CLINICAL AND SURVEY ABDOMINAL
ULTRASONOGRAPHY IN DOGS

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THESIS

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INTRODUCTION

Ultrasonography has established itself as an invaluable diagnostic aid in surgical diseases. In addition to the diagnosis of thoracic and abdominal disease ultrasonography is increasing in importance in the examination of muscles, tendons and joints in small animals (Fritch, 1993).

The veterinary profession has traditionally responded to the needs of animals, by providing health care for a variety of species, and to the needs of society by caring for animals in ways that reduce the risk of people acquiring animal related diseases and injuries.

The public health significance of large population of stray dogs is considerable, particularly when these are allowed to roam free. The prevalence of obscure dog disease in such animals needs to diagnose these diseases by ultrasonography when these are brought in Surgery Clinic for sterilization under animal birth control programme. Usually such sophisticated diagnostic methods are used for pet dogs particularly those belonging to affluent society.

In addition to providing health care for pets of affluent to human patients veterinarians in the present scenario are however, challenged to search for methods to diagnose the diseases of stray dogs also.

The 1970's witnessed phenomenal growth in the technology of radiological practice with striking advances in abdominal imaging by nuclear medicine, CT, ultrasound, interventional radiology and MRI.
Need arises to choose one particular technique that would help to reach at an accurate diagnosis with minimum expenditure of time, money and risk to the patient.

Though CT provides better anatomical localization and extent of the lesion it cannot be used as a screening method because it is quite costly, not readily available and employs ionizing radiation which could be harmful.

Ultrasound on the other hand uses sound waves which are not harmful. Beginning in the late 1970s with the first reports of two dimensional gray-scale ultrasonography used to image small animal abdominal organs, during the last 5 to 7 years the volume of veterinary literature on ultrasonographic imaging equals or exceeds that on contrast radiographic imaging of the small animal abdominal organs (Feeney etal., 1991).

Ultrasound tends to separate one soft tissue organ within the abdomen from another and displays their internal architecture. Ultrasound is one of the most reliable methods for differentiating solid from cystic lesions (Miles, 1997). Ultrasound allows visualization of many internal organs and this may provide important information covering the extent of diseases and in the absence of suspected disease may suggest another cause for it. Ultrasound is defined as sound waves of frequencies greater than those audible to human ear, i.e. greater than 20,000 Hz cycles/second. Frequencies between 1 to 10 MHz are mainly used for the purpose of diagnostic ultrasound (Goddard, 1995). A sound wave travels in a pulse and when it is reflected back it
becomes an echo it is this pulse echo principle which is used for the ultrasound imaging.

In small animal practice ultrasonography is largely used to scan visceral organs. The unique ability of ultrasound to image the internal structures of an abdominal organ makes it an indispensable diagnostic modality in scanning of various organs. The primary advantage of ultrasonography is that it can non-invasively scan the structure or architecture of the parenchymatous organs (Goddard, 1995).

Abdominal ultrasound is usually performed as a complementary technique to radiography. The combination of both imaging modalities results in more information as to size, shape, and position of an organ. The ultrasound provides accurate information on the outline and architecture of tissues.

Ultrasonography can be performed anywhere on the abdominal wall; the only impediment being bone and gas filled structures (Kealy and McAllister, 2000). Ultrasonography is used to study the normal as well as altered (pathological) structures of kidney, ureter and bladder (Biller et al, 1990; Leveille et al, 1992; Nyland et al, 1995), liver and gall bladder (Bhadwal et al, 1999) and reproductive organs (England, 1998).

Every organ has a distinct normal ultrasonographic appearance called as echotexture. Any alteration from this normal echotexture is diagnosed as a diseased condition. However, presence of gas makes scanning of gastrointestinal tract difficult although normal
ultrasonographic appearance of stomach, small and large intestine has been established in cats (Newell et al, 1999). Ultrasonography also helps in obtaining biopsy of different organs like liver, spleen and kidneys to reach a definitive diagnosis of pathological conditions (Ryke et al, 1999).

Many diseases can be diagnosed easily by ultrasonographic procedures. Anurea is very common in dogs and to find out a definitive cause an ultrasonographic examination is helpful as it can scan both the kidneys, ureter, urinary bladder and calculi (Saini and Singh, 2002). Also other diseased condition of these organs can be identified. Similarly, an abdominal mass can usually be identified on a plain radiograph but these masses are frequently marked by intra-abdominal fluid. In contrast, during ultrasonographic examination presence of intra-abdominal fluid assists in examination as it provides an acoustic window through which organs or masses appear more echogenic and their boundaries or outline is more clearly visible (Kealy and McAllister, 2000).

Besides the scanning of visceral organs ultrasonography is also used to scan external organs like mammary glands and testes.

Although literature on ultrasonography in small animals is available but it is scarce and not much systematic study of the abdominal organs-ultrasonographically is reported.

A number of factors can be cited to recommend ultrasound as the initial step for abdominal imaging. This can become even more
significant if serial studies are done to monitor progression or resolution of disease.

In view of the encouraging results with ultrasound and paucity of work in India on the role of ultrasound in the diagnosis of abdominal organs of dogs, the present study is being undertaken to evaluate the usefulness and accuracy of sonographic technique in diagnosis of abdominal organs with following objectives.

1. To carry out abdominal ultrasonography in clinical cases of dogs as and when presented during this period for a possible diagnosis related to the canine abdomen.

2. To carry out the abdominal sonography in dogs undergoing sterilization in animal birth control programme in order to identify the pathological tissue or organs during survey ultrasonography of canine abdomen.
Nyland and Gillett (1982) evaluated sonographically the bile duct in the dog after experimental ligation. The common bile duct was surgically ligated in five normal adult dogs. Ultrasonographic examinations of the gallbladder and biliary system were performed after duct system ligation at intervals of 24 hours. The sequence of biliary system dilation was from the common duct to the peripheral intrahepatic ducts. Common duct enlargement was evident in 24-48 hours, while peripheral biliary duct dilation was recognized by 5-7 days after obstruction. When compared with hepatic and portal veins, dilated biliary ducts were more tortuous and had irregular branching patterns. Gross pathological changes were correlated with ultrasonographic findings at 7, 14, 15, 18 and 21 days after obstruction.

Cartee and Rowles (1983) evaluated the canine prostate by ultrasonography. Trans-abdominal ultrasonography of the prostate gland was carried out in eight normal dogs and four dogs with prostatomegaly. To determine the accuracy of the technique, results were compared with clinical, surgical, post-mortem and histopathological findings. All dogs were scanned in dorsal recumbency with moderately full urinary bladder to facilitate ultrasonographic examination by pulling the prostate closer to the edge of the pelvic inlet. It was found that measurement by ultrasonography was a useful technique but the results should be considered in conjunction with other findings. Architectural observation of the prostate during scanning enabled differentiation to be made between cystic and solid enlargements, this being a valuable diagnostic procedure in prostatomegaly. However, the technique did not produce definitive distinction between neoplastic and benign hyperplasia in cases of solid prostatic enlargement and it was recommended that other methods should be employed to assist diagnosis.
Nyland et al (1983) described the ultrasonic features of experimentally induced acute pancreatitis in the dogs. Acute, necrotizing pancreatitis was produced in the three dogs by injection of oleic acid into the accessory pancreatic duct. The ultrasonic features of acute pancreatitis were compared with radiography and gross pathology. They concluded that ultrasonography was very useful for the detection and characterization of experimental pancreatitis. The results must be carefully compared with the ultrasonic abnormalities found in naturally acute canine pancreatitis before the usefulness of pancreatic sonography can be determined for this disease in the dog.

Cartee and Rowles (1984) described pregnancy diagnosis and fetal development in the dog by ultrasonography. Eighteen bitches were examined by ultrasound during pregnancy. At day 7 of gestation, uterine enlargements indicative of possible pregnancy was observed. At day 10, the embryo was observed. Fetal and cardiac activities appeared in 28 days. Rapid increases of the crown-rump length and imparietal diameter occurred between the 5th and the 6th weeks of gestation and of the body diameter between the 4th and 5th weeks and again between the 6th and 7th weeks.

Feeney et al (1984) reported the assessment of hepatic and splenic neoplasia in the dog and cat by ultrasonography. An analysis was made of 17 cases of microscopically proven hepatic and splenic neoplasms, with the objective of describing the ultrasonographic findings and determining how interpretation of these findings contributed to diagnosis and prognosis. The ultrasonographic appearance ranged from focal, large (6 to 20 cm diameter) mixed hyperechoic/hypoechoic masses to multifocal (0.5 to 2.0 cm diameter) hypoechoic masses. The ultrasonographic appearance was not specific for the microscopic cell-type of the neoplasm. When the combined clinical, haematological, serurm chemical and ultrasonographic findings were interpreted, neoplasia was
always the primary consideration, but microscopic confirmation was mandatory. The use of ultrasonography in these cases were: (1) to characterize the internal architecture of a mass identified radiographically, (2) to confirm the organ of origin of the mass, (3) to define the extent of disease in or around an affected organ, (4) to evaluate palpable abdominal mass(es) in the presence of poor abdominal radiographic contrast, and (5) to identify previously undetected or unsuspected metastases. Three interpretive errors were found, but only one would have influenced the prognosis for that specific patient.

Kaemmerer (1984) described the current status of ultrasonic scanning in the diagnosis of liver diseases and diseases of other internal organs of dogs and cats, and to a limited extent pigs.

Konde et al (1984) examined the kidneys of 12 healthy dog: by radiography and by ultrasound during normal hydration and during diuresis induced with furosemide (2 mg/kg Urn). The dogs were killed to compare the anatomy of the kidneys with the ultrasound images. The renal cortex, medulla, pelvic diverticulum, intra-renal vessels, renal pelvis and renal sinus fat were identified in sonography. Kidney enlargement during, diuresis was caused by an increase in the size of the renal medulla.

Katilainen et al (1987) conducted ultrasonic pregnancy, testing in sheep. Real-time ultrasonic scanning was used in pregnancy, testing of 76 ewes, 25-116 days after mating. All ewes with a positive pregnancy diagnosis lambed, but 8 out of 11 negative pregnancy diagnoses turned out to be wrong. The incorrect diagnoses were in ewe: with gestation lengths of < 40 days. Prediction of fetal numbers was 72% accurate. The most practical method was to examine ewes standing without shaving. Cooking oil or mineral oil was preferred as a contact gel between the probe and the skin.
Kleemann et al (1987) ultrasonographically studied the ovine fetal growth under field conditions. Six single-bearing and 2 twin-bearing 6-8 year old strong wool Merino ewes were scanned -6n the day before slaughter, the 3.6 MHz transducer was positioned cross-sectionally under the fetal thorax, immediately posterior to they heart. Means and measurements in utero and at slaughter, and their relationships to fetal weight, are tabulated. Actual head width and thoracic depth and girth were of similar predictive value for fetal weight estimation. In utero, thoracic depth was the most precise measurement. A comparison of the mean values showed that accuracy of in utero measurement was greatest for head, width and least for thoracic depth.

Komarek et al (1987) performed sonography in small animal: and reported that sonography of the liver and bile ducts, spleen and urogenital system gives information about the size of the organ, the outline and the echo structure of the parenchyma and contents of the organ.

Mulley et al (1987) diagnosed pregnancy in fallow deer b) ultrasonography. Using ultrasound equipment (a real-time mechanical sector scanner with a 3.5 mHz transducer), 52 fallow does (Daa dama) with known mating dates, were each examined on 1-3 occasions for pregnancy. Eight fallow does with a history of reproductive failure were( also examined. The deer were caught in a darkened room, blind-folded an( held upright to allow positioning of the ultrasound probe anterior to the( udder on the ventral surface of the abdomen. Scanning was complete( within 60 seconds of restraining the animal. Pregnancy was easily detected in does greater than 50 days gestation. The foetus was clearly visible ani fetal movement was common. At 105 days various sections of fete anatomy and placentomes were recognized. All 54 does that wen considered pregnant by ultrasound subsequently fawned; the remaining i failed to fawn.
Walter et al (1987) analysed by ultrasonography in 32 dogs with proven renal parenchymal disease. Ultrasonography provided additional information on internal renal architecture in 18 dogs with radiographic evidence of structural abnormality. Ultrasonography determined the renal origin of 2 abdominal masses, defined the extent and distribution of neoplastic disease in 6 dogs, and identified kidneys not seen on survey radiographs or excretory urograms in 5 dogs because of decreased abdominal contrast or poor function. The ultrasonographic patterns were most specific for focal and multifocal or diffuse neoplasia. Ultrasonographic findings were least specific for diffuse parenchymal disease without architectural disruption such as glomerulo/interstitial nephritis, renal tubular necrosis, and nephrocalcinosis. In these cases, biopsy was recommended. Six interpretive errors were made. Four of these errors were related to the overestimation of renal pelvic and diverticular size because of confusion with medullary papilla. Two errors occurred in the diagnosis of renal lymphosarcoma, one of which was interpreted to be pyelonephritis. The other was an interpretive dilemma because of absence of hypoechoic multifocal nodules. Renal tubular necrosis was confirmed in this case.

Fluckiger et al (1988) compared abdominal palpation and ultrasonography for early pregnancy diagnosis in the bitch. Thirty bitches (16 pregnant and 14 nonpregnant) were screened for early pregnancy diagnosis using ultrasonography. The results were compared with those of abdominal palpation. Using ultrasonography correct diagnosis was possible in all 16 pregnant bitches. Using abdominal palpation only 6 out of 16 pregnant bitches were identified correctly within 25 days.

Gerwing (1988) used a contrast medium for improving ultrasonographic appearance of abdominal organs in dogs. Sonography for abdominal examination was used in 7 healthy dogs of different breeds and in 5 dogs with pathological abdominal conditions. Prior to examination 300
to 2500 ml of saline were instilled into the peritoneal cavity of the dogs under sedation. The technique improved the clarity and contrast of the ultrasonic pictures of the liver, spleen and left kidney but not of the prostate, urinary bladder and the right kidney. In 5 dogs with pathological conditions, the new method gave a clearly delineated ultrasonic picture of neoplastic lesions in the livers and spleens.

Godshalk et al (1988) performed static and real-time B-mode hepatic ultrasound imaging on 16 anaesthetized dogs (7.7-29 kg). Sagittal static B-mode scans were acquired at 1-cm intervals, and transverse scans were made with both static and real-time units. Measurements were made from the surface of the liver to the diaphragm and were tested individually and when added or multiplied together for significant correlation with lives and body weight. Only one of the static B-mode measurements had a significant correlation, and none of the real-time measurements were dependent on liver weight. Ultrasonographic assessment of canine lives size using these methods was of little value in predicting actual live weight.

Nautrup et al (1988) reported two-dimensional echocardiograph of non-anaesthetized, healthy dogs and cats. Long-axis and short-axis, images of the left heart are the main features. The mitral valve is recorded closed, open, and half open. The aorta is shown, including the arcus aortae. Cats tend to resent being examined using a contact gel and respond with an increased beat frequency of the relatively small hear which lies not very deep in the thorax, with the result that assessment of mitral valves as well as contraction competence of the left ventricle are only readily achieved by playing back a video recording of the movements. This problem does not arise with dogs.

Poffenbarger et al (1988) evaluated ultrasonography for diagnosis of adrenal neoplasia. A retrospective analysis was made of the
case records of 6 dogs with histologically confirmed adrenal neoplasia, with the objective of describing the radiographic and ultrasonographic findings and comparing them with the morphological findings at laparotomy or postmortem. One adrenal mass was not seen by survey radiography, whereas the masses were found in the remaining 5 dogs. The sizes of the masses were underestimated in those cases, however. All 6 neoplasms were detected ultrasonographically, and the sizes of the tumors were accurately determined. The tumors varied from hypoechoic to hyperechoic, and there was no consistent pattern of echogenecity. Caudal vena cava compression was seen ultrasonographically in 1 dog. Hepatic metastases were detected ultrasonographically in 2 dogs.

Schelling et al. (1988) reported ultrasonographic findings of splenic infarction and necrosis in three dogs. Two previously unreported ultrasonographic patterns were identified, focal, hypoechoic or isoechoic, circular, well-marginated nodular masses with peripheral lesions causing deformation of the splenic margin, and diffuse hypoechoic or heteroechoid coarse/"lacy" parenchymal pattern with no deformation of margin. The presence of gas within the splenic parenchyma of one dog was detected by both radiography and ultrasonography. Ultrasonographic patterns of splenic infarction in both man and dog are discussed.

