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RESEARCH ARTICLE

Doppler Ultrasonography of Abdominal Vasculature in Canines

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Abstract

Present study was conducted with the objective of describing the sonographic appearance of major abdominal vessels in canines. The study was conducted on ten healthy animals. Abdominal aorta and caudal vena cava were located caudal to the kidneys. Aorta was located on midline and to the left of the more ventrally located caudal vena cava. Pulsating movements of aorta helped its differentiation from caudal vena cava. Iliac arteries and veins were the major branches of abdominal aorta and caudal vena cava respectively, visualized in caudal abdomen. In animals with relaxed abdomen celiac, cranial mesenteric, splenic and hepatic arteries were observed in cranial abdomen. Main portal vein was visualized in an oblique sagital plane. Portal vein was lying ventral to the caudal vena cava and aorta was dorsal to the caudal vena cava and portal vein. On color doppler study, aorta had the blood flow towards the transducer and caudal vena cava away from the transducer. Pulse wave doppler study revealed that aorta had a typical pulsatile arterial waveform. Flow in caudal vena cava was laminar and undisturbed. Periodicity in the flow of caudal vena cava was marked in cranial part and mild in caudal part. Mean velocity of Abdominal Aorta and Caudal Vena Cava in caudal abdomen was found to be 0.84m/sec and 0.78m/sec respectively.

INTRODUCTION

Abdominal vessels such as aorta, caudal vena cava, portal vein and their branches like external and internal ileac arteries, celiac arteries, mesenteric arteries, external and internal ileac veins, mesenteric veins are typically standard in location. They have characteristic appearance and specific flow pattern. Diseases of abdominal organs will cause variation in the appearance of the vessels supplying them. This altered appearance of vessels may help in early diagnosis of diseases of the organs supplied by them (Finn-Bodner and Hudson, 1998). Vascular diseases and anomalies like thrombosis, infarction, vasculitis, neoplastic infiltration of vessels, stenosis, dilatation, aneurysm, arteriovenous fistula and shunts are also encountered in veterinary practice (Spaulding, 1992). Presently exploratory angiography is considered as the gold standard technique for diagnosing vascular disorders. This technique is having many side effects and cannot be applied in clinically ailing patients. Other non-invasive techniques like nuclear scintigraphy and computed tomography are used routinely in human medicine. High cost and non availability at all places limits their application in veterinary practice and this leads to under diagnosis of vascular anomalies in canine patients (Szatmari *et al.,* 2001).

Doppler ultrasonography is relatively new within small animal sonography. Duplex doppler ultrasonography provides both real time anatomic and dynamic information. The presence, direction and type of blood flow can be determined during duplex examination. The doppler signal is fairly specific to a particular vessel or even vessel site. Hence, the knowledge of normal doppler signs of each blood vessel is important in their identification. If the sonographer is familiar about the normal vascular anatomy and principles of doppler technique, then doppler ultrasonography may prove beneficial in many ways (Mattoon, 2013). The possible benefits of doppler ultrasonography of abdominal vasculature include, it will serve as landmark in locating many organs eg: pancreas and lymph nodes. It will be useful in detecting altered blood flow to organs eg: decreased blood flow to kidneys in chronic kidney disease and increased blood flow to liver in portal hypertension. It will be helpful in differentiating the benign tumors from malignant ones and also in assessing the degree of neoplastic infiltration to neighbouring organs and lymph nodes. After assessing the blood flow to the tissues, it may also aid in choosing the biopsy site. Most importantly the vascular diseases and anomalies can be easily diagnosed (Nautrup, 1998).

Besides this doppler ultrasonography is simple, noninvasive readily available technique with no side effects on the patients. If sonographic techniques are mastered over, then doppler ultrasonography will be a major breakthrough in the diagnosis of vascular disorders and affections (Kinns, 2010). Lot of research has been done in human medicine and presently doppler ultrasonography is being used in the diagnosis of vascular disorders whereas in canines, still it has to be explored. Keeping in view of this fact, the present study was conducted to standardize the technique for 2-D imaging of major abdominal vessels and describe their sonographic appearance in canines.

