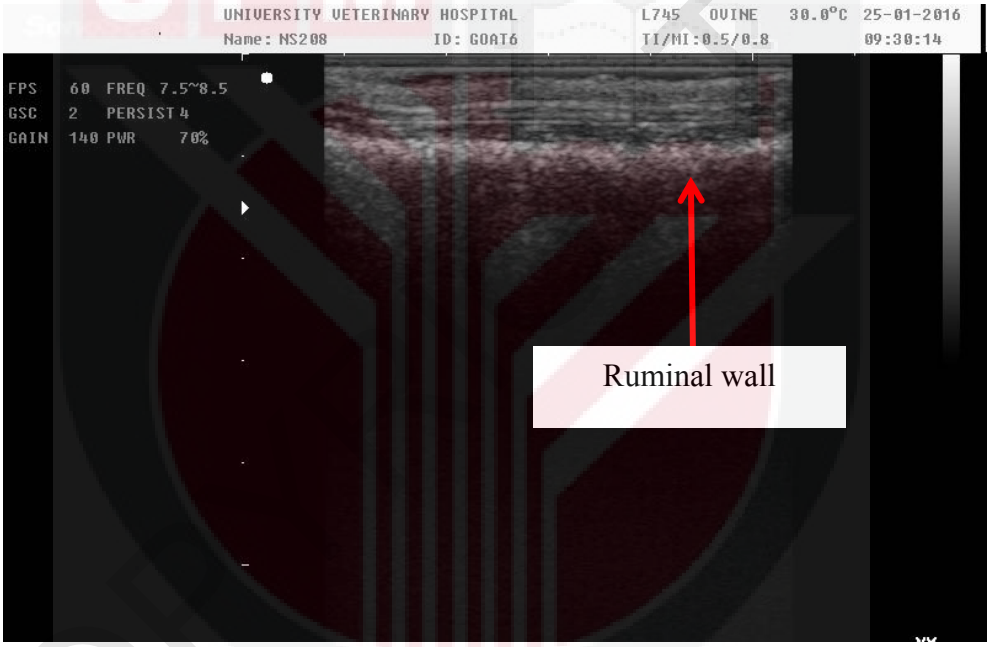

Figure 11: Rumen image at the left paralumbar fossa. Ruminal wall is indicated by red arrow.

vii. Omasum

The omasum was examined at the 8th intercostal spaces at the right side of the abdomen with 4-6MHz convex transducer. The omasal wall was examined and appeared as a thick echogenic line as indicated by red arrow in Figure 12.

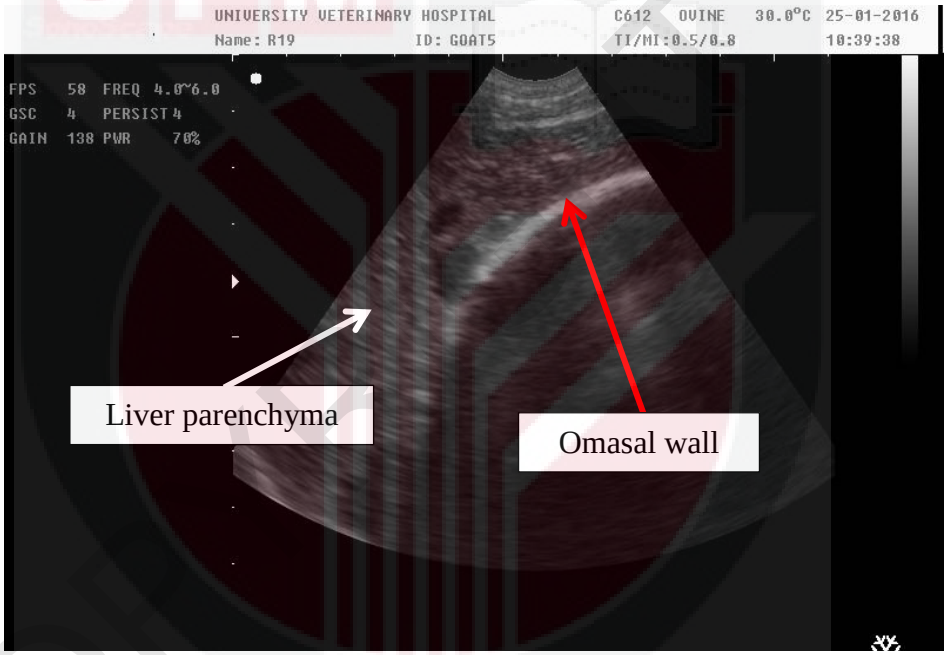

Figure 12: Omasum image at the 8th intercostal space. Omasal wall is indicated by red arrow.

viii. Abomasum

The abomasum was visualized at the area similar to the reticulum, unless it is more towards at the 7th intercostal spaces and more ventral with 4-6MHz convex transducer. It was seen immediately caudal to the reticulum and its wall appeared as a quite thick echogenic line. Sometimes it is quite difficult to identify the abomasal wall suring the examination in this study. The abomasal fold also visible during the examination and its content appeared as a moderate heterogenous structure.