Wrigley et al. (1988) reviewed the ultrasonographic appearance of the spleen and adjacent organs in 12 dogs with splenic lymphosarcoma. Poorly marginated hypoechoic to anechoic nodules (4 mm to 3 cm in diameter) were found in all dogs. The anechoic nodules did no result in reflective shadowing or acoustic enhancement of the underlying tissues. The remainder of the splenic parenchyma appeared relatively hypoechoic when compared with the liver or renal cortices in 9 dogs. Recognition of this ultrasonographic pattern appears to be a useful diagnostic tool. Needle aspiration guided ultrasonographically will then enable histological confirmation of lymphosarcoma.
Barr et al (1989) described the ultrasonographic changes in the kidneys of three dogs with hypocalcaemia nephropathy and compared them with the changes described in the same human condition. All three dogs had increased renal cortical echogenicity as compared to echogenicity of the hepatic parenchyma and a distinct echogenic line at the corticomedullary junction. It was suggested that ultrasound could be a useful technique for evaluation of the severity of renal damages and the potential return of renal function in such instances.

Eilts et al (1989) described ultrasonographic evaluation of induced testicular lesions in male goats. To study testicular ultrasonographic features, unilateral testicular artery ligation was performed in 12 bucks to induce predictable ischaemic necrosis of the testis. Both scrotal testes were scanned subsequently on days 1, 3, 5, 7, 15 and 30. On each of the designated days, 2 bucks each were castrated and the incised testes were rescanned outside the scrotum before gross and histological examinations. In each buck, the testis without the ligated artery served as a control. Gross and histopathological findings in the testis were compared with ultrasonographic observations. As the study progressed from day 0 to day 15, visually and microscopically, the testis involved in the testicular necrosis shows thickening of the testicular capsule. On day 30, the affected testis had granulation tissue in the area that previously had been necrotic. Ultrasonographically, the testicular changes were consistent with the gross and histopathological findings. There were areas of decreased echogenicity that corresponded in the necrotic areas and foci of high echogenicity that corresponded to areas of tubular mineralization. On day 30, the granulation tissue was difficult to differentiate ultrasonographically from normal testicular parenchyma. On day 3 hydrocele was seen ultrasonographically in several bucks. The excellent association between ultrasonographical findings and gross and histological changes suggested that testicular ultrasonography might be a valuable diagnostic tool for assessing disease in domestic animals.
England and Allen (1989) reported the ultrasonographic and histological appearance of canine ovaries. Ultrasound images of canine ovaries obtained in vivo and in vitro were compared and correlated with histological findings. In vivo imaging of the left ovary was performed in 5 bitches, examined in the standing position at various stages of the oestrous cycle using a 7.5 mHz real time linear array transducer. Ovaries collected at laparotomy or necropsy from 3 bitches in oestrus, 4 in early metoestrus and 4 in anoestrus were immersed in a water bath and then fixed in formalin before histological sections were made and stained. Follicles varying between 7 and 11 mm in diameter were identified in all oestrous bitches by ultrasound. The in vitro appearance of each ovary was similar to that in vivo, but clearer. Histologically the ovaries were typical of oestrus. Preovulatory and postovulatory follicles were grossly and ultrasonographically similar. In the metoestrous bitches follicle wall gradually thickened and the shape of the cavity became irregular. Corpora lutea still had small central anechoic regions, confirmed histologically as luteal tissue surrounding a central antrum. Follicle collapse was not seen in any of the bitches. In anoestrus, ovarian tissue could not be reliably detected. In vivo and in vitro the ovaries were relatively hypoechoic with small focal anechoic regions which probably represented the small follicles found histologically.

Gerwing (1989) described the sonographic appearance of various diseases of the prostate and spleen of the dog. The prostate gland of 214 dogs and spleen of 329 dogs were examined by using an ultrasonic scanner having a dynamic range of 55 dB and two types of transducer (3.5 and 5 mHz). The sonographic appearance of various diseases of the prostate and spleen was described. For induction of hydroperitoneum 300 to 2000 ml of normal saline was introduced into the peritoneal cavity. Cysts were present in the prostate of 36% of the dogs.
Henley et al. (1989) compared two dimensional ultrasonography and radiography for detection of small amounts of free peritoneal fluid in the dog. Ultrasound examinations and radiographs were performed after increments (1 ml/lb body weight) of fluid were injected intraperitoneally. Ultrasonography detected fluid in one animal at 2 ml/lb. All other animals had fluid detected at 3 ml/lb. With radiographs, fluid could be detected with a high degree of accuracy at 4 ml/lb. All other animals had fluid detected with a high degree of accuracy at 4 ml/lb. The lateral view was more accurate than the ventrodorsal view in detecting fluid. The authors concluded that ultrasonography is more sensitive than radiography and is the method of choice to detect small amounts of free peritoneal fluid.

Konde et al. (1989) reported the clinical, radiographical and sonographical signs in three dogs with splenic torsion. All dogs exhibited weight loss, anorexia, and lethargy. Splenomegaly was a consistent radiographical finding in two dogs and a large ill-defined midabdominal mass was seen in one dog. The spleen was easily imaged sonographically in all dogs. Splenic sonography in two dogs showed a diffuse, hypoechoic pattern consistent with splenic congestion. Hilar splenic vessels were enlarged on the sonograms of two dogs.

Miles (1989) reviewed the image production including emission and reception of ultrasound, acoustic impedance and attenuation, image resolution, time gain compensation and image artifacts display modes (A-, M, and B-mode); techniques image interpretation clinical applications for ultrasonically guided biopsy; echocardiography contrast echocardiography; Doppler techniques; evaluation of the liver and diaphragm, renal examination; imaging the prostate, pregnancy diagnosis and ocular ultrasonography.
Nyland et al (1989) evaluated the ultrasonic determination of kidney volume in the dog: Canine kidney measurements were obtained in vivo using ultrasound before and after anaesthesia and were compared with excision, the kidney dimensions were also measured ultrasonically in a water bath and the results were used to calculate kidney volume by a modified parallel planimetric method and three variations of a prolate ellipsoid method. The calculated volume was compared with actual kidney volume determined by volume displacement. All methods underestimated actual volume so that a linear correction of ultrasonically calculated volume was required to predict actual volume. The modified parallel planimetric method and a prolate ellipsoid method using height and width determinations cranial and caudal to the renal pelvis were the best models. The prolate ellipsoid model was chosen for subsequent kidney volume calculation of kidney volume using ultrasound was sufficiently accurate to be clinically useful, particularly when serially evaluating kidney size changes in the same dog.

Stowater and Lamb (1989) described the ultrasonographic features of paraprostatic cysts in nine dogs along with historical, clinical surgical and pathological findings. Cysts occurred predominantly in older larger breed dogs (mean age 8 years, range 3-11 years). The most common presenting complaints were depression, inappetance, stranguria, tenesmus and bloody penile discharge. A palpable abdominal mass was the most common physical finding. Ultrasonographically, paraprostatic cysts were usually larger anechoic structures; many contained internal septa. Moderately large anechoic cavities or cysts were also detected in the prestatic parenchyma of five dogs, and two of these communication; with the paraprostatic cysts were visualised. There were no clearly distinct ultrasonographic criteria to discriminate septic from nonseptic paraprostatic cysts.
Yeager and Anderson (1989) studied the association between histologic features and echogenicity of architecturally normal cat kidneys. Thirty-eight grossly and histologically normal cat kidneys were examined using ultrasound. The echogenicity of the renal cortex was subjectively evaluated by scoring it as largely or not largely different from the echogenicity of the renal medulla and is similar or not similar to the echogenicity of the renal sinus. The presence or absence of a medullary hyperechoic band was determined. The length, width, and height of each kidney were measured. Haematoxylin and eosin-stained secretions of each kidney were examined microscopically. The amount of fat vacuoles in the tubular epithelium of the renal cortex was scored as plentiful or not plentiful. The presence or absence of a medullary band of mineral deposits within the lumina of renal vacuoles in renal cortex was associated positively with a large difference in echogenicity of cortex and sinus. The presence of a medullary hyperechoic band was associated positively with a band of mineral deposits within medullary tubular lumen. Kidneys with a large difference in echogenicity between cortex and medulla and kidneys with a plentiful amount of vacuoles were not significantly different in size. These groups were larger in length, width, and height than were kidneys without a large difference in echogenicity between cortex and medulla and kidneys that did not have plentiful cortical fat vacuoles.

Barr (1990) evaluated the use of ultrasound as a method of measuring renal size in the dog. The reproducibility and accuracy of ultrasonographic measurement of linear renal parameters in the dog were determined. Thus determined that renal length, width and depth could all measure with a high degree of reproducibility, assuming a renal scanning technique. These measurements were an accumulation reflecting the true dimensions of the kidney, although there was a tendency for renal length to be underestimated. A true method of renal volumetric was then evaluated assuming the kidney approaches the shape of an ellipsoid. This technique was quick and simple to perform. The volume estimated in the way prove(17}
to be a good indicator of the true renal volume although the estimated volume tended to be lower than the true volume measured by water displacement.

Barr et al (1990) imaged ultrasonographically both kidneys of 100 normal adult dogs. Small but significant differences were found in the dimensions of the left and right kidneys and in renal dimensions of male and female dogs of similar body weight. There was a statistically significant correlation between renal length and body weight. The relationship between renal length and body weight was linear except at very low or very high bodyweights. There was also a statistically significant correlation between renal volume and body weight, and the relationship remained linear even at extremes of body weight. Graphs could therefore be constructed for renal length/body weight and renal volume/body weight with 95% confidence limits.

Cartee et al (1990) evaluated drug induced prostatic involutions in dogs by ultrasonography. The relative anti-androgen-induced prostate involution activity of the newly synthesized hydroxyflutamide prodrug was compared with that of flutamide in 25 Beagles. Secondary anti-androgen activity of both drugs on the testes and mammary tissue was investigated. Daily oral administration of both compounds at 2 dosage, (i.e. 2.5 and 5.0 mg/kg body weight) during a 7 week period was monitored by Transabdominal ultrasonography of the prostate twice week (4 sonograms presented). Cross-sectional area estimates of the prostate gland calculated from oblique dorsoventral, and transverse sonographic measurements were diminished significantly in some of the treated dogs as early as day 14 of drug administration. All treated dog had significant differences in reduction by day 47. Involution was related directly to dose, but no difference was observed between test compounds. Differences in secondary antiandrogen activity were not remarkable. It was concluded that ultrasonography can be a highly effective means of
monitoring prostate size, and of monitoring drug-induced involution over time.

According to Lamb (1990), hepatic nodular hyperplasia is a benign, usually clinically inapparent, proliferative lesion commonly found al PM in older dogs. Three examples of hepatic nodular hyperplasia are described in dogs with clinical signs compatible with hepatic disease it which ultrasonography detected a variety of echotextural changes in the liver similar to those reported in primary or secondary hepatic neoplasia. In subsequent in vitro ultrasonographic studies of hepatic nodular hyperplasia lesions detected PM in dogs without clinical signs of hepatic disease, only subtle echotextural changes were seen. Hence, hepatic nodular hyperplasia may be inapparent in vivo in many dogs. Hepatic nodular hyperplasia is a potentially confusing occasional finding which must be considered when examining dogs with clinical signs of hepatic disease. The diagnosis of hepatic neoplasia should not be made on the basis of ultrasonographic findings alone.

Lamb (1990) reviewed abdominal ultrasonography in small animals and described the indications, examination technique and interpretation of abnormal findings in clinical cases.

Nyland and Fisher (1990) measured the portal blood flow with duplex doppler ultrasound in 10 normal dogs; and in 10 dogs, 4 weeks after hepatic cirrhosis were induced by common bile duct ligation. Mean portal blood flow velocity in the 10 dogs with experimental hepatic cirrhosis was markedly reduced (9.2 ± 1.70 cm/sec vs. normal 18.1 ± 7.6 cm/sec) Mean portal blood flow was also decreased compared to normal 17.2 ± 4.1 cc/min/kg versus normal 31.06 ± 9.1 cc/min/kg) while portal vein diameter remained unchanged. The dogs with induced hepatic cirrhosis developed extensive extrahepatic portosystemic shunting that was confirmed at postmortem examination. It was concluded that decreased portal velocity!
and portal flow, which resulted from hepatic cirrhosis was detectable non invasively with Doppler ultrasound.

Penninck et al (1990) reviewed the sonographic findings of 18 dogs and 4 cats with gastrointestinal (GI) diseases. Wall thickness, wall layer identification, wall symmetry, extension of the lesion, nature of the GI contents, motility and regional and/or systemic involvement were recorded for each animal. Ultrasonographic appearance of gastrointestinal neoplasms, gastrointestinal obstruction, ileus, intussusception, inflammatory GI diseases, and congenital disorders were described.

Pugh et al (1990) described the ultrasonic appearance of normal testes in the dog. The testes of 10 dogs presented for routine castration were imaged with real time ultrasound. A scanning technique using multiple imaging planes (sagittal, transverse, and dorsal planes) was developed to image the testes and epididymis. The testes were characterized by a coarse medium echo pattern. The mediastinum testis was consistently seen as a 0.2 cm wide linear hyperechoic structure in the central long axis of the testis. The ability to identify the appearance of the epididymis were variable. The tail was consistently seen as an anechoic to hypoechoic structure. Ultrasound images were compared for anatomical structure with frozen gross sections. Ultrasonic and gross measurement$ were made and analysed. Individual gross and ultrasonic measurement; compared favourably. Linear regression coefficients between body surface area versus testicular length and diameter were 0.73 and 0.58 respectively. A Wilcoxin signed rank test for similarity $p = 0.33$ value was found when comparing the right to the left testicle.

Spaulding et al (1990) diagnosed by sonography, enteric duplication in two dogs. Both dogs had characteristic sonographic, gross and histopathological patterns described for enteric duplication in man. Three adjoining cysts that communicated and shared a common wall with
the ileum were present in the first dog. Ectopic gastric mucosa was present in the single cyst that shared a common wall with the jejunum in the second dog. Other abdominal cystic masses may mimic the gross appearance of the duplication cyst and may result in a misdiagnosis of the underlying aetiology. Sonographic findings were characteristic for duplication cysts and are the preferred primary diagnostic modality, however, histopathology is warranted to confirm the diagnosis.

Voorhout (1990) examined adrenal glands of healthy dogs by X-ray, computed tomography (C.T.), nephrotomography, and ultrasonography in all 10 dogs, CT enables visualization of both adrenal glands. Cross-sectional diameter was measured accurately. The size and shape of CT sections of the adrenal glands varied widely because of individual differences in the actual size and shape of the CT scans. In dog, nephrotomograph enabled visualization of one or both adrenal glands as oblong craniocaudal-directed densities in the craniodorsal portion of the abdomen. In 7 dog, transverse ultrasonography enabled visualization of one or both adrenal glands as round or oval hypoechoic structures in the surrounding hyperechoic fat.

Voros (1990) described the technique of the ultrasonic examination, as well as examination method of the heart, liver, spleen and kidneys of dogs and cats. Normal ultrasonographic findings of those organs were demonstrated and the pathological disorders were illustrated by an example of each. Ultrasonographic diagnosis of pyometra was described, based on differential diagnostic aspects.

Wood and McCarthy (1990) described the ultrasonographic and anatomic observations of the kidneys of the dogs. The anatomic studies established precise correlations between the gross anatomic features of the organ and its ultrasonographic images obtained in transverse, sagittal, dorsal and 2 oblique planes. Uniformly mottled
echogenicity of the renal cortex could be cleanly differentiated from the less echogenic renal medulla. In the mid-dorsal plane, the papillae of the renal pyramids were directed towards the renal sinus. The bases of the pyramids were almost circular in outline in the mid-sagittal images and the renal crest was seen as an echogenic line. Although the renal sinus was highly echogenic, neither the renal pelvis nor its recesses were detected. The walls of each of the interlobar arteries provided echogenic parallel lines, passing in the renal recesses between the renal pyramids. Arcuate arteries were demonstrated at the corticomedullary junction and interlobular arteries were detected within the renal cortex. For the right kidney, transverse images were obtained with the ultrasonographic transducer at the last 2 inter-costal spaces; images in the dorsal, sagittal, and oblique planes were obtained with the transducer placed over the caudal extremity of the kidney. In the left kidney, transverse images were made with the transducer at, and caudal to, the last intercostals space; images in the dorsal, sagittal and oblique planes were obtained with the transducers placed over the lateral border of the kidney. The use of such a protocol ensures that the entire organ is inspected and a diagnosis of either a normal or pathological kidney is made.

Wood et al (1990) described the anatomic correlation and imaging protocol for ultrasonography of the spleen in dogs. Sonographic and/or anatomical observations were made of the spleen in 27 dogs. Anatomical studies were used to establish precise correlations between the gross anatomical features of dogs, ultrasonographic images of the spleen were made in dorsal, transverse and sagittal planes. When it was incident to the ultrasonic beam, the splenic capsule was represented by fine echogenic line that defined the boundaries of the organ. The splenic substances had a uniformly mottled echogenicity apart from the anechoic lumen of the splenic venous rami, which were detected at and near the hilus of the spleen. Less regularly, splenic arterial rami were detected at the hilus, but not within the splenic substance. Dorsal and transverse
images were made face directed cranially, placed parallel to the left lateral abdominal wall, and pushed under the costal arch. The adoption of such an ultrasonographic imaging protocol ensures that all of the spleen is inspected. A definite opinion can then be given as to whether the spleen is normal or abnormal. Pathological changes in the spleen must also be differentiated from changes in adjacent organs or structures.