Material and Methods:

Present study was conducted at Small Animal ultrasound unit of Department of Clinics, Madras Veterinary College, Chennai, during the year 2013-2014. Ten clinically healthy canines belonging to different breed, sex and age group presented at Small Animal Clinic Outpatient Unit of Madras Veterinary College Teaching Hospital for routine health check up and vaccinations were selected for the study. Ultrasonography was performed with an ALOKA SSD 3500 ultrasound machine with curvilinear probe and 5 MHz frequency was used. The preparation of canines for ultrasonography was done according to the standard procedure given by Nyland and Matton (2002). The animals were fasted for 12 hours and liberal amount of water was given to drink. Hair over the entire abdomen was clipped from the xiphoid along the costal arch to the areas of the right and left kidney, respectively and to the cranial aspect of the pubic bone and liberal amount of acoustic gel was applied to the skin. Animals were examined in right lateral recumbent position. To visualize the main portal vein, animals were placed in dorsal recumbency and viewed through oblique sagital plane.

Results and Discussion:

Two dimensional visualization of aorta and caudal vena cava:

In caudo dorsal abdomen, aorta and caudal vena cava were located caudal to the kidneys. In longitudinal view the cranial two third of the abdominal aorta was located on midline and to the left of the more ventrally located caudal vena cava (Fig.1). In transverse plane, aorta was visualized just off midline on the left and vena cava was lying adjacent to it on the right (Fig.2). Findings of the present study are in accordance with Pugh (1994) and Szatmari *et al.* (2001), they studied the normal morphology of canine abdominal vasculature and found that morphological appearance and their location was specific to each vessels.

Abdominal blood vessels in longitudinal plane had a tubular structure with well-defined walls. The walls were parallel, hyperechoic and appeared as thin smooth lines. Non-compressed vessels imaged transversely appeared circular or oval. The lumen was anechoic because of the echofree blood inside. Aorta was less compressible than the caudal vena cava and had a thicker wal1. In addition aortic pulses were also observed. Urinary bladder as an acoustic window enhanced the visualization of aorta and caudal vena cava. These findings are in agreement with other workers (Szatmari *et al.,* 2001; Kamikawa and Bombonato, 2007).

Two dimensional visualization of major branches of aorta and caudal vena cava:

In caudal abdomen, the aorta and caudal vena cava were bifurcated into the iliac arteries and veins respectively. The external iliac arteries were the first to bifurcate from aorta followed by the internal iliac arteries. The common external iliac veins branched off the caudal vena cava in this region; the internal iliac veins arose from the external iliac veins (Fig 3). Findings of the present study are in correlation with many workers (Spaulding, 1997; Nautrup, 1998).

In cranial abdomen, celiac and cranial mesenteric arteries were visualized. The celiac artery arose from the ventral wall of the aorta caudal to the stomach and branched shortly into the splenic artery (Fig.4) to the left and hepatic artery to the right. The cranial mesenteric artery arose from the ventral surface of the aorta caudal to the celiac artery. Visualization of these vasculatures in cranial abdomen was difficult owing to tense abdomen. This is in concurrence with Nyland and Fisher (1990) as they opined that tense abdominal musculature and gastrointestinal gas hindered the clear visualization of vasculature in cranial abdomen and suggested that sedation and overnight fasting may facilitate their visualization.

It was possible to follow aorta and caudal vena cava cranially till diaphragm only in one dog which was in agreement with Nyland *et al.*, (1995) and Kantrowitz *et al.*, (1998). They observed that sonographic tracing of aorta and caudal vena cava till diaphragm was not possible in all animals. They further stated that visualization was easy in patients with pleural effusion and ascites. Szatmari *et al.*, (2001) also opined that cranial part of aorta was not easy to image, especially in deep chested canines because of the artifacts caused by gastrointestinal gas and ribs.