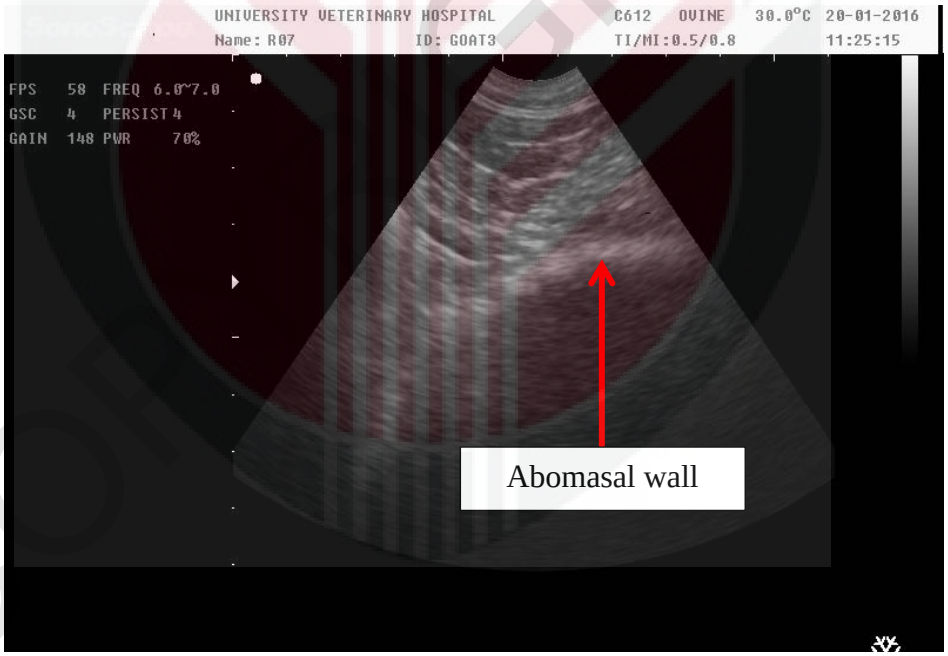

Figure 13: Abomasum image at the ventral part of 7th intercostal space. Abomasal wall is indicated by red arrow.

5.0 DISCUSSION

Ultrasonography should be the modality of choice for the examination of the abdominal organs in goats because it is safe and it enables a quick assessment on the internal organs. There is also no risk or biological hazard had been reported toward the animal and also to the sonographer until recently. The other diagnostic imaging techniques for detecting diseases of the abdominal organs of goat such as radiography, computed topography (CT scan) and magnetic resonance imaging (MRI) are not very appropriate and applicable in ruminants. For radiology, it is not a preferred method because of the gas filled rumen as well as the biological hazard risk. Computed topography scanning (CT scan) and Magnetic Resonance Imaging(MRI) also not very preferable since they require high costs and also not applicable in ruminants or livestocks. Goddard (1995) also stated that ultrasonography of the abdomen is particularly useful for the measurements of organs and to obtain anatomical information which is not easily obtainable by other means such as to identify the biliary tract, investigating peritoneal fluid as well as to determine the origin and structure of masses and guiding biopsy in order to obtain the definitive diagnosis.

For the ultrasonography examination on the abdominal organs in goats, two types of probes were usually used which are the convex and also the linear

probe. Convex probe has a large point of contact with the skin surface, with the ultrasound beam spreading to a wider field of view, giving a sector-shaped image. Convex probe typically have a lower frequency range between 3.0-5.0MHz, therefore the image resolution that can be achieved is lower than the other types of probe. However it fits much better than the linear probe within the intercostal spaces of the goat's abdomen. Linear probe is primarily used for superficial structures such as rumen and gall bladder. Linear probe normally give a higher resolution images than convex probe because it scan at higher frequencies and the ultrasound beams do not diverge as they travel away from the probe. Other than that, an ultrasound gel was also required to perform ultrasonography examination to enable a good contact between the skin surface and the transducer to avoid air artifacts. Thus, better scanned images can be obtained.

In this study, the does were fasted prior the examination. Fasting of the animals provide an adequate examination of the abdominal organs (Paddy, 2006). However, (Braun *et al*, 1992) stated that full rumen will push the left kidney closer to the abdominal wall in the right side which provided better ultrasonography examination of the left kidney in goat. Thus, this can be one of the reasons why the left kidney cannot be visualized in this study excluding other factors such as the incorrect placement and orientation of the probe on

examined area. On the other hand, according to (Goddard, 1995), the presence of gas in the gastrointestinal tract (GIT) may interfere with the transmission of the ultrasound beam, therefore this may produce artifacts on the scanned images.