Yeager and Concannon (1990) described the postpartum changes in uterine shape, architecture, echogenicity and diameter during the serial examinations of five Beagle bitches. During the first week after parturition, the uterine horns were tubular structures composed of multiple layers of various echogenicity and had multiple, discrete enlargements with hypoechoic centres at placental sites. Diameters ranged from 1.1 to 3.8 cm at placental site enlargements, and 0.5 to 1.4 cm between enlargements. Uterine involution appeared to be completed by 15 weeks postpartum. At 15 weeks the uterine horns of each dog were uniform hypoechoic, tubular structures without enlargements and had a reduced diameter of 0.3 to 0.6 cm. The ultrasonographic findings were similar to previously reported gross and light microscopic descriptions of canine uterine involution.

England (1991) examined the ultrasonographic appearance of the dog testis and epididymis in vivo and in vitro. The relationship between specific testicular and epididymal dimensions was studied in normal animals. Assessment of testicular volume using ultrasound compare favourably to the volume calculated by water displacement. The correlation between testicular volume, epididymal cross-sectional area and semen parameters was however, poor. Changes in the normal testicular architecture were identified in a variety of pathological conditions including testicular cysts and neoplasia.

Gall bladder emptying studies using ultrasonography were performed on 10 normal dogs, one normal control dog, 3 dogs with biliary
obstruction and 3 dogs with nonobstructive hepatobiliary disease (Fin et al., 1991): An i.v. bolus of a synthetic cholecystokinin (sincalide) was used to induce emptying. The normal canine gall bladder emptied at least 40% of its volume within one hour of synthetic cholecystokinin (0.04 mg/kg) administration. Maximum response was seen within 5 to 20 minutes. The gall bladder in icteric dogs with nonobstructive hepatobiliary disease (1 cholecystitis, 1 cholangitis, 1 cholangiohepatitis) also empties at least 40% of its volume within one hour. A difference in the maximum percent gall bladder emptying was found between the dogs with biliary obstruction and nonobstructed, icteric dogs. No side effects were observed.

Hinrichs K (1991) summarized the results from use of ultrasonography for diagnosis of granulosa cell tumors, ovarian haematomas, anovulatory follicles and atypical follicular size and shape. On ultrasound examination pen rectum, granulosa cell tumors were variably appearance, being multicystic, solid, or unilocular. Ultrasonography was valuable in determining that the structure of the enlarged ovary was abnormal, and also that the contralateral ovary was small and without significant follicular activity. A serous cyst-adenoma resembled the ovary of a mare in early pregnancy. Ovarian hematomas were similar in appearance to some granulosa cell tumors, and these could not be differentiated ultrasonographically on a single examination. Ultrasonography was valuable in monitoring ovarian hematomas over time to define changes in size and density. An ovulatory follicles varied in their echogenicity and in the rate of decrease in size over time. Changes in follicular shape were common prior to ovulation and did not indicate an abnormality.

Johnston et al. (1991a) described the ultrasonographic features of testicular neoplasia in dogs. For 16 dogs with testicular neoplasia (19 tumors), ultrasonography was performed to determine whether a correlation exists between ultrasonographic features of testicular
tumors and cell type. The echogenicity of the tumors varied depending on the size of the tumor and whether the tumor had focal or diffuse distribution within the testis. The ultrasonographic characteristics of Sertoli cell tumors were variable, with no predominant pattern. This variation may be related to tumor size, because of 6 of 7 Sertoli cell tumors were > 5 cm in diameter. Focal seminomas and interstitial cell tumors <3 cm in diameter had hypoechoic texture. Focal seminomas and interstitial cell tumors > 3 cm in diameter had mixed echogenicity. Tumors of multiple cell types were > 5 cm in diameter and had mixed echogenicity. It is concluded that in valuable breeding dogs with a small (< 3 cm) focal intra-scrotal lesion, testicular ultrasonography would be of benefit for localization of the mass to the testis or epididymis for subsequent biopsy. In dogs with intra-abdominal neoplastic testes, ultrasonography may be of benefit in determining intra-abdominal metastases and invasion of contiguous structures.

Voros et al (1991) analysed findings of hepatic ultrasonography in 22 dogs with liver disease and compared with the results of final morphological diagnoses. Ultrasonographic appearance of the liver demonstrated focal alterations in 11 dogs (50 per cent); multifocal lesions in hepatic neoplasia (six), hepatic cirrhosis (one), generalized mycosis (one) and unifocal lesions in haemangiosarcoma (one), nodular hyperplasia (one) and misdiagnosed intestinal invagination (one). Diffuse ultrasonographic alterations were found in 11 dogs (50 per cent), hyperechoic liver of normal/enlarged size in lymphosarcoma (four) and hepatic lipidosis (two), hyperechoic 'bright' but small liver in atrophic cirrhosis (two), hypoechoic to normal intensity liver of normal size in lives dystrophy (two) and hepatic venous distension (one). Gall bladder abnormalities were detected in 14 of 20 dogs (70 per cent). Correct ultrasonographic diagnoses were made in 11 dogs (50 per cent). The best results were achieved by combining the clinico-laboratory and
ultrasonographic findings, providing a correct diagnosis in 17 dogs (77.3 per cent).

Aiumlamai et al (1992) examined seven Swedish peltssheep ewes weekly by transabdominal ultrasound scanning from 1.5 to 2 months gestation until parturition. By means of a simple regression analysis the heart rate, the biparietal diameter of the skull and the diameter of the body trunk were correlated with fetal age, and it was concluded that these measurements could be used to estimate the age of the fetus.

Biller et al (1992b) were of the view that ultrasonography can be an important adjunct in the evaluation of diffuse parenchymal hepatid disease. Diffuse liver disease appears ultrasonographically as a change in liver echogenicity from normal when compared with the renal cortex or spleen. Diffuse liver disease can be characterized as either hyperechoic due to fatty change, steroid hepatopathy, and cirrhosis or hypoechoic due to congestion, suppurative hepatitis, and lymphoma. Ultrasonographic diagnosis of diffuse liver disease should be substantiated by biopsy and histopathologic evaluation.

Biller et al (1992a) described an echogenic line in the outer zone of the renal medulla, paralleling the corticomedullary junction; described as the renal medullary rim sign. This renal ultrasonographic change was detected in 4 dogs and 2 cats with renal disease. The renal medullary rim sign provides additional ultrasonographic criteria indicating primary renal disease in some patients. However the renal medullary rim sign may prove to be a poor correlate for prognosis across the range of different clinical signs in these patients.

Braun et al (1992) determined the position, dimensions and structure of the kidneys, ureters, bladder and urethra of 62 female shear by use of ultrasonography. A 5.0 MHz convex transducer was placed over the right flank to examine the kidneys, and a 5.0 MHz-linear transducer
used to examine the bladder and urethra transrectally. All examinations were performed on sheep in a standing position. The left kidney was 7.1 to 8.9 cm long, 3.4 to 5.5 cm wide and 3.3 to 4.7 cm deep. Diameter of the parenchyma and renal sinus of the left kidney ranged between 1.1 and 1.9 cm, and 1.1 and 2.0 cm, respectively. Circumference of the medullary pyramids varied between 2.1 and 3.3 cm. Similar ultrasonographic measurements were obtained for the right kidney. The diameter of the bladder varied between 0.3 and 6.9 cm in 96.8% of the sheep. The diameter of the bladder could not be determined in 32% of the sheep because it was > 10 cm, and therefore, was beyond the penetration depth of the scanner. The only part of the urethra that could be seen using ultrasound was the internal urethral orifice. It had a diameter between 0.1 and 0.2 cm. The ureters could not be ultrasonographically seen in any of the sheep examined. It was concluded that the ultrasonographic findings described in this study can be used as references for diagnosis of morphological changes in the kidneys, bladder, and urethra of sheep.

Felkai et al (1992) used Ultrasonographic linear and area measurements on both kidneys of 15 clinically healthy dogs to calculate renal volumes by applying 3 prolate ellipsoid models. Ultrasonographic volumes were then compared using linear regression analysis with kidney volumes measured in vitro by water displacement. In vivo ultrasonographic volumes had a statistically significant relationship with the in vitro volume. The highest correlation was provided by the single lane area method. There was also a correlation between body weight and ultrasonographically detected changes in dogs with renal disease.

Grandy et al (1992) assessed the accuracy of the Doppler technique for indirect systolic blood pressure measurement in 1E anaesthetized cats. Eight cats were anaesthetized with isoflurane and 8 were anaesthetized with halothane. Anaesthetic depth and mode of ventilation were varied to obtain a wide range of arterial blood pressure. A
Doppler transducer was placed on the palmar surface of the left forelimb over the common digital branch of the radial artery to detect blood flow, and a blood pressure monitoring cuff with a width 37% of the limb circumference was placed half way between the elbow and the carpus. To enable direct arterial pressure measurements, the left femoral artery was catheterized and the blood pressure waveforms recorded simultaneously. Systolic blood pressure measured by use of the Doppler ultrasonic technique was significantly lower than that obtained from the femoral artery catheter. Using linear regression, a clinically useful calibration adjustment was determined for Doppler indirect blood pressure measurement in cats: femoral systolic pressure = Doppler systolic pressure + 14 mm of Hg.

Kahn et al (1992) performed transrectal and transcutaneous ultrasonography on 187 pregnant Merino ewes to measure diameter of the eye, cranium and trunk, rib width, crown-rump length and dimensions of the uterine lumen from the 26th day of gestation. The best measurements to estimate gestational age were trunk diameter, crown-rump length and eye diameter.

Kirberger et al (1992a) investigated the blood flow velocities and flow patterns in the normal dogs using pulsed wave spectral Doppler echocardiography in 8 areas of the heart. 21 Beagles and 29 German shepherd dogs were investigated, aged between 8 and 112 week and of both sexes, were used. The dogs were fully conscious and no drugs were used. The areas examined were the mitral valve, left atrium, tricuspid valve, right atrium, aorta, left ventricular outflow tract, pulmonary valve and the right ventricular outflow tract. The peak ad mean velocities, direction of flow and whether flow was systolic or diastolic was measured for each of these flow areas. Additionally each of these waveform were described. Aortic flow was also measured from the thoracic inlet by continuous wave Doppler.
Kirberger et al. (1992b) used Doppler echocardiography to determine blood flow velocities in the normal canine heart. The areas examined were the mitral valve, left atrium, tricuspid valve, right atrium, aortic valve, left ventricular outflow tract, pulmonic valve and right ventricular outflow tract. This study then statistically evaluated the effect of breed, age, sex, heart rate, mass and various interaction of these factors on the cardiac flow values determined. Mass and heart rate had the most significant effect on the various parameters with decreasing mass and increasing heart rates generally resulting in increasing peak and mean velocities. The pulmonary artery was statistically the flow area most susceptible to such effects. Compressions were made between pulsed and continuous wave Doppler for peak velocities over the 4 valve areas with only aortic flow as measured from the left caudal view, showing a significant difference between the two techniques. Mitral flow as compared to tricuspid flow showed a statistically significant difference between peak late diastolic velocities only. The ratio of early mitral diastolic flow to late mitral diastolic flow was always greater than one. Pulmonary flow showed a number of statistically significant differences when compared to aortic flow.

Leveille et al. (1992) compared imaging of transitional cell carcinoma of the urinary bladder in 15 dogs using intravenous urography, double-contrast cystography and ultrasonography. Intravenous urography detected filling defects in the urinary bladder in 3 of the 5 cases examined. Double-contrast cystography identified bladder masses in 8 of 10 animals. Ultrasonography was the only imaging technique which detected bladder masses in all patients.

Renton et al. (1992) monitored twenty bitches through pro-oestrus and oestrus using both circulating plasma hormone levels and ultrasonic examination of the ovaries. Using luteinising hormone (LH) as being the generally accepted optimum indicator of the day of ovulation,
comparisons were made of the accuracy of progesterone and ultrasound to identify ovulation. Progesterone agreed with LH in 12 of 20 bitches and was within 1 day in 7 of the other 8. Ultrasound was less accurate in that only 4 of the 16 estimates agreed, with a further 6 being within one day. However, if only the bitches which were examined by ultrasound with the latest equipment were included, while only 3 of 11 coincided, 6 of the remaining 8 were within one day of the LH estimated ovulation. It is concluded that, at present, of the rapid assessments, the measurement of plasma progesterone is a better estimator of ovulation than ultrasound.

Yeager and Mohammed (1992) studied the accuracy of ultrasonography in detection of feline hepatic lipidosis retrospectively (case from January 1984 to July 1990). The following ultrasonographic criteria were associated positively with severe hepatic lipidosis: the live hypoechoic, compared with falciform fat; the liver isoechoic or hyperechoic, compared with omental fat; poor visualization of intrahepatic vessel borders; and increased attenuation of sound by the liver. In a group of 36 cats with clinically apparent hepatobiliary disease and in which live biopsy was one, liver hyperechoic, compared with falciform fat, was the best criterion for diagnosis of severe hepatic lipidosis with 91% sensitivity 100% specificity, and 100% positive predictive value.

Eilts et al (1993) reported the ultrasonic measurement of canine testes. Thirty fresh carcasses of intact dogs of unknown health and breed were obtained. Total scrotum width was measured with a caliper and the length, width and height of each testis (excluding the epididymis in the scrotum) were measured by ultrasonography. The testes were removed from the scrotum and weighed, excluding the epididymis. Regression models were fitted to predict total testes weight from ultrasonographic measurements (model 1), all testis measurements (mode 2), total scrotum width (model 3), and body weight (model 4); stepwise multiple regression models (models 5 and 6) were fitted using external
testis measurements. Models 1, 2, 3, 4 and 6 yielded $r^2$ values of 90, 0.94, 0.88, 0.48 and 0.95, respectively. Model 5, which used all measurements from the left testis, yielded an $r^2$ of 0.90; additional accuracy achieved by using testis height was low.

Finn-Bodner et al (1993) examined twelve resected canine gallbladders (in vitro) and the gallbladder in each of 14 dogs (in vivo) were examined ultrasonographically. Gallbladder volume was calculated from ultrasonographically measured geometric dimensions, using 4 volumetric model formulas: cone, ellipse, biplanar ellipse, and rotate ellipse. Calculated volume was compared with true gallbladder volume, a; measured by water displacement. All examined models for calculation of gallbladder volume were closely associated with true gallbladder volume and all models provided accurate predictions of true gallbladder volume. Calculated volumes could be corrected mathematically by use of the regression coefficient and constant for each model. Body weight was no significantly associated with gallbladder volume in any of the model considered. It was concluded that use of ultrasonography to accurately measure gallbladder volume could be combined with synthetic cholecystokinin-stimulated gallbladder emptying to provide information about biliary function and patency in icteric animals. Such information could aid the clinical decision between surgical or medical treatment. Correction of calculated volumes would not be necessary in association with induced emptying studies, because volume change is more important than absolute volume.

Gilger et al (1993) used ultrasonic pachymetry to measure central, superior peripheral, and temporal peripheral corneal thickness in 35 cats (70 eyes) with normal corneas, anterior chambers, and intraocular pressures. Mean central corneal thickness for both eyes in 3 locations for 35 cats was $578 \pm 64$ µm. Significant differences did not exist between central and peripheral corneal thickness. Corneal thickness increase
significantly with age up to 100 months. There was no significant difference in corneal thickness with regard to sex of the cats when adjusted for age.

Leveille et al (1993) reviewed medical records of 195 dogs and 51 cats that underwent a total of 233 ultrasound-guided biopsies and 70 ultrasound-guided fine-needle aspirations for diagnostic quality of the specimens obtained and for procedural complications. Three animals (1.2%) had major post-biopsy complications, 2 cats with hepatic lipidosis had punctured bile ducts after liver biopsy and needed surgical repair and one dog had symptoms of perirenal haemorrhage. All 233 biopsy specimens, 226 (97%) were considered to be of adequate quality for histological interpretation. Results of cytological examination of 59 (84.3%) of 70 specimens obtained by fine needle aspiration correlated with the final diagnosis made during surgical exploration or at PM examination.