Two dimensional visualization of portal vein:

The main portal vein was visualized with the animal in dorsal recumbency in an oblique sagittal plane. The cranial part of the transducer was placed on the linea alba and turned slightly to the right. In longitudinal view, portal vein was lying ventral to the caudal vena cava and aorta was dorsal to caudal vena cava and portal vein. In a transverse view of the cranial abdomen, the caudal vena cava was situated dorsal and slightly to the right of the portal vein and aorta was on the midline or slightly to the left. These observations are in correlation with Boswood *et al.*, (2000) and Nyman *et al.*, (2004).

Doppler evaluation of aorta and caudal vena cava:

On color flow doppler, aorta showed the blood flow towards the transducer i.e. red color and caudal vena cava was having the flow away from the transducer i.e. blue color (Fig.5). This observation was in agreement with Spaulding (1997), he stated that flow within the vena cava would be towards the heart (away from transducer) and flow within the aorta towards the limbs (towards the transducer).

On pulse wave doppler study, the aorta had a typical pulsatile arterial waveform. It had a sharp systolic peak with large and clear spectral window. The velocity distribution was narrow. Systolic peak was followed by a retrograde flow wave (Fig.6). This finding is in agreement with Ochoa *et al.*, (2011) and Mattoon, (2013). They also observed typical high resistance flow pattern in abdominal aorta. Flow in Caudal vena cava was laminar and markedly periodical in cranial part of caudal vena cava whereas, in caudal part of abdominal vena cava the flow was laminar and mildly periodical (Fig.7 and 8). This observation is in concurrence with Boswood *et al.*, (2000), they reported that Caudal vena cava had undisturbed laminar flow. Influence of respiration was more in cranial abdomen causing markedly periodic flow in cranial part of caudal abdominal vena cava than in caudal part of caudal abdominal vena cava (Szatmari *et al.*, 2001).

Doppler evaluation of major branches of aorta and caudal vena cava:

Blood flow pattern in iliac arteries and veins was typical arterial and venous pattern respectively. Iliac arteries showed sharp systolic peaks with a very small spectral window which was also observed by Szatmari *et al.*, (2001). They studied the doppler pattern in major branches of aorta and caudal vena cava and stated that iliac arteries had plug flow velocity profile i.e. clear spectral window and narrow velocity profile.

Doppler evaluation of portal vein:

Portal vein had typical undisturbed laminar venous flow with variation in the velocity. This variation in the velocity might be due to respiratory movements as observed by Lamb *et al.*, (1999). They calculated the portal blood flow in canines and stated that portal vein had phasic laminar blood flow pattern owing to inspiratory and expiratory movements.

Velocity of Abdominal Aorta and Caudal Vena Cava:

Mean velocity of Abdominal Aorta and Caudal Vena Cava in caudal abdomen was found to be 0.84m/sec and 0.78m/sec respectively. Results are in agreement with Szatmari and coworkers (2001), they found velocity of abdominal aorta and caudal vena cava as 0.83m/sec and 0.79m/sec respectively.

Fig.1. Longitudinal Appearance of Caudal Vena Cava and Aorta in Caudal Abdomen

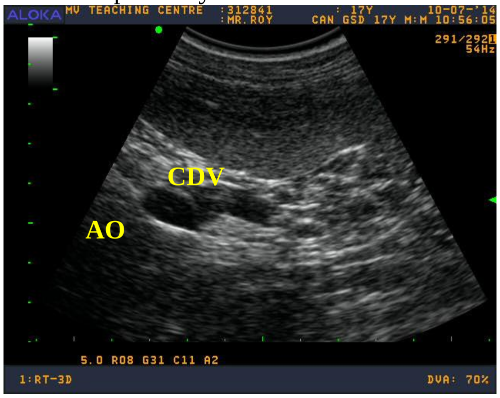
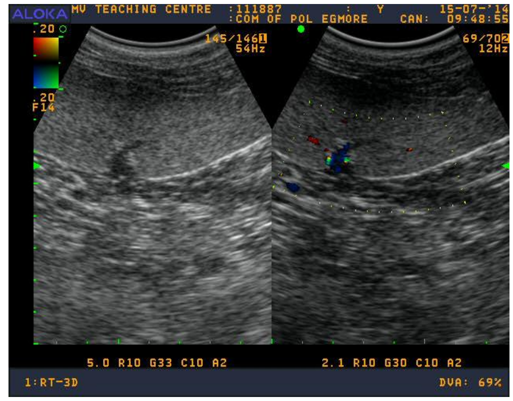