The liver was visualized from the 7^{th} to 12^{th} intercostal spaces (ICSs). The liver echogenicity consisted of low echogenicity that was homogenously distributed to the entire organ and the portal vein and hepatic vein also visible (Pugh, 2002; Sarang *et al*, 2008 & Kandeel *et al*, 2009). The portal vein appeared to has a border or wall that appeared more prominent or more echogenic than the hepatic vein. This statement was in agreement with that reported by (Goddard, 1995 & Kandeel et al, 2009).

The gall bladder was examined at the ventral part of 10^{th} ICS which is about 20cm from the dorsal vetebrae. It appeared to be an elongated circular shape or oval with a smooth contour of echogenic band and the content, which is the bile, appeared anechoic. This statement was reported by (Alsafy *et al*, 2013). It is stated that the gall bladder appeared as anechoic oval or pear shaped structure with a bright margin adjacent to the abdominal wall.

For the spleen, it was examined at the 11^{th} ICS and its parenchyma appeared similar with liver, which is consisted of low echogenicity that is

homogenously distributed over the entire organ with splenic vessel is rarely can be seen. Braun & Kruger (2013) reported that spleen is appeared slightly more hyperechoic than the liver. Thus, the differentiation between the spleen and the kidney can be done from their different anatomical location itself. In this study, it is quite difficult to scan the spleen on goat. However, Braun *et al*. (2010) reported that the appearance, location and size of the spleen are easily assessed by examining from the left side extended from the 9^{th} to 12^{th} ICS. It appeared as a homogenous with coarse granulation organ that contained small regular anechoic blood vessels. These results were agreed with that obtained by (Yamaga &Too, 1983 and Nyland & Hager, 1985).

For the kidney, it was visualized at the right side at the area just caudal to the last rib which was about 1cm from the 13^{th} rib. Right kidney was easy to be identified and examined at the area. From the scanned images, the echo pattern of the kidney is different indicating its structure which is the cortex and the medulla. Renal cortex appeared to be more echogenic than the medulla and the renal parenchyma was less echogenic than the liver. These results were in agreement with those reported by (Alsafy *et al*, 2013). The left kidney was not be able to be examined in this study. According to (Abd.Elhameed, 2008) the left kidney lied in the dorsal region of the left paralumbar fossa behind the last

rib while, (Yamaga & Too, 1983 and Braun *et al*., 1992) mentioned that both kidneys can be visualized at the area of right paralumbar fossa.

Ultrasonography of the reticulum in goats is a valuable tool to determine its anatomical information and its appearance. It was examined at the ventral part of 6th ICS at the right side. It is also quite difficult to examine reticulum in this study. According to Alsafy *et al*. (2013), the reticulum also can be visualized on the left side from the 5th to 8th ICS. From the obtained images, reticular wall appeared as a half-moon shaped with the honeycomb appearance was not be able to be examined. This result was in agreement with Alsafy *et al*. (2013) and Braun *et al*. (2011). They stated that the reticulum appeared as a crescent-shaped structure with smooth contour located immediately adjacent to the diaphragm.

Then, the ultrasonography examination of rumen was done using linear probe. Rumen was easily examined at the area of left paralumbar fossa. Braun *et al*. (2011) stated that rumen could be visualized from the 8th ICS to the flank on the left side of the goat's abdomen. In this study, the rumen wall appeared as a thick smooth echogenic line while its content appeared anechoic, which is in agreement with Sheikh *et al*. (2011).

Omasum also can be examined by ultrasound scanning by examining the 10th ICS and only the omasal wall that was able to be examined in this study. Braun *et al.* (2011) stated that the omasum was located medial to the liver, but only the omasal wall that was closest to the transducer was visible.

In the present study, abomasum was examined at the ventral part of 7th ICS and and its wall appeared as a quite thick echogenic line and sometimes it is difficult to identify its wall during the examination. Similar finding was also reported by Braun *et al.* (2011) in goat. They stated that the abomasum wall could not be easily differentiated from its contents and the abomasum in cattle and goats was described as a thin echogenic line.

6.0 CONCLUSION

The results of this study showed that different abdominal organs of goat can be examined using ultrasound machine. Thus, it proves that ultrasound imaging technique is a modality of choice to examine not only the structure and the location but also be able to compare between the normal and abnormal structure of various abdominal organs in goat.

7.0 RECOMMENDATION

It is recommended that this study should be done in more animals and initial information on the anatomical location of each organ could be obtained from a post mortem carcass, thus providing a guide during the ultrasonography examination of the organs. It is also best to include all the organs in the abdominal cavity including the small and the large intestines and also to use M-mode for examination of reticular movement and biphasic contraction.

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