Probst and Kunzel (1993) described the sonographic differentiation of liver lobes in the dog. Segmental sonograms of the liver and gall bladder of 10 euthanized dogs were made. The location of these organs was verified by PM examinations. In 12 dogs the portal vein system was displayed radiologically by injecting contrast medium into the vena lienalis. In 15 other dogs the hepatic vein system was filled through the caudal vena cava. The livers of 9 anaesthetized dogs were examined sonographically. The dogs were killed and the hepatic veins were also injected with contrast medium and X-rayed. Segmental frozen sections and corrosion casts of liver vessels were made. A tabular summary indicates the maximum expansion of each liver lobe and the traceable liver lobes in each intercostals space in dead dogs. The portal vein gives off 2 branches to the right, curves to the left and finally divides into 3-5 sizeable vessels left of the median plane. 2-5 smaller hepatic veins can be displayed to the right. A major hepatic venous trunk is located directly caudal to the diaphragm and can be traced to left, caudoventro-laterally. The veins of the left and central parts of the liver flow into this trunk. From the left side,
only the hepatic veins of the left lobes can effectively be displayed sonographically. From the right side the hepatic veins of the quadrate lobe and the right medial lobe were differentiated in 3 out of 9 anaesthetized dogs. The smaller hepatic veins of the right part of the liver were imaged with difficulty. The vein of the papillary process cannot be displayed sonographically. Contrast presentation of liver veins, corrosion preparations of liver blood vessels and 2 sonograms of liver were presented.

Arnbjerg and Jensen (1994) reported a case of hepatic abscessation in a 3 week old female German shepherd puppy in which the diagnosis was assisted by ultrasonography is reported. The puppy had a history of pyrexia, depression and jaundice at the age of 3 days that was treated with streptomycin and penicillin. Another puppy from the same litter died with hepatomegaly, fibrinous perihepatitis and peritonitis. On clinical examination the involvement of the liver was suspected but could not be verified by routine haematological and serum chemical analyses. Radiography of the abdomen did not decisively reveal the presence of any hepatobiliary diseases. Ultrasonic examination of the liver showed the presence of several hypoechoic, round-to-oval areas with a diameter between 1 to 20 mm. Postmortem examination showed multiple hepatic abscesses from which streptococci (type G) were isolated; however, the source of infection could not be determined. This case indicated that ultrasonography may be of value in the early detection and therapy for hepatic abscesses in puppies.

Felkai et al (1994) reported the indications, methods and applicability of renal ultrasonography and demonstrated in 9 dogs with kidney diseases (data on breed, sex, age, symptoms, laboratory findings, sonographic clinical and/or postmortem diagnosis are tabulated). In addition to the normal conditions, the ultrasonographic findings of
processes associated with lesions of renal parenchyma and renal pelvis-urethral complex were described and differential diagnosis of the lesions were discussed. It was concluded that focal parenchymal renal diseases and lesions of renal pelvis-urethral complex could be detected easily and with certainty. Although ultrasonographic images showed some quantitative alterations, the findings pathognomonic for diffuse renal lesionsexcept for ethylene glycol nephrosis were definitely not diagnosed by the method. In these cases, ultrasound guided biopsy was the method of choice for providing histological diagnosis. Ultrasonography was suggested as an effective procedure in the diagnosis of certain diseases of the kidney and the upper urinary tract in dogs.

Grooters et al (1994) conducted abdominal ultrasonography in 7 cats with intestinal lymphoma and 4 with gastric lymphoma and detected abnormalities including a hypoechoic mass associated with the gastrointestinal tract, focal or diffuse thickening of the gastric wall, symmetric thickening of the bowel wall, loss of normal layered appearance of the gastrointestinal wall, and abdominal lymphadenopathy. The thickness of the stomach wall ranged from 5 to 20 mm in cats with intestinal lymphoma. Fine needle aspiration of a gastrointestinal lesion was carried out without complication in 6 cats, and was diagnostic for lymphoma in 5 of them. The results indicate that ultrasonography is an effective noninvasive means of identifying lesions consistent with alimentary lymphoma in cats.

Myers and Penninck (1994) reviewed the history, physical clinicopathological, radiographic and ultrasonographic findings of 13 dog: with gastrointestinal (GI) smooth muscle tumors (11 leiomyosarcomas, leiomyomas) were reviewed. History, including signalment and chief complaint, physical examination and blood chemistry were neither sensitive nor specific for GI neoplasia. Imaging procedures, radiology and ultrasonography, identified abdominal masses in 12 dogs, including
lacking palpable mass on initial examination. Survey radiographs of 10 of the 13 dogs showed a mass effect in 5, evidence of peritoneal effusion or free abdominal gas in 3, and obstructive pattern with gas' and fluid distension of the intestinal tract in one. Ultrasonography identified an abdominal mass in 12 of 13 dogs, and peritoneal effusion in 5. Ultrasonography correctly recognized an association of the mass with bowel segments by the presence of intraluminal gas, within or adjacent to the mass effect, in 10 dogs and strongly suggested an intestinal origin in one other animal. GI smooth muscle tumors often appeared as large masses, eccentrically projecting from the bowel wall, frequently containing single or multiple hypo-anechoic regions. It was concluded that ultrasonography is more sensitive than survey radiography in the detection of GI smooth muscle tumors, and may present specific features to distinguish smooth muscle tumors from other types of GI tumors.

Ahmad and Noakes (1995a) studied the semen quality, plasma testosterone concentrations and ultrasonographic changes for up to 20 weeks after the unilateral vasectomy of 2 adult goats and 2 rams, and the gross and histological changes were examined post mortem. An intact ram and an intact goat served as controls. There was a marked decrease in the sperm concentration and the total numbers of sperm per ejaculate in both species. However, there seemed to be no effect on ejaculatory volume, mass motility and individual motile sperm, percentages of dead and abnormal sperm and plasma concentrations of testosterone. Ultrasonographically, the epididymal tail lost its characteristic heterogenous texture and appeared enlarged. Anechoic masses representing sperm granulomata, were visible within the epididymal tail of both the rams, and the epididymal head of one of the goats and at the cut end of the vas deferens in the other. They were observed as early as 4 to 8 weeks after surgery and their nature was confirmed post mortem. The sequential ultrasonographic changes in the testis and the epididymis are described.
Ahmad and Noakes (1995b) studied sequential ultrasonographic changes in the testis and the epididymis, semen quality and plasma testosterone concentration after unilateral intra-testicular and intra-epididymal injections of chlorhexidine gluconate solution in 3 goats and a ram; the untreated, normal testis and epididymis were imaged as controls. Sixteen weeks after treatment, unilateral vasectomy, ipsilateral to the normal testis and epididymis, was performed in 2 goats and ram. Gross and histological changes post mortem were also recorded. Ejaculates collected after injection showed a decrease in mass and individual motility, sperm concentration and total sperm per ejaculate with an increase in the percentages of dead and abnormal spermatozoa. Those collected after vasectomy on the normal side had <20% motile sperm, most of which were dead (77-100%) and abnormal (62-100%). When observed ultrasonographically, within 24 h, the testis showed hypoechoic areas corresponding to the sites of injection. Later, the lesions decreased in echogenicity and showed acoustic shadowing, and were surrounded by a distinctly hyperechoic border. The epididymal tail showed an increased echogenicity, and had anechoic lesions with ill-defined borders within 24 h after injection. A hyperechoic border was subsequently observed around the lesions. Gross and histological examination of the testis revealed areas of long-standing tubular necrosis surrounded by mineralized tissue at the sites of injection. The epididymal tail showed fibrosis and sperm granuloma formation. It is concluded that ultrasound imaging is useful for diagnosis of the presence of focal lesions of the testis on the epididymis.

Braun et al (1995) published first report on the use of radiography and ultrasonography for the diagnosis of pneumonia in sheep. In a 2 year old, White Alpine ram in which bronchopneumonia had been tentatively diagnosed on the basis of clinical findings, endoscopic examination of the respiratory tract and ultrasonic and radiographic examination of the thorax were performed. Cytological and bacteriological examination of tracheal secretions revealed large numbers of neutrophils.
and Actinomyces pyogenes organisms. Radiography showed a pocket of gas, surrounded by a capsule of soft density tissue, overlying the base of the heart, and a horizontal fluid line. Ultrasonography revealed an effusion between the pleura and the lung on the left side of the thorax, and an encapsulated abscess on the right side of the thorax. Cystoscopy and aspiration of accumulated fluid yielded foul-smelling pus. PM examination confirmed the clinical, radiographic and ultrasonographic findings.

Wu and Carlisle (1995) described in dogs a method for systematic examination of the liver was developed, based on identification of the hepatic and portal veins in 16 dogs. The right medial, quadrate, left medial and lateral hepatic veins and the hepatic branches of the portal veins were easily located with the dog in dorsal recumbency. The left lateral and caudate hepatic veins were identified more easily from the right side with the transducer positioned between the ninth to the eleventh intercostals spaces. Visibility was affected by the fullness of the stomach but this effect could be minimized by changing the position of the transducer to select a more suitable anatomical approach. Identification of the 2 systems depended on their echogenicity, the anatomical position of the main branches and their pattern of distribution. As in man, the portal veins were in general, more echogenic than the hepatic veins and the hepatic veins could be traced from their junctions with the caudal vena cava. Identification of the branches of the hepatic and portal veins was complicated by the anatomical shape, the nutritional status and respiratory stage of the animals. A systemic approach based on the knowledge of the distribution patterns produced by the hepatic and portal veins ensures that all liver lobes are identified and all important structures are assessed.

Carlisle et al (1995) obtained anatomical details from the formalin fixed livers of 10 dogs. The hepatic and portal veins were removed intact from these livers so that a detailed pattern of distribution could be established and the numbers of branches could be counted. Silastic cost...
were also made of the hepatic and portal veins of 2 livers, one in situ and one in which it had been removed. The former was to enable the relationship of the portal to the hepatic veins to be established as closely as possible within the animal and the other to provide a model of the distribution of each venous system within the liver. Contrast medium was infused into 2 other livers and radiographs taken to establish the relationship of each branch to each lobe. There was a consistent pattern of venous branching to each lobe of the liver in the dog with little variation between individual specimens. All liver lobes contained definite venous branches so that the left lateral and medial, quadrate, right medial and lateral, caudate and papillary veins could be distinguished in each venous system. An appreciation of this venous distribution will aid in the systematic evaluation of the liver during ultrasonography by identification of each liver lobe. It should be of value for differentiating portal from hepatic veins and veins from dilated bile ducts.

Fleecy et al. (1995) studied the applicability of ultrasonography in the diagnosis of lesions of the renal pelvis and ureter in 10 dogs. Ultrasonographic findings of processes associated with dilatation and concretion formation in the renal pelvis were described and the differential diagnosis of the lesions was discussed. The authors propose a new classification system for judging processes characterized by dilatation of the renal pelvis. Experience suggests that ultrasonography is an effective procedure in the diagnosis of certain disease of the upper urinary tract in dogs.

This is a first comprehensive book on the use of ultrasound in veterinary medicine covering issues from diagnosis of diseases to its use in research and therapy (Goddard, 1995). The book is not as generously illustrated as some manuals on specific areas of ultrasound diagnosis but with its wide coverage of the subject it serves well as a text book. The theoretical basis of ultrasonography is explained. The 14 contributors
including the editor, have written 15 chapters covering abdominal and reproductive ultrasonography in different species, ultrasound diagnosis and examination of the eye, echocardiography in different species, ultrasound examination and use of ultrasound in therapy and finally the use of ultrasonography in assessing the body composition in sheep. There is a subject index.

Grooters et al (1995) performed ultrasonographic examination of the adrenal glands in 14 fasted healthy adult dogs. Frequency of visualization as 100% for both the left and right adrenal glands. Moderate correlation was present between ultrasonographic and gross measurements of thickness for both left ($r_g=0.727; \ p<.005$) and right left = 0.537; $p <.05$) adrenal glands. However, no correlation was seen between ultrasonographic and gross measurements for length or width of either adrenal gland. Differentiation of adrenal cortex and medulla was possible in 79% of left adrenal glands and length of right adrenal glands. The echogenicity of the adrenal glands was less than that of the renal cortex in all dogs.

Horauf and Reusch (1995) reported the measurements of adrenal gland size obtained on 20 healthy dogs, 18 dogs with no evidence of endocrine disease (NED), 10 dogs with pituitary dependent hyperadrenocorticism (PDH) and 2 dogs with functional adrenocortical tumors (FAT). There was no significant difference in length and width of the left and right adrenal gland between normal dogs (median: left adrenal length = 17.4 mm; left adrenal width = 4.1 mm; right adrenal length = 16.7 mm; right adrenal width = 4.3 mm) and NED dogs (median: left adrenal length = 19.0 mm; left adrenal width = 3.9 mm; right adrenal length = 16.8 mm; right adrenal width = 4.0 mm). The length and width of the left and right adrenal gland however were significantly greater in dogs with PDH than in normal dogs and in NED dogs (median: left adrenal length = 22.1 mm; left adrenal width = 8.1 mm; right adrenal length = 22.3 mm; right adrenal width = 7.0
The ratio of left kidney length: left and right adrenal gland width was significantly lower in dogs with PDH than in normal dogs and in NED dogs. The ratio left kidney length: left and right adrenal gland length in dogs with PDH vs normal dogs and NED dogs was not significantly different.

Hotz and Saunders (1995) evaluated the technique for ultrasonography of canine adrenal glands and concluded that when specific preconditions are met it is feasible to image both adrenal glands.

Mathews et al (1995) reported the ultrasonographic diagnosis of cystic reproduction disease in a koala. A mature female koala with a history of depression, anorexia, and purulent urogenital discharge was examined. Using abdominal ultrasonography, a presumptive diagnosis of polycystic uterine or vaginal mass was made. Exploratory abdominal surgery revealed distended uteri and multiple cysts involving the uteri, cervices, and vaginal cul-de-sac. Ovariohysterectomy and partial vaginectomy resulted in the resolution of clinical disease. Histological examination of the reproductive tract revealed the presence of vaginitis, cervicitis, endometritis, pyometra, and salpingitis. Streptococci were identified within both uteri. Antibodies to Chlamydia psittaci were detected in serum using a recently developed immuno-dot-not screening test.

Neuwirth et al (1995) compared nephrosonography in labeled WBC for detection of experimentally induced pyelonephritis in 12 dogs. Nephrosonography abnormalities were found in all infected kidneys studied early after infection. In the chronic phase of pyelonephritis, the sonographic abnormalities had decreased in severity in 9 kidneys, increased in severity in 2 kidneys, and had resolved in 2 kidneys. After histopathology, 11 of 15 kidneys (73%) with pyelonephritis had been identified by sonography. The WBC scan was performed during the acute phase of pyelonephritis in 9 dogs and during the chronic phase in all dogs. During the acute phase of pyelonephritis, the WBC scan was positive in E.
and 9 dogs (89%) on images acquired 24 and 48 h after injection of the labeled WBC. During the chronic phase of pyelonephritis, the WBC scan was negative in all 12 dogs. The sensitivity of the WBC scan was poor compared to nephrosonography for detection of chronic pyelonephritis. In this study, optimal detection of renal infection/pyelonephritis by WBC may be dependent on the presence of clinical signs and leukocytosis in dogs. Even when leukocytosis is present, the WBC may fail to accumulate in the kidney in dogs with pyelonephritis, particularly if there are no clinical signs (fever, depression, inappetence).

Tiemessen et al (1995) studied dogs for the specificities of diagnosing 36 dogs, suspected of having portosystemic shunts, were scanned using the right lateral approach and the diagnosis was confirmed either by laparotomy, liver biopsy or PM examination. The sensitivity, specificity and accuracy of the scanning method were 0.74, 1.0 and 0.86, respectively. They concluded that ultrasonography is highly specific and reasonably sensitive in diagnosing congenital portosystemic shunts in dogs.

Wu Yeonghuey (1995) correlated nephrosonographic measurements and some urinary component levels in canine unilaterally hydronephrosis. The left ureters of 8 adult crossbred dogs were obstructed surgically for 6 weeks. Renal length, width, parenchymal thickness, cortical thickness and pelvic width of the left hydronephrotic kidney were measured on sonographs of a kidney mid-dorsal image before and one week after obstruction. Pelvic urine of the left hydronephrotic kidney was collected at the same times and the concentrations of creatinine, urea-N and potassium were measured. The results showed that sonographic measurements were significantly related to the levels of each urinary component (P>0.001). This simple non-invasive imaging technique may be useful for assessing renal recovery potential in the completely obstructed canine kidney.
Agut et al (1996) recorded the sonographic observations of the gastroduodenal junction of dogs. Twenty healthy, mixed-breed dogs (mean b. wt. 15.1 ± 7.1 kg) were used. In vitro sonographic observations of the gastroduodenal junction were made after each had been mounted on an acrylic rack placed in an organ bath. In vivo studies were performed in anaesthetized dogs. The wall of the pyloric antrum was 4 to 5 mm thick, that of the pylorus was 3 to 4 mm thick, and that of the cranial part of the duodenum was 2 to 3 mm thick. The pyloric canal had a length of 16 to 17 mm and overall in vivo diameter of 22 mm, and the muscular part of its wall was 2 to 3 mm thick. In vivo sonographic images were best made with the dog in dorsal recumbency, tilted 30° to the right. The feasibility study clearly demonstrated the form and function of antroduodenal motility, including gastric and duodenal peristalsis, opening and closing of the pyloric canal, and duodenogastric reflux of fluid and gas.