Fig.2. Transverse Appearance of Caudal Vena Cava and Aorta in Caudal Abdomen



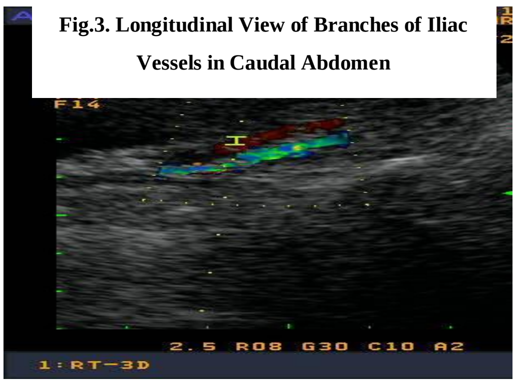


Fig.3. Longitudinal View of Branches of Iliac Vessels in Caudal Abdomen

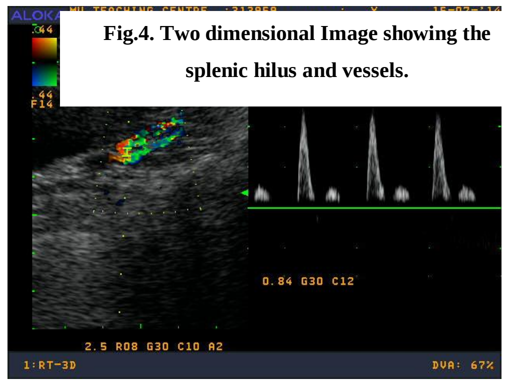


Fig.4. Two dimensional Image showing the splenic hilus and vessels.

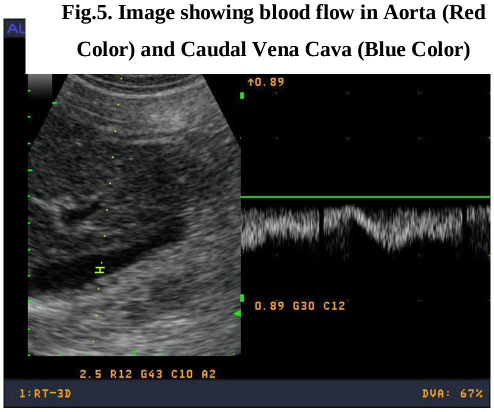


Fig.5. Image showing blood flow in Aorta (Red Color) and Caudal Vena Cava (Blue Color)

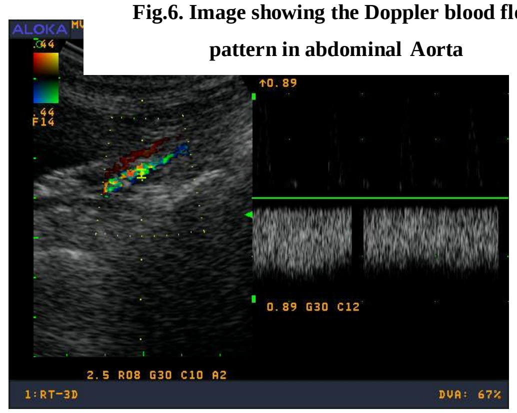


Fig.6. Image showing the Doppler blood flow pattern in abdominal Aorta

Conclusion:

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Fig.7. Image showing the Doppler blood flow pattern in cranial part of abdominal Caudal Vena Cava

Fig.8. Image showing the Doppler blood flow pattern in caudal part of abdominal Caudal Vena Cava

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