Chang Ho et al (1996) described the ultrasonic findings in 24 dogs with reproductive and urinary tract diseases including pyometra, fetal death, cystic calculi, cystitis and prostate hyperplasia.

England (1996) reported the sonographic findings of liver and kidneys in pups. The ultrasonographic appearance and size of the liver and kidneys of a litter of 5 pups was examined from birth until 6 months of age, and compared with a group of 5 adults of the same breed. Increased renal cortical echogenicity was evident for the first 2 weeks of life. Up to 12 weeks of age renal size was relatively large in comparison with body size parameters. After 12 weeks measures of renal size were proportionate with body size and were not significantly different from adult dogs. The neonatal liver had a similar ultrasonographic appearance to the adult, although in the first 8 weeks parenchymal echogenic stippling was less coarse and portal veins were less well delineated. Measures of hepatic length were inaccurate during the first 4 weeks after birth due to changes in body
conformation. From 8 weeks to 6 months of age these measures were proportionate with body size, although the ratios differed from adult dogs.

Fung Hang-Poung and Shih Chieh (1996) evaluated USG for diagnosing pregnancy and predicting whelping and parturition in dogs. Eight primiparous dogs (7-14.5 kg body weight), which had been mated once or twice, were monitored every other day from 10 days after mating, using a 5.0 MHz linear-array transducer. The first sign confirming pregnancy was the detection of the gestational sac at 17.0 ± 0.9 (15 to 20 days) after the first mating. When the embryonic heartbeat could be detected, the accuracy of litter size determination was 88% at 24.8 ± 1.0 days (21 to 28 days). A fence like imaging in the thoracic cavity of the fetus was observed at 10.0 ± 0.4 days (8 to 11 days) before parturition and the fetal crown-rump length was about equal to the width of zonary placenta at 22.6 ± 0.4 days (21 to 24 days) before parturition. Other ultrasonic images such as the earliest detection time of the cardiac chamber, urinary bladder, stomach, liver, and loss of round outline of gestational sac were also useful for predicting the day of parturition.

Hanson and Tidwell (1996) reported the USG appearance of urethral carcinoma in dogs. Twelve dogs examined at the Tufts University School of Veterinary Medicine for clinical signs referable to the urinary bladder, urethra or vagina were examined ultrasonographically. Seven were neutered females and 5 were neutered males. Each dog had a hyperechoic, non-shadowing line at the epithelial surface of the proximal urethra. In the 7 females and one of the males, the urethral wall was also thick and hypoechoic to surrounding tissue. In the other males, the urethra epithelial changes were at the level of the prostate, and the limits of the urethra were not visible. In 6 dogs, the urethral change was the only abnormality seen, while in 6, bladder wall, bladder luminal and/or other prostatic parenchymal changes were also detected. Three dogs had hydronephrosis, and one had enlarged medial iliac lymph nodes. Biopsies were
obtained via suction with urinary catheterization (6), exploratory coeliotomy (3), urethroscopy (2), or at PM examination (1). A histopathological diagnosis of urethral transitional cell carcinoma was obtained in 10 dogs. The ultrasonographic appearance was not pathognomonic for transitional cell carcinoma, as one dog with transitional cell dysplasia and one dog with severe ulcerative and necro-suppurative cystitis and urethral stricture had similar findings.

Hotz et al. (1996) reviewed the ultrasonographic findings in 13 dogs with histopathologically proven gastric tumors. The echogenicity of gastric wall lesions was variable and independent of the type of tumour. All dogs had an increase in gastric wall thickness and in only one dog was the wall layering intact. Regional lymph node involvement was a common finding. Gastric neoplasia was observed most commonly in middle-aged and old, medium to large-sized dogs. Carcinoma was the commonest tumour found. It is concluded, that thickening of the gastric wall accompanied by loss of its layering and enlargement of regional lymph nodes were ultrasonographic signs likely to be found with gastric neoplasia. Histological type of gastric tumor could not be predicted on the basis of the ultrasound examination.

Jones et al. (1996) measured the effects of 4 experimental nerve root comparison treatments on arterial flow velocities in the seventh lumber spinal ganglion of dog's Doppler ultrasonography. Graphed blood flow velocity changes (change = treatment value-pretreatment value) were below baseline during the first 3 compression treatments and above baseline following compression release. Mean blood flow velocity change for both central-plus-lateral compression and lateral compression differed from changes for central compression. Changes for central-plus-latera compression did not differ from changes for lateral compression. Change among the first 3 compression treatments differed from changes for compression release. No histological abnormalities were identified it
compressed nerve tissues, compared to contralateral controls. It is concluded that stenosis within the L7-S1 intervertebral foramen may cause ischaemia of the L7 spinal ganglion in dogs.

Koch et al (1996) recorded M-mode echocardiograms in 62 healthy giant breed dogs, in 6 dogs with asymptomatic dilated cardiomyopathy (DCM, NYHA class I), and 13 dogs with symptomatic DCM (NYHA class III-IV). There was a general trend that several echocardiographic parameters were significantly different in control Great Danes as compared with Newfoundlands and Irish Wolf-hounds. There were substantial differences in left ventricular size both in systole and diastole and in systolic indices of the left ventricle between the control group, the asymptomatic dogs and symptomatic dogs with DCM. There was also a significant decrease in the interventricular septum thickness and left ventricular free wall thickness in systole and diastole between the 3 groups. The left atrial/aortic ratio was significantly different between the 3 groups. It is concluded that these echocardiographic reference values may be useful to study heart diseases in giant breed dogs.

Kramer and Gerwing (1996) described the ultrasonographic appearance of different material such as plant parts, wood, metal or plastic. While in the abdominal organs, excluding the intestinal tract, a foreign body can be well detected, it can however only be visible in the abdominal cavity, when the surrounding tissue is inflamed (such as granuloma, abscess, and free fluid). The ultrasound can only detect foreign bodies in the intestinal tract in approximately half of the cases. In those cases secondary sonographic signs of an ileus are often decisive. Penetrating foreign bodies in the area of the soft tissue of the musculoskeletal system are evaluated in the ultrasound according to their position, size and form. They are best seen when the inflamed reaction-line is well developed. Probes and catheters are definitively detected in the sonographic examination. Their position can be checked.
Lamb (1996) evaluated the efficiency of diagnosing portosystemic shunts in dogs by USG. Diagnosis of congenital portosystemic shunt was confirmed in 38 of these dogs using operative mesenteric portography. Out of these 14 (37%) dogs had an intrahepatic shunt and 24 (63%) had an extrahepatic shunt. Ultrasonography had a sensitivity of 95%, specificity of 98%, and accuracy of 94%. Ultrasonographic signs in dogs with congenital portosystemic shunts included small liver, reduced visibility of intrahepatic portal vessels, and anomalous blood vessel draining into the caudal vena cava. Correct determination of intra-versus extrahepatic shunt was made ultrasonographically in 35 of 38 (92%) dogs. Increased and/or variable portal blood flow velocity was present in 21 of 30 (70%) dogs with congenital portosystemic shunts. In one dog with an intrahepatic shunt the ultrasonographic diagnosis was based partly on finding increased mean portal blood flow velocity because the shunting vessel was not visible. Detection of the shunting vessel and placement of duplex-Doppler sample volumes were facilitated by use of colour-flow Doppler. Two-dimensional, grey-scale ultrasonography alone is sufficient to detect most intrahepatic and extrahepatic shunts; sensitivity is increased by additional use of duplex-Doppler and colour-flow Doppler. Increased and/or variable portal blood flow velocity occurs in most dogs with congenital portosystemic shunts.

Lamb et al. (1996) diagnosed portal vein thrombosis in four dogs by ultrasonography. In each dog the thrombus was visible in 2-dimensional, grey-scale images of the portal vein obtained through a right intercostals window. Duplex-Doppler measurements and colour-Doppler images provided information about the effects of thrombosis on portal blood flow. Reduced portal blood flow compatible with portal hypertension was detected in dogs. A hypercoagulable state was probably involved in the pathogenesis of portal vein thrombosis in 2 dogs, 1 with pancreatitis and gastrointestinal blood loss and another with protein-losing nephropathy.
and probable immune-mediated anaemia. The third dog had chronic ehrlichiosis; thrombosis was probably secondary to vasulitis. The remaining dog had thrombosis secondary to invasion of the portal vein by a recurrent duodenal neoplasm. This dog was killed because the tumour was considered inoperable. The dog with pancreatitis developed acute portal hypertension due to obstruction of the portal vein by the thrombus and was killed. The dogs with protein-losing nephropathy and ehrlichiosis were treated medically and recovered. Although portal vein thrombosis is uncommon, it is suggested that this complication should be considered in dogs with a variety of abdominal or systemic disorders. It is concluded that ultrasonography is a practical method for diagnosis of portal vein thrombosis and detection of the underlying cause.

Mwanza et al (1996) examined the canine liver vessels by ultrasonography the portal vein and its branches were visualized in 10 adult mongrel dogs by cranial mesenteric portography while hepatic veins were visualized using the transvenous retrograde angiography method. Longitudinal and transverse ultrasound scans of the liver were obtained to determine the best positions for imaging the different liver vessels. The distribution patterns of the hepatic and portal veins were demonstrated by both ultrasonography and contrast angiography. Hepatic arteries were not usually visualized ultrasonographically. Ultrasound provided dynamic information that could not be obtained by contrast radiography. It was suggested that both methods may provide important complementary information in the diagnosis and planning of surgical procedures for correcting vessel anomalies in the canine liver.

Nyland et al (1996) reported the hepatic ultrasonographic and pathologic findings in dogs with canine superficial necrolytic dermatitis. A unique, "honeycomb" pattern was identified in ultrasonographs of the lives of 5 dogs with canine superficial necrolytic dermatitis (hepatocutaneous syndrome). This pattern consisted of variably sized, hypoechoic regions
0.5-1.5 dm in diameter, surrounded by highly echogenic borders. Histologically, the hypoechoic regions corresponded to distinct regenerative nodules bounded by severely vacuolated (fat-laden) hepatocytes, numerous bile ductules, and a network of reticulin and fine collagen fibres representing remnants of collapsed hepatic lobules. While some features of the architectural disruption were characteristic of cirrhosis, the lesion lacked the extensive fibrosis and reduced liver size usually associated with chronic cirrhosis. This hepatic ultrasonographic pattern has only been seen with canine superficial necrolytic dermatitis. Therefore, it appears to be pathognomonic in a dog with suspicious skin lesions. A liver biopsy is required to confirm the unique histopathological features of the hepatopathy found in this syndrome.

Silva et al (1996) evaluated ovarian changes in bitches by ultrasonography, laparoscopy and hormone assays. To identify the time and characteristics of ovulation, 5 bitches were examined during heat by ultrasonography, laparoscopy and hormonal assays. Blood was collected for progesterone and oestradiol 17-B assays and ultrasonography were performed every day and laparoscopy every other day. At ultrasonography, ovaries appeared as anechoic structures about 5 days before the estimated LH peak and gradually increased in size. The greatest changes were observed between days 2 and 4 post-LH peak; echogenicity varied greatly from one animal to another and from one day to the following going from totally anechoic to mixed hypo- and hyper-echogenicity. Then from day 6, ovaries always appeared as hypoechoic structures assimilated to corpora lutea. At laparoscopy, small follicles were seen as early as day 1C before the LH peak. Their size slowly increased to become large protubering follicles around the day of LH peak (day 0). At day 1, corpora lutea was observed for the first time and was present in all animals by day 5. During the period preceding day 5, some ovaries had both corpora lutes and follicles clearly visible on their surface. In one animal, haemorrhagic foci were observed at day 3. Neither ultrasonography, nor laparoscopy
allowed precise determination of the time of ovulation. Indeed, follicle collapse was never observed, but changes in echogenicity and in the appearance of the ovaries observed by laparoscopy, suggested that ovulation occurred.

Tello et al (1996) examined 50 bitches with clinical signs of pyometra by ultrasound and radiography at lateral and ventro-dorsal view and scored from 0 to 3 according to the presence of signs of increased uterine volume. The uteri were measured at 3 anatomical points after surgical removal at points caudal to kidneys and lateral to navel and caudal to bifurcation. It was concluded that lateral radiographs were more successful in diagnosing increased uterine volume than ventro-dorsal images, and that ultrasound was more efficient than radiography in distinguishing positives cases of pyometra, diagnosing 100% of the cases.

Zhao Ying et al (1996) tested Doppler ultrasound (D-mode, with a 5 MHz probe and ultrasonography (B-mode) with a 5 MHz recta probe were tested for early diagnosis of pregnancy in ewes in Beijing China. Of 17 Mongolian ewes tested, 5 were scanned 3 times a week, 15-18 days after mating; 5 were scanned twice a week, 30-38 days after mating, and 7 were scanned once, 25-38 days after mating. The result: showed that pregnancy could be diagnosed at 30-38 days of gestation b) detecting the umbilical sounds or fetal heart beats (FHB) using D-mode and at days 18-19, 19-20 and 20-22 of gestation by detecting fetal fluid fetal body and FHB using B-mode. Ultrasonic scanning enabled pregnancy diagnosis to be made 5 days earlier than with previously reported techniques. The D-mode apparatus is smaller, cheaper and easy to use than that of the B-mode.

Douglass et al (1997) reported the ultrasonographic adrenal gland measurement in dogs without evidence of adrenal disease. Dog! with elevated serum cholesterol or alkaline phosphatase levels
polyuria/polydipsia, and/or clinical diagnosis of adrenal pathology were excluded. Dogs with ultrasound-documented abnormalities (mass lesions, 
abnormal architecture) of either adrenal were not considered: Age, sex, weight and breed were recorded, and the body surface area of each dog was calculated. Adrenal length and caudal polar width were determined from longitudinal, two-dimensional ultrasound images. Adrenal measurements were compared with body size measurements and age using least-squares linear regression analysis and the correlation coefficient (r) and coefficient of determination (r²) calculated. One hundred and ninety three dogs were included in the study, with a weight and body surface area range of 1.8-72 kg and 0.2-1.8 m², respectively. The left adrenal gland (n=182) length range was from 10.7 to 50.2 mm, and the range of the caudal polar widths was 1.9 to 12.4 mm. Right adrenal gland (n=85) length range was from 10 to 39.3 mm, and the range of the caudal polar width was from 3.1 to 12 mm. In dogs where both adrenal gland lengths were measured (n=74), the right adrenal gland length was less than that of the left in 46 dogs, linear to the left in one dog, and greater than the length of the left in 27 dogs. The strongest linear association was noted between the left adrenal gland length and body weight (kg, r=0.71, p < 0.0001) or body surface area (m², r=0.71, p < 0.0001). Similar significant association was noted between the right adrenal gland length and body weight (kg, r = 0.69, p < 0.0001). A significant positive association was also noted between age and left adrenal gland length, (r = 0.25, p = 0.009) The summation of all four adrenal measurement values (left length an( width, right length and width) did slightly improve the correlation (r = 0.74 p < 0.0001) when compared with body weight (kg). There was not significant difference in the adrenal measurements with regard to sex. Witt regard to the correlation coefficient values, there was no advantage note( to calculating the body surface area from body weight. The causes for the low degrees of the correlation between adrenal size and the variable; investigated in their study were unknown; measurement error, effects a
non-adrenal illness on adrenal size, and a non-linear or complex linear relationship between adrenal gland size (as measured by longitudinal parameters) and descriptors of body size are among possible explanations).

Geese et al (1997) evaluated urinary bladder wall thickness by ultrasonography in 16 healthy dogs. Sterile saline solution was administered via urinary catheters to control the degree of bladder distension. Bladder wall thickness was measured on static ultrasound images in 4 locations and at 3 degrees of bladder distension (minimal, mild and moderate). Four randomized distension sequences with 3 detensions per sequence were performed on each dog and the data were analysed using Williams' balance Latin square. Mean bladder wall thickness was 2.3 mm in minimally distended bladders (0.5 ml/kg saline), 1.6 mm in mildly distended bladders (2 ml/kg saline) and 1.4 mm in moderately distended bladders (4 ml/kg saline). Mean bladder wall thickness increased significantly with increasing body weight and with decreasing bladder distension. The caudoventral measurement location produced a statistically significant smaller measurement with a difference of 0.3 mm. Sex did not affect bladder wall thickness. Distension sequence and repetition of detensions did not affect bladder wall thickness.

Kramer et al (1997) examined 546 cats and dogs with ultrasound in the Department for Veterinary Surgery at the Justus-Liebing University in Giessen. All animals were suspected of having a disease involving the musculoskeletal system. In most of the patients a 7.5 MHz linear transducer was used because of its flat application surface and resolving power. It was found that the evaluation of bone by sonography is limited, but sonography can provide additional information regarding the bone surface and surrounding soft tissue. Ultrasound is valuable for assessing joint disease. Joint effusion, thickening of the joint capsule and cartilage defects can be identified sonographically. It is also possible to
detect bone destruction. Instabilities are often identified with the help of dynamic examination. Soft tissue abnormalities of the musculoskeletal system lend themselves to sonographic evaluation. Partial or complete muscles or tendon tears are able to be differentiated and the healing process can be monitored. Most of the disease that are in the area of the biceps or the Achilles tendon, such as dislocation of the tendon, c injuries with scarification, tendinitis and/or tenosynovitis can be differentiated by sonography. In addition, with clinical and laboratory findings, it is often possible to make a correct diagnosis with ultrasound patients with abscesses, foreign bodies, haematomas, soft tissue tumor and lipomas.

Miles (1997) reported that both radiography and ultrasonography provide non-invasive imaging of suspected abdominal masses with minimum discomfort or risk for the geriatric patient. Radiography is more readily available and less expensive than ultrasonography, but contrast resolution is poor. Displacement of adjacent structures and addition of special contrast studies will provide clues to the possible organ of origin and extent of suspected abdominal masses. Cystic lesions can differentiated from solid masses with ultrasound, but the appearance focal abnormalities is not specific for any one disease process. Abdominal ultrasonography often provides the best diagnostic yield when used combination with radiography and image-guided biopsy techniques.

The adrenal glands of 26, 12-53 month old, apparent healthy ferrets were examined by ultrasonography and the finding compared with those from gross examination and histopathology (Neuwir et al, 1997). Of 51 adrenal glands examined, 27 were healthy, 23 either nodular or diffuse cortical hyperplasia and one had adrenocarcinoma. Neither the sonographic nor gross size of heal adrenal glands were significantly different to those of adrenal glands.
hyperplasia. There was significant correlation between gross and sonographic measurements of length for both right and left adrenal glands, however, the sonographic measurements were less than the gross measurements. There was also correlation between the sex and weight of the ferret and adrenal gland length and width, with males, which were significantly heavier than females, having longer and wider adrenal gland than females. The length, width and depth of the right adrenal gland were sonographically measured as 7.5 ± 1.2 mm, 3.7 ± 0.6 mm and 2.8 ± 0.6 mm, respectively, in female ferrets and 8.9 ± 1.6 mm, 3.8 ± 0.6 mm, 3.0 ± 0.8 mm, respectively in male ferrets. The same measurements of the left adrenal gland were 7.4 ± 1.0 mm, 4.2 ± 0.6 mm and 3.0 ± 0.6 mm respectively, in male ferrets. Accessory adrenal tissue was not identified during the sonographic examination but was found on postmortem examination of ferrets, associated with either or both adrenal glands.

Nyland et al (1997) did ultrasound examination of transplanted kidneys started 3 days after surgery and continued at 2 to day intervals until the dog died after a mean of 38 ± 2 days. Transplanter kidneys rapidly increased in volume and cross-sectional area by an average of 103% and 83% above baseline levels, respectively, 17 day, transplantation. The increased size was attributed to a combination of hypertrophy and acute rejection. The latter was confirmed at postmortem examination. Kidney volume decreased to approximately 35% above baseline volume by day 34 as rejection became more advanced. Qualitative changes associated with rejection included medullar enlargement with decreased echogenicity early in the study, followed by increased cortical thickness and echogenicity with poor cortical medullar definition in the latter stages of the survival period. It is concluded that relative changes in renal allograft size can easily be monitored with ultrasound. Changes associated with acute rejection were more pronounced in kidney width than in height or length. It is suggested that measurements that incorporate the width, such as volume or cross
sectional area, appear to be the most sensitive for monitoring changes in allograft size.

Rivers et al (1997a) evaluated the utility of ultrasonography in the diagnosis of canine gastric neoplasia prospectively in 6 dogs subsequently confirmed as having adenocarcinoma by cytological or histological examination or birth. The dogs were 7-8 years of age and were selected on signalment and clinical signs suggestive of gastric neoplasia, absence of renal failure, hypoadrenocorticism, diabetic ketoacidosis or pancreatitis and the willingness of owners to permit cytological or histological confirmation of diagnosis. Gastric neoplasia was associated with mural thickening with loss of normal wall sonographic layers and decreased or absent local motility. Sonographic findings were consistent with neoplasm localization obtained by the other diagnostic techniques. Ultrasonographic guided, percutaneous, fine needle aspiration biopsies were successful in 2 of 3 cases in which they were performed. It is concluded that ultrasonography is useful in the diagnosis of canine gastric neoplasia.

Rivers et al (1997b) did ultrasonographic-guided, percutaneous cholecystocentesis in confirming diagnosis was studied in 4 dogs with canine acalculous cholecystitis. The commonest clinical sign was vomiting. Increased echogenicity of gall bladder bile, with or without biliary sludge, was observed in all 4 cases. Two cases showed signs of discomfort when pressure was applied to the ventral abdominal wall over the gall bladder bile was positive in each of the 4 cases. The commonest organism cultured was Escherichia coli. Anaerobic cultures were positive in 3 cases. It is concluded that cytological examination and microbial cultures of gall bladder bile obtained by ultrasonographic-guided, percutaneous cholecystocentesis appear useful in conforming diagnosis.
Diez-Bru et al (1998) reviewed clinical signs, clinical history, physical examination, clinical pathology, radiographical and ultrasonographic findings of 10 female dogs with histologically confirmed ovarian neoplasms. Ultrasonographic images and reports were reviewed for location, size, outer margins, and echogenicity of the mass or abnormalities and signs of metastatic disease. The masses were classified according to their ultrasonographic pattern in solid, solid with cystic component, and cystic. The masses were ultrasonographically reported as ovarian origin in 8 dogs, and this origin was included in the list of differential diagnoses in the remaining 2 dogs. When present, abdominal effusions and uterine abnormalities were diagnosed by ultrasound.

Forest et al (1998) reported the sonographic renal finding in 20 dogs suffering from leptospirosis. Three dogs had a normal ultrasound examination. The remaining 17 dogs had sonographic abnormalities of the kidneys. These abnormalities, seen either alone or in combination included renal megaly (n=10), pyelectasia (n=9), increased cortical echogenicity (n=1), perinephric effusion (n=5), and a medullary band of increased echogenicity (n=6). At our institution, the medullary band of increased echogenicity has only been seen in dogs with leptospirosis and may therefore be a specific sonographic sign for this disease.

Lamb and Mantis (1998) reviewed ultrasound images with respect to appearance of the intussusception, suspected location evidence of predisposing cause and concurrent lesions. Ten intussusceptions were found, affecting a variety of breeds. The mean (range) age of affected dogs (four females and six males) was 2.5 (0.3 to 7) years and the reported duration of clinical signs, 48 (one to 150 days). Intussusceptions were jejunojejunal (five dogs), ileocolic (three) caecocolic (one) and colocolic (one). A concentric ring sign was identified ultrasonographically in each dog and anatomical location predicted correctly in five instances. Additional ultrasonographic findings associate
with intussusceptions included intestinal neoplasm in two dogs, enlarged abdominal lymph nodes in two, multiple mesenteric cysts in one and intestinal foreign body in a further dog. Thus, ultrasonography enables accurate diagnosis of intestinal intussusception and is a useful method for searching for concurrent or predisposing lesions.

Leveille (1998) recommended ultrasonography as the first diagnostic imaging modality in patients with haematuria or dysuria. Ultrasonography can provide information relative to the capacity of the urinary bladder, changes in bladder outline, changes in wall thickness, identification of mural and luminal masses, and identification of extrinsic lesions that may displace the bladder wall causing changes in its shape. Ultrasonography allows an evaluation of the entire urinary tract (except distal urethra) in both female and male dogs as well as the sublumbar region for lymphadenopathy.

Ultrasonography of the urinary tract was performed by Lamb and Gregory (1998) to evaluate ultrasonography as an alternative to contrast radiography for diagnosis of ectopic ureter in dogs. 14 dogs had Ectopic ureter based on surgical, postmortem findings or unequivocal contrast radiographical findings. There were 8 females and 6 males of different breeds including 5 Labrador Retrievers. Mean (range) age at the time of diagnosis was 1.2 (0.2 - 4) years for females and 3.5 (0.3 - 5) for males. Ectopic ureters were unilateral in 5 dogs (2 left, 3 right) and bilateral in 9 dogs. Both ultrasound images and contrast radiographs were positive for 21 (91%) Ectopic ureters; the same 2 ectopic ureters were not detected using either method. The termination of each of the 5 normal ureters was visible on ultrasound images; 2 (40%) were visible on radiographs. Other ultrasonographic findings included dilatation of the Ectopic ureter and/or ipsilateral renal pelvis in 10 (43%) instances, evidence of pyelonephritis in 2 dogs (with enlargement of the contralateral kidney in one), and urethral diverticuli in one dog. Ultrasonography is a
practical diagnostic test for Ectopic ureter in dogs. In this series there was close correlation between the ultrasonographic and contrast radiographic findings for each Ectopic ureter, but ultrasonography enabled more accurate determination of normal ureteral anatomy.

Manczur et al (1998) performed ultrasonography on 44 dogs to decide whether small bowel obstruction was present. The sonographic criteria for small bowel obstruction were (1) the presence of pendulous movement of the ingesta inside the dilated bowel, (2) observation of invaginated intestines or an ingested intraluminal foreign body, (3) observation of non-uniform peristaltic activity of the dilated intestines, or (4) observation of akinetic intestinal loops together with abdominal fluid accumulation. By using these criteria, obstruction was correctly diagnosed by ultrasonography in 11 of the 13 dogs with mechanical ileus, and obstruction was correctly excluded in 29 of the 31 non-obstructive cases. Thus, the above-mentioned sonographic criteria had 85% sensitivity and positive predictive value and 94% specificity and negative predictive value. Their study suggested that ultrasonography is a valuable tool for diagnosing small intestinal obstruction in the dog.

Morita et al (1998) examined four dogs with caerulein-induced pancreatitis using endoscopic ultrasonography (EUS), grey scale histogram analysis of EUS images (GEUS) and transcutaneous ultrasonography (TUS). Pancreatic lesions were detected 60 min after the start of caerulein infusion using EUS and after 120 to 150 mm using TUS. EUS findings included swelling, distinct lobular patterns, subcapsular hypoechoic areas and anechoic strips in the pancreatic tissue. No marked changes were seen in the first 30 min using GEUS. From 30 to 60 min, the mean brightness of the pancreatic tissue reduced and vacuolization of acinar cell and interstitial oedema of the pancreas occurred. It is concluded that EUS can detect slight and diffuse changes in pancreatic tissue and
that GEUS is more sensitive than EUS in detecting histopathological changes in dogs with pancreatitis.

Poulsen NC (1998) used two-dimensional ultrasonography in combination with colour-flow imaging and pulsed wave Doppler ultrasonography to study maternal circulation and development of fetal vascularization in 6 Beagles during normal gestation. The blood stream was examined in small uteroplacental arteries, the umbilical artery, the fetal aorta and the common carotid artery. The study began 3 weeks after insemination and continued until parturition. Relatively large vessels were detected by cross-sectional ultrasonography, and small vessels were detected by colour-flow imaging. In pulsed wave Doppler ultrasonography, blood flow was measured and described using the parameters of systolic peak velocity, diastolic peak velocity, end-diastolic velocity, pulsatility index, resistance index, A:B ratio (systolic peak velocity:end-diastolic velocity) and S:D parameter (systolic peak velocity: diastolic peak velocity). The pulsatility index, resistance index and A:B ratio decreased 4-5 weeks after insemination in nearly all vessels; only the fetal common carotid artery had constant pulsatility and resistance indices during gestation.

Ruel et al (1998) did ultrasonography of the prostate glands of 100 healthy adult intact male dogs to estimate length, width, and height on transverse and sagittal images as well as the presence of prostatic cysts. Linear regression and correlation analysis were performed between prostatic parameters (length, width, height on sagittal and transverse images, and estimated volume) and parameters related to body size (body weight, body height, left kidney length and aortic diameter) and age of the dogs. There were significant positive correlations between all prostatic parameters and parameters to body size and age. Maximum predicted values for prostatic parameters for a given body weight and age were determined based on the upper limit of the 95% confidence interval of the mean predicted values. Such values should be useful for ultrasonographic
evaluation of the prostate in the dog. Prostatic cysts were found in 14% of the dogs.

Schwarz et al (1998) reviewed the historical, physical, clinical pathology, radiographics and ultrasonographic findings of 13 dogs with hepatic abscess. Liver abscessation was characterized by number, size, shape echogenicity and location. Solitary lesions greater than 3 cm were more common than multiple ones. The abscesses were mainly poorly echogenic lesions, often with central cavitation. The shape of the lesion ranged from round to oval or irregular. Enhancement artifact, abdominal effusion, regional lymphadenopathy and hyperechoic perihepatic fat, were identified in several dogs. Ultrasound-guided aspiration was performed in 10 of 13 dogs, and confirmed abscessation with cytologic and microbiologic evaluation. Ultrasound-guided percutaneous drainage of abscesses was performed as an adjunct to medical management in four dogs.

St-Vincent and Pharr (1998) examined the mediastinum of 8 normal laboratory dogs by transoesophageal ultrasonography with a 5 MHz frequency transducer to establish a baseline for this new imaging technique. Each examination consisted of 360 degree scans in both transverse and sagittal planes from the thoracic inlet to the oesophageal hiatus. Four of these dogs were dissected to confirm transoesophageal ultrasonography findings. Transoesophageal ultrasonography of the mediastinum was a good imaging technique for examining the heart base, the major cranial mediastinal vessels, the descending aorta, and occasionally part of the azygos vein. Anatomical orientation was best obtained by beginning the examination at the heart base. Lymph nodes and smaller caliber vessels could not be distinguished from surrounding tissues; however, Doppler ultrasound was useful for identifying the smaller vessels. Although a 5 MHz frequency transducer is preferred for transoesophageal echocardiography, a higher frequency transducer would
improve the resolution of the images of small near-field structures and may be more appropriate for mediastinal imaging.

Wacker et al (1998) evaluated the use of ultrasonography to assess the gastropexy site for permanent adhesion in clinical cases. Two groups, each comprising eight dogs, were studied, all 16 cases undergoing decompression, anatomical repositioning of the stomach and an incisional gastropexy after gastric dilatation-volvulus (GDV). Group I was set up as a prospective group in which ultrasonographic examinations were performed three times (mean 3, 12 and 67 days) after surgery to evaluate the gastropexy region. The gastropexy site was assessed ultrasonographically at only one stage (mean 449 days after surgery) in the group 2 dogs. Criteria used to assess the usefulness of the ultrasonographic evaluation included the ability to identify the gastropexy site, to obtain measurements of the length and thickness of the site and to assess the ultrasonographic appearance of the different gastric wall layers. The average number of peristaltic contractions and degree of gastric filling were also evaluated. The fixation between the stomach and the abdominal wall was easily detected in all 16 cases. Ultrasonography proved to be a simple and non-invasive technique to assess the permanency of the gastropexy. The incisional gastropexy was relatively easy to perform and induced permanent adhesions in all 16 dogs, without recurrence of GDV.

Atalan et al (1999a) compared the ultrasonography and radiographic measurement of canine prostate dimensions in 29 dogs. Prostate, length and depth were measured from ultrasonography and radiographic images. Each dog was placed in right lateral recumbency and a plain lateral caudal abdominal radiograph was made. The bladder length and depth were measured in centimeters from the radiograph, taking into account magnification errors. Immediately after radiography was completed, ultrasonographic measurements of bladder length and depth or longitudinal section were measured in centimeters. The bladder was then
emptied by catheterization and the actual urine volume measured. Best subsets analysis indicated that radiographic and ultrasonographic bladder lengths were the best predictors of actual bladder volume. Formulae were derived from radiographic and ultrasonographic bladder dimensions for estimating bladder volume. The formula using radiographic measurements was found to be a better predictor of actual bladder volume than the formula derived from ultrasonographic measurements, since it had higher F and lower error mean square values.

Atalan et al. (1999b) compared the ultrasonographic and radiographic measurement of bladder dimensions and volume discrimination in 40 dogs. A subjective assessment of prostate size (small, normal or enlarged) was made in dogs by one of the authors who were unaware of radiographic or ultrasonographic measurements. In addition, the distance from sacral promontory to the pubic brim was also measured. A prostate length or depth of >70% of this distance was defined as enlarged and <70% as normal. After the effects of magnification on radiographic measurement were eliminated, there were no significant differences between prostatic lengths measured by the two methods. However, a significant difference was obtained between prostatic depth measurements. The subjective assessment agreed with a previously described objective assessment of prostatic size in 21/29 dogs for prostate length but in only 12/29 for depth. Prostatic length varied from 46.6 to 116.4% (mean 75.7%) of the distance from the pubic brim to the sacral promontory. Prostatic depth varied from 33.0% to 94.6% (mean 59.7%) of the same distance. It is recommended that prostate length, rather than depth, be used when evaluating prostate size from lateral abdominal radiographs.

Besso et al. (2000) evaluated the ultrasonographic appearance of 14 dogs with gall bladder mucoceles. On the basis of their studies they suggested that, ultrasonographically, mucoceles were
characterized by the appearance of the stellate or finely striated bile patterns and differ from biliary sludge by the absence of gravity dependent bile movement. On ultrasound, gall bladder wall thickness and we appearance were variable and nonspecific. The cystic or common bile du was normal sized in 5 dogs although all 5 had evidence of biliary obstruction at surgery or necropsy. Loss of gallbladder wall integrity and/or gallbladder rupture was present in 50% of the dogs, all located in the fundus. Gallbladder wall discontinuity on ultrasound indicated rupture whereas neither bile patterns predicted the likelihood of gallbladder rupture. Pericholecystic hyperechoic fat or fluid were suggestive of but n diagnostic for a gallbladder rupture. Two alternate courses of action in the presence of a distended gallbladder with an immobile ultrasonograph stellate or finely striated bile pattern: a cholecystectomy when clinical biochemical signs of hepatobiliary disease were present or a medic treatment (antibiotics and choleretics) and patient monitoring by follow-1 ultrasound examinations when the patient does not have clinical biochemical abnormalities.

Merlo and Lamb (2000) reviewed the radiographic and ultrasonographic signs in 8 dogs with a surgical and pathologic diagnosis of retained surgical sponge. The most frequent previous surgery was ovariohysterectomy, either as an elective procedure or to retained surgical sponge was 9.5 months (range 4 days to 38 months). Five dogs had draining sinus, four had a palpable abdominal mass. Radiologic signs included localized, speckled or whirl-like gas lucency, abdominal mass and non-focal soft tissue swelling. Survey radiography and sonography were considered diagnostic for retained surgical sponge in 4/7 (57%) and 3/5 (60%) dogs, respectively. The combined use of survey radiography and ultrasonography enabled detection of 6/7 (86%) sponges. In each dog that had ultrasonography, a hypoechoic mass was found that had an irregular hyperechoic centre. The possibility of retained surgical sponge should
considered in animals with a history of previous surgery and a sinus or abdominal mass.

*Kull et al.* (2001) reported the ultrasonographic characteristic of intestinal lymphangiectasia in 17 dogs and found intestinal abnormalities in 8 dogs and peritoneal effusion in 7 dogs. Exploratory laparotomy revealed abnormalities in 9 out of 16 dogs including thickened small intestine, dilated lacteals lymph adenopathy and adhesion. Imaging abnormalities are common in dogs with intestinal lymphangiectasia. But are not specific enough to differentiate from other gastrointestinal disorder.

Sonnenfield *et al.* (2001) reported a twelve year old neutered male beagle for a cranial abdominal mass. The results of physical examination, laboratory tests, radiography, and ultrasonography are presented. A torsion of the quadrate lobe of the liver was diagnosed at surgery and confirmed by histopathology. A brief discussion of liver lobe torsion is presented.

Voros *et al.* (2001) analyzed the following obstruction caused by bile sludge (correct/incorrect: \( \frac{1}{2} \), surgical diagnosis: choleliths in one case), gallbladder obstruction caused by neoplasm (0/1, surgical diagnosis: mucocele), gallbladder and extrahepatic biliary tract obstruction due to choleliths (3/3), extrahepatic biliary tract obstruction caused by pancreatic mass (1/1) and small intestinal volvulus (1/1). Bile peritonitis caused by gallbladder rupture (4/4) was correctly diagnosed by ultrasound, aided with ultrasonographically-guided abdominocentesis and peritoneal fluid analysis. Rupture of the gallbladder should be suspected in the presence of a small echogenic gallbladder or in the absence of the organ together with free abdominal fluid during ultrasonography. Laparotomy was correctly indicated by ultrasonography in all cases. However, the direct cause of obstruction could not be determined in 2 of the 12 dogs by ultrasonography alone.
Choi et al. (2002) reported ultrasonographically that all experimental dogs were administered with saline and soup solution (10 ml/kg, B.W.). The mean values of contraction number of pyloric antrum in saline and soup group were 4.19 ± 1.30/min and 4.82 ± 0.65/min before feeding, and overall mean values were 4.66 ± 1.37/min and 5.13 ± 1.71/min, respectively. The mean values of the GET by urea and volume method were 36.73 ± 11.27, 40.00 ± 8.87 min in saline group and 61.35 ± 17.58, 59.11 ± 14.46 min in soup group. In the GET in saline and soup groups, there was no significant difference between the area and volume method (p > 0.05).

Cuccovilo and Lamb (2002) reported the cellular feature of sonographic target lesion of the liver and spleen in 21 dogs. Target lesion were seen in U.S. images of liver or spleen as nodules or masses with a hypoechoic rim and a hyperechoic or isoechoic centre. To assess the diagnostic significance of finding a target lesion, the cytologic and/or histopathologic findings were reviewed in a series of 21 dogs that had hepatic and/or splenic target lesions noted during abdominal ultrasonography. Twelve of 16 hepatic target lesions and 5 of 7 splenic target lesions were malignant. In this series, the finding of one or more target lesions in the liver or spleen had a positive predictive value for malignancy of 74%, for the finding of multiple target lesions in one organ the positive predictive value for malignancy was 81%. Benign lesions; associated with target lesions were nodular hyperplasia of the liver and spleen, pyogranulomatous hepatitis, cirrhosis and chronic active hepatitis.

Liu et al. (2002) studied intra-abdominal haemorrhage by contrast enhanced two and three dimensional sonography. Bleeding sites were created within the livers (n = 3), spleens (n = 5), and kidneys (n = 3 of 3 dogs. A sonographic contrast agent with vascular and parenchyma enhancement capabilities was administered intravenously at a dose of 0.0: mL/kg. Before and after each contrast agent injection, the bleeding site-
were imaged with two and three-dimensional sonography in gray scale harmonic imaging and color flow modes. Sonographic findings were compared with gross pathologic findings. Noncontrast-enhanced sonography was not able to show the specific location of the active bleeding in any of the organs evaluated. The contrast agent enhanced the sonographic detection of blood flow in normal vessels and extravasated blood from damaged vessels or organs in all cases. Intrasplenic and intrahepatic hematomas were better identified on delayed imaging sequences because there was marked enhancement of the normal parenchyma, whereas the hematomas remained unenhanced. Reconstructed three-dimensional sonography showed spatial relationships of the bleeding sites and surrounding structures. Gross pathologic findings were consistent with the contrast-enhanced sonographic results. They concluded that contrast enhanced sonography improves the detection and evaluation of abdominal bleeding site.

Troxel et al (2002) studied the uterus of a female German shepherd bitch with history of severe haemorrhage from the vulva. Ultrasonographic examination demonstrated at the uterine body and cranial vaginal lumen were fluid-filled and contained hyperechoic, polypoid masses that were suspected to the blood clots. Exploratory laparotomy revealed a mildly enlarged uterus with a diffuse, cystic endometrium; significant amounts of blood and blood clots within the lumen; and several focal accumulations of yellow fluid presumed to be a purulent exudate.

Varshney and Hoque (2002) analysed the findings of ultrasonography in 24 dogs with hepatopathies and, in 3 dogs without hepatopathy and compared with the results of haemato-biochemical investigations. Ultrasonographic appearance of liver demonstrated diffuse hyperechoic "bright" but small liver in cirrhosis and in intrahepatic porto-systemic shunt (PSS), and diffuse fine hypoechoic hepatic changes with hepatomegaly in chronic active hepatitis. Mostly a single shunt either
between intrahepatic vena cava and portal vein (most common) or intrahepatic portal and hepatic vasculature was detected sonographically, confirming the diagnosis of intrahepatic PSS. Predominance of target cells, poikilocytes, microcytes, crystals of ammonium biurate in urine was constant finding in PSS. Serum protein, serum albumin, BUN, blood glucose, SAP, ALT were on lower side in PSS. However, SAP, ALT and arginase values were high in chronic active hepatitis.

Ultrasonographic diagnosis of ovarian tumour in a bitch was made by Prathaban et al (2003). Multi cystic structures were visualized in the ovarian area, which were extending up to the bladder. Normal ovarian tissue was not distinguished. Uterus was hyperechoic, but no accumulation of fluid or pus was detected. The ovarian tumor found in both the ovaries were excised with hysterectomy.
MATERIALS AND METHODS

The present study was conducted on 140 dogs brought either to the clinic of the Department of Veterinary Surgery and Radiology, College of Veterinary and Animal Science, Bikaner for diagnosis and treatment of various diseases and sterilization, or to the Canine Welfare Society (Collaborated with College of Veterinary and Animal Sciences, Bikaner) by the Municipal Corporation of Bikaner under Animal Birth Control (ABC) Programme. These dogs were of either sex and of all age groups.

The animals were studied in two groups:

Group I: In this group the clinical cases of dogs presented for various ailments or for pregnancy diagnosis were scanned and ultrasonography of the canine abdomen was done, externally and internally. The diagnosis made was therefore clinical in nature and had an associated definitive medical history.

Group II: In this group the dogs of ABC programme were scanned and a survey ultrasonography of the canine abdomen was done, externally and internally. The diagnosis made was therefore incidental in nature and had no associated medical history.

Ultrasound Machine

The ultrasonographic scanning was done on Schimadzu's ultrasound machine in B-mode with a 2.5 - 5 MHz sector convex transducer with a constant output of 4.5 MHz. An ultrasonography gel was used as a coupling medium. The print out of the scan was obtained on a thermo printer.
Preparation of Animal

The dogs of ABC programme and ultractable dogs amongst clinical cases were fasted overnight before administration of general anaesthesia.

The entire lateroventral abdominal area was clipped and shaved for ultrasonographic scanning.

Anaesthesia

The dogs of ABC programme were anaesthetized using xylazine (2 mg/kg/B.wt.), ketamine hydrochloride (5.5 mg/kg/B.wt.) and atropine sulphate (0.25 mg/kg/B.wt.) as a cocktail anaesthesia, intramuscularly. The maintenance of anaesthesia was done using Ketamine Hydrochloride @ 10 to 22 mg/kg B. wt., intravenously.

This anaesthetic regime was used in some clinical cases also where the dog was not cooperative or was furious.

Position of Animal

The animal was positioned in lateral (right and left) to dorsal recumbent positions, for scanning of various abdominal organs. The placement of ultrasound probe at various points in lateral recumbency has been depicted in Fig 1 and in dorsal recumbency has been depicted in Fig 2.

Ultrasound scanning

After securing the animal either in lateral or dorsal recumbency a sector convex probe was placed in sagittal, longitudinal, oblique or dorsal manner in different regions to view various organs (Table 1).
Radiography

A lateral or dorsoventral survey radiograph without use of a grid was taken on a screened film as and when deemed required to substantiate the ultrasonographic findings.

Induction of diuresis to fill up the bladder

In cases where the urinary bladder was either empty or partially filled up, injection of Furosemide 20 mg intramuscularly was given at least 15 minutes prior to the ultrasonography.

Interpretations

The ultrasonograms obtained were interpreted and various affections were diagnosed based on their echogenic pattern and comparing these with normal ultrasonic appearance of a particular abdominal organ in accordance to the veterinary sonography text; authored by Keally and McAllister (2000) and Goddard (1995). A survey radiograph was also taken wherever feasible to substantiate the ultrasonographic findings.
Table 1. Anatomical locations for transducer to visualize various organs sonographically.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Organs</th>
<th>Anatomical location for probe placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Liver</td>
<td>Ventral midline immediately caudal to the xiphoid</td>
</tr>
<tr>
<td>2.</td>
<td>Gall bladder</td>
<td>Ventral midline immediately caudal to the xiphoid</td>
</tr>
<tr>
<td>3.</td>
<td>Spleen</td>
<td>Caudal aspect of the left 13(^{th}) rib</td>
</tr>
<tr>
<td></td>
<td>Stomach</td>
<td>Left post xiphoid</td>
</tr>
<tr>
<td>5.</td>
<td>Left kidney</td>
<td>Caudal to the dorsal part of the spleen</td>
</tr>
<tr>
<td>6.</td>
<td>Right kidney</td>
<td>Through last intercostal space on right side</td>
</tr>
<tr>
<td>7.</td>
<td>Urinary bladder</td>
<td>Pelvic or prepubic region</td>
</tr>
<tr>
<td>8.</td>
<td>Prostate gland</td>
<td>Pelvic or prepubic region</td>
</tr>
<tr>
<td>9.</td>
<td>Uterus (pyometra)</td>
<td>Pelvic or prepubic region</td>
</tr>
<tr>
<td>10.</td>
<td>Uterus (pregnancy)</td>
<td>Mid to posterior abdomen</td>
</tr>
<tr>
<td>11.</td>
<td>Abdominal fluid</td>
<td>Xiphoid to pelvis</td>
</tr>
<tr>
<td>12.</td>
<td>Mammary gland</td>
<td>On mammary gland region</td>
</tr>
<tr>
<td>13.</td>
<td>Scrotum</td>
<td>Posterior or caudal aspect of scrotum</td>
</tr>
<tr>
<td>14.</td>
<td>Vagina</td>
<td>On inflammed vulvar lips</td>
</tr>
<tr>
<td>15.</td>
<td>Ovary</td>
<td>Adjacent to the caudal pole of the kidney at the level of 5(^{th}) lumbar vertebral.</td>
</tr>
<tr>
<td>16.</td>
<td>Penis</td>
<td>Over the lateroventral aspect of sheath</td>
</tr>
</tbody>
</table>
RESULTS

In animals of present study, 140 dogs were examined and diverse affections were diagnosed in 71 dogs only thus the incidence was found to be 50.71%. Out of which 30% were males and 20.71 were females. A group-wise classification of diverse affection diagnosed is given in table 2. The diverse affections were clinical in nature (53.52%) in animals of group I and were incidental in nature (46.478%) in animals of group II. The diagnosed affections were seen in 24 (33.80%) males and 14 (19.718%) females in animals of group I whereas these were 18 (25.352%) in males and 15 (21.126%) in females in animals of group II. In both the groups of the present study the incidence was found more in males as compared to females. It was further observed that incidence of urinary system was found more in males whereas incidence of affections of genital system was found more in females.

Table 2. A sex-wise classification of number of diverse affections diagnosed in animals of group I and group II which were clinical and incidental in nature, respectively out of 140 dogs examined (abbreviations used: M=Male, F=Female, T=Total).

<table>
<thead>
<tr>
<th>S.Diverse Affections No. Diagnosed</th>
<th>Number of diverse affections diagnosed</th>
<th>Total Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group I Clinical in nature Incidental in nature</td>
<td>Group II Clinical in nature Incidental in nature</td>
</tr>
<tr>
<td></td>
<td>M F T</td>
<td>M F T</td>
</tr>
<tr>
<td>1. Digestive system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Foreign body</td>
<td>4 - 4</td>
<td>- - -</td>
</tr>
<tr>
<td>b. Livery cyst</td>
<td>1 - 1</td>
<td>- - 2</td>
</tr>
<tr>
<td>c. Liver cirrhosis</td>
<td>1 2 3</td>
<td>- - 2</td>
</tr>
<tr>
<td>d. Gall bladder sludge</td>
<td>1 - 1</td>
<td>- - 2</td>
</tr>
<tr>
<td>e. Splenic calcification</td>
<td>1 - 1</td>
<td>- - -</td>
</tr>
</tbody>
</table>

82
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Diverse Affections Diagnosed</th>
<th>Number of diverse affections diagnosed</th>
<th>Group I Clinical in nature</th>
<th>Group II Incidental in nature</th>
<th>Total</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
<td>T</td>
<td>M</td>
</tr>
<tr>
<td>2.</td>
<td>Urinary system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Renal calculi</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>b. Hydronephrosis</td>
<td></td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>c. Cystic calculi</td>
<td></td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>d. Cystitis</td>
<td></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Genital system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Pyometra</td>
<td></td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>b. Pregnancy diagnosis*</td>
<td></td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>c. Mammary gland tumor</td>
<td></td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>d. Venereal granuloma</td>
<td></td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>e. Ovarian cyst</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>f. Enlarged prostate</td>
<td></td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>g. Monorchid</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>h. Hydrocele</td>
<td></td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Ascites</td>
<td></td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>24</td>
<td>14</td>
<td>38</td>
<td>18</td>
</tr>
<tr>
<td>Incidence (%)</td>
<td></td>
<td></td>
<td>33.80</td>
<td>19.72</td>
<td>53.52</td>
<td>25.35</td>
</tr>
</tbody>
</table>

* Pregnancy is a physiological manifestation.

The affections related to genital system are given in table 3 and these were 21.428% and were found in 14 (10%) male and 16 (11.428%) female dogs.
Table 3. Affections observed in genital system and incidence expressed in per cent (except pregnancy diagnosis* which is a physiological manifestation).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Affection</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pyometra</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2.142</td>
</tr>
<tr>
<td>2.</td>
<td>Pregnancy diagnosis*</td>
<td>-</td>
<td>6</td>
<td>6</td>
<td>4.285</td>
</tr>
<tr>
<td>3.</td>
<td>Mammary gland tumor</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>3.571</td>
</tr>
<tr>
<td>4.</td>
<td>Ovarian cyst</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>0.714</td>
</tr>
<tr>
<td>5.</td>
<td>Venereal granuloma</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1.428</td>
</tr>
<tr>
<td>6.</td>
<td>Enlarged prostate</td>
<td>11</td>
<td>-</td>
<td>11</td>
<td>7.857</td>
</tr>
<tr>
<td>7.</td>
<td>Monorchid</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>0.714</td>
</tr>
<tr>
<td>8.</td>
<td>Hydrocele</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>0.714</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>14</td>
<td>16</td>
<td>30</td>
<td>21.428</td>
</tr>
</tbody>
</table>

The diagnosed affections were pyometra (2.142%), pregnancy diagnosis (4.285%), mammary gland tumor (3.571%), ovarian cyst (0.714%), venereal granuloma (1.428%), enlarged prostate (7.857%), monorchid (0.714%) and hydrocele (0.714%).

The affections related to urinary system are given in table 4 and these were 15% and were found in 19 males and 2 female. Various affections recorded were renal calculi (1.428%), hydronephrosis (2.857%), cystic calculi (7.857%) and cystitis (2.857%).
Table 4. Affections observed in urinary system and incidence expressed in per cent.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Affection</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Renal calculi</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1.428</td>
</tr>
<tr>
<td>2.</td>
<td>Hydronephrosis</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>2.857</td>
</tr>
<tr>
<td>3.</td>
<td>Cystic calculi</td>
<td>11</td>
<td>-</td>
<td>11</td>
<td>7.857</td>
</tr>
<tr>
<td>4.</td>
<td>Cystitis</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2.857</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19</td>
<td>2</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Incidence (%)</td>
<td>13.571</td>
<td>1.428</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

The affections related to digestive system are given in table 5 and these were 11.428% and were found in 8 male and 8 female dogs.

Table 5. Affections observed in digestive system and incidence expressed in per cent.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Affection</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Foreign body in stomach</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>2.857</td>
</tr>
<tr>
<td>2.</td>
<td>Liver cyst</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2.142</td>
</tr>
<tr>
<td>3.</td>
<td>Liver cirrhosis</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>3.571</td>
</tr>
<tr>
<td>4.</td>
<td>Gall bladder sludge</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2.142</td>
</tr>
<tr>
<td>5.</td>
<td>Splenic calcification</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.714</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>16</td>
<td>11.428</td>
</tr>
<tr>
<td></td>
<td>Incidence (%)</td>
<td>5.714</td>
<td>5.714</td>
<td>11.428</td>
<td></td>
</tr>
</tbody>
</table>

Diverse affections diagnosed were foreign body in stomach (2.857%), liver cyst 2.142%, liver cirrhosis (3.571%), gall bladder sludge (2.142%) and splenic calcification (0.714%).

Ascites was diagnosed in 4 dogs out of which 3 were females which constituted 2.857% of total diagnosed cases (Table 6). It has been placed in the category of miscellaneous affection.
Table 6. Miscellaneous affection observed in canine abdomen.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Affection</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ascites</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2.857</td>
</tr>
</tbody>
</table>

The ultrasonographic and radiographic details of various diagnosed affections are given below:

**Affections of Digestive System**

Out of 140 dogs examined 16 dogs had affections of digestive system.

**Foreign bodies in stomach:** Four dogs were diagnosed foreign bodies in the stomach belonged to group I and were clinical cases out of which three had radio-opaque and one had radiolucent foreign bodies. All the dogs were subjected to radiographic examination in lateral view. This affection was not seen in animals of group II.

**Radiologic signs:** Out of 4, 3 cases had presence of radio-opaque metallic foreign bodies in the stomach. One dog had three metallic balls of 2-3 mm diameter each (fig 3) whereas other dog had similar sized balls which were four in number (fig 4). Third dog had a pellet sized 2.25 cm non-penetrating metallic foreign body in the stomach (fig 5). The fourth dog had a radiolucent foreign body which had an irregular margins and shape in the stomach (fig 6). All the dogs had a history of vomiting, but radiographically gastritis was not evidenced because the foreign bodies were having smooth edges and mucosa lining of stomach was not thickened.
**Ultrasonographic findings:** Ultrasonograms of cases of gastric foreign bodies depicted in radiographic figs 3, 4, 5, 6 were scanned and represented in figs 7, 8, 9, 10, respectively.

The ultrasonogram depicted in fig 7 showed metallic foreign bodies in form of hyperechoic rounded bodies in the stomach as seen in fig 3 radiographically. A distinct acoustic shadow was also associated with two hyperechoic masses suggestive of presence of metallic balls as seen in the radiograph. However, three balls were distinctly visible in radiograph whereas only two were detected in ultrasonogram in the given view.

The ultrasonogram depicted in fig 8 showed metallic foreign bodies in form of hyperechoic rounded bodies in the stomach as seen in fig 4 radiographically. A mild acoustic shadow was also associated with these hyperechoic rounded bodies suggestive of presence of metallic balls. However, the radiograph of this case evidenced 4 metallic foreign bodies and ultrasonogram evidenced only two.

The ultrasonogram depicted in fig 9 showed a long metallic foreign body as hyperechoic structure in the stomach with distinct acoustic shadow. The shape of foreign body was similar to that seen in fig 5 radiographically where it was present in pellet shape.

The ultrasonogram depicted in fig 10 showed a hyperechoic mass with irregular border and shape in stomach. A distinct acoustic shadow was visible.

The metallic foreign bodies were identified as hyperechoic structure in the lumen of stomach in animals of present study. The metallic balls were distinctly visible as rounded hyperechoic structure, with acoustic shadows (figs 7, 8). However, the pellet type foreign body, as seen in radiograph appeared as hyperechoic structure (fig 9) which was almost rectangular in shape. Acoustic shadow was present in this case. The radiolucent foreign body which was evident radiographically
Liver cyst: Liver cysts were observed in 1 male of group I and 2 females of group II. The ultrasonographically diagnosis of male was clinical in nature where as it was incidental in nature in 2 females. In male dog liver cyst appeared as small circular anechoic zone and was located dorsal to the diaphragm and ventral to the hepatic portal vein. A sparse hyperechoic pattern were visible dorsal to the gall bladder which was suggestive of a concurrent occurrence of mild liver cirrhosis. Distal acoustic enhancement was not seen in the present case (fig 11).

Ultrasonogram of a female dog revealed a well circumscribed rounded anechoic area suggestive of a hepatic cyst and was located anterior to the gall bladder (fig 12). Distal acoustic enhancement was not seen in this case. A similar sized liver cyst was observed dorsal to the gall bladder in another bitch ultrasonographically.

Liver cirrhosis: Liver cirrhosis was observed in 3 cases of animals of group I and 2 cases of animals of group II. The ultrasonographically diagnosis was clinical in nature in (1 male and 2 female) 3 dogs and incidental in nature 2 female dogs. The ultrasonogram revealed a diffuse increase in the echogenic pattern in the liver parenchyma which appeared to be hyperechoic in majority of cases. The liver lobe had irregular margin and a significant amount of ascitic fluid was also visible as anechoic zone (F) dorsal to the cirrhotic liver (fig 13). A sunken gall bladder was also visible amid hyperechoic shadow of cirrhotic liver. A simultaneous presence of ascites was seen in all the cases (fig 14). A distinct difference between male and female cirrhotic liver was not observed.
Gall bladder sludge: Gall bladder sludge was observed in one male of group I and 2 females of group II. The gall bladder appeared as a dark (anechoic) area between the diaphragm and liver. The ultrasonographically diagnosis was clinical in nature in male dog and was incidental in females. Bile sludge appeared as mildly echogenic sediment with an appreciable acoustic shadowing in one case only which indicates a possible presence of choleliths because acoustic shadowing occurs due to mineralization (fig 15). However, acoustic shadowing was absent in 2 cases (fig 16). A thickness in the wall of gall bladder was not seen.

Splenic calcification: Splenic calcification was seen in one male dog of group I only. It appeared as a hyperechoic lesion in its right half upon ultrasonography (fig 17). This parenchymal abnormality was diffuse in nature and dog did not exhibit any clinical sign which could be correlated with the splenic lesion. A distortion in size and changes in the margins of spleen were not observed in animals of present study.

Affections of Urinary System
Renal calculi: Renal calculi was diagnosed in 2 dogs of group I. Out of these one male dog revealed single (fig 18) and other female had multiple renal calculi (fig 19). Renal calculi appeared as hyperechoic discrete structure with marked acoustic shadowing in renal pelvis. Mild hydronephrosis was also associated in cases of this study. This was evidenced by presence of fluid in renal pelvis and dilated fluid filled in renal calyces marked by anechoic zones. Out of 2 dogs the male was lean and female was obese. Kidney was more clearly visible in lean dog as compared to obese one. Both the dogs of present study were clinical cases and showed clinical signs of urinary calculosis.
Lateral radiograph of a male dog showed presence of mildly radio-opaque renal calculi in left kidney (fig 20). However, radiograph of other female dog could not be obtained.

**Hydronephrosis:** Hydronephrosis was diagnosed in 2 males of group I and 2 males of group II. It was characterized by marked dilatation of renal pelvis by an anechoic region (fig 21). These cases did not evidence renal or ureteric calculi and the dog of group I showed signs of possible renal disease because they had an associated swelling in the limbs together with inappetence.

**Cystic calculi:** Cystic calculi was diagnosed in 4 male dogs of group I and 7 male dogs of group II. Cystic calculi was evaluated in urinary bladder after an injection of furosemide 20 mg intramuscularly in 4 cases of group I in present study. The cystic calculi were identified ultrasonographically as hyperechoic concretions in seven cases and hypoechoic sediments were seen in four cases. Mineralized calculus appeared as a hyperechoic structure, round in shape with associated acoustic shadowing on the floor of urinary bladder (fig 22). However hypoechoic concretions were also seen on the floor of urinary bladder (fig 23 and 24). A change in position of calculi was seen during ultrasonic examination and with slight movement of animal's body.

**Cystitis:** Cystitis was diagnosed in 3 dogs of group I and 1 dog of group II. The diagnosis was incidental in nature in 1 male and clinical in nature (in 2 males and 1 female. Ultrasonographically it was characterized by diffusely thickened wall which was hyperechoic with irregular mucosa edges. Urine contained suspended particles of variable echogenicity (fig 25). A nonspecific intramural sedimentation was observed on the floor c ventral aspect of urinary bladder and this sedimentation was hypoechoic in 2 dogs. The cystitis was evident clinically also because thy manifestation like frequent micturition etc. were seen in clinical cases.
The thickened bladder wall was further evaluated by completely emptying the urinary bladder. Sonogram of such a case showed shrunken urinary bladder with thickened wall (fig 26). Marked inflammatory exudate as suspended particles was evident ultrasonographically in yet another case of cystitis with thickened bladder wall (fig 27).

In 5 cases of present study the cystitis was associated with calculus formation. Ultrasonographically it was characterized by irregular and rough mucosal border of urinary bladder.

**Affections of Genital System**

**Enlarged prostate:** Enlarged prostate gland was seen ultrasonographically) in 4 males of group I and 7 males of group II. Enlarged prostate was seen radiographically also (fig 28). It appeared as a radiolucent swelling around the urethra caudal to the neck of urinary bladder. However, the same case was evaluated ultrasonographically also (fig 29). The prostatic tissue showed slightly more prominent echogenicity with small anechoic area; representing retention cyst on ventral aspect. In yet another case the sonogram revealed increased echogenicity of the hyperplastic prostatic tissue (fig 30). Few focal areas which were hyperechoic in nature represent calcification of the prostatic tissue. The diagnosis in 4 animals of group I was clinical in nature and in 7 animals of group II was incidental in nature.

**Monorchid:** Monorchidism was an incidental finding in a dog of anima birth control programme of group II. It was manifested ultrasonographically! by absence of testicular echotexture in one scrotal sac. However, normal testicular echotexture was observed in other scrotal sac (fig 31).

**Hydrocele:** Hydrocele was diagnosed in 1 clinical case of group I of present study which was characterized, ultrasonographically, by the presence of anechoic fluid between testicular parenchyma and scrotal wall. The scrotal sacs appeared distended (figs 32, 33).
**Pyometra:** Pyometra was diagnosed in 3 females of group I of present study which were clinical in nature. Distended uterus with flattened margin and anechoic fluid were diagnosed as closed pyometra cases. The ultrasonographic diagnosis was in corroboration with clinical history of the case where the affected bitches were septicaemic, anorectic and had occasional vomiting. Several portions of the anechoic fluid dilated uterus were seen ultrasonographically (fig 34) and the organ was coiled upon itself. In another case of pyometra uterus appeared as relatively anechoic and dilated tube with a thin hyperechoic wall (fig 35).

**Pregnancy diagnosis:** Ultrasonography was done in 6 bitches in present study at various phases of gestation. Out of which one case was clinical and 5 were incidental in nature. Although determination of exact age of foetus was not ascertained because it was not incorporated in the objective of study and more over the number of pregnant bitches sonographed were insufficient to conclude the edge of foetus. The number of fetuses could not be determined exactly. The allantoic fluid around the foetus was visible as anechoic in nature.

The ultrasonogram further revealed foetal head and spine in the posterior abdominal region in a bitch (fig 36). Foetal head, spine, stomach and heart were also visible ultrasonographically indicating it to be a foetus of advance gestation (fig 37). In yet another ultrasonogram the foetal spine and ribs in posterior abdominal regions were visible (fig 38). However, foetal mass with long bones and amniotic fluid were also visible (fig 39). In animals of present study the radiography gave a better detail of foetal number, position, developmental stage etc (fig 40) The lateral radiograph of canine abdomen showed well developed fetuses in the gravid uterine horn of a bitch. **Ovarian cyst:** This was diagnosed ultrasonographically in one bitch of group II wherein the finding was incidental in nature. The ovarian cyst was located in the right ovary. Ultrasonographically it revealed a
circumscribed structure with thin hypoechoic wall and anechoic fluid in cranial portion of the ovary (fig 41).

**Mammary gland tumor:** It was diagnosed in 3 bitches of group I and 2 bitches of group II. Ultrasonogram of one bitch revealed a variable echotexture with a distinct zone of hyperechoic structure which was suggestive of presence of fatty tissue in the tumor mass (fig 42). Ultrasonogram of other bitch revealed a non-homogenous tissue with varying and mixed echogenicity. The acoustic shadowing was absent (fig 43).

**Venereal granuloma:** It was diagnosed in a male clinical case of group I and a female dog of ABC programme of group II. Ultrasonogram of a swollen vagina revealed a hyperechoic zone with irregular anechoic borders and few anechoic zones were located within the hyperechoic tissue mass (fig 44). Ultrasonogram of a male sheath revealed a mass of mixed echogenicity over the os penis which was suggestive of presence of venereal granuloma and it was present clinically too (fig 45).

**Miscellaneous Affection**

**Ascites:** Ultrasonogram of a male dog revealed a hyperechoic tissue which was cirrhotic liver (ventrally) and anechoic zone (dorsally representing the ascitic fluid (fig 46). The ultrasonogram of a female revealed a well demarcated left kidney with a surrounding anechoic zone caused by the ascitic fluid (fig 47). The ultrasonogram of other female revealed a clearly suspended urinary bladder in the anechoic zone of ascitic fluid. The thick hyperechoic wall of urinary bladder indicated cystitis which was clinically evident too (Fig 48). Tho ultrasonogram of a third female revealed distinctly visible anechoic areas representing peritoneal fluid and separating the visceral organ;
like liver (fig 49). Lateral radiograph of abdomen of this female showed a uniform opacity of abdomen which is characteristic of ascitic fluid (fig 50).
DISCUSSION

Diagnostic ultrasound proved a useful tool in diagnosing the diverse affections of canine abdomen as a narrow difference of incidence was seen between the survey diagnosis (group II) and clinical diagnosis (group I). Since ultrasound is noninvasive and a harmless diagnostic technique hence may be considered for a routine abdominal check-up in health and disease of a pet. Miles (1997) opined that abdominal ultrasonography often provides the best diagnostic yield when used in combination with radiograph image guided biopsy techniques. Cystic lesion can be differentiated from the solid masses with ultrasound.

Kealy and McAllister (2000) also opined that ultrasonography is a more sensitive tool than radiography in diagnosing even small volumes of fluid in abdomen which appears as anechoic. Similar observations were found in present study also where ultrasonographic diagnosis made were clinical in nature in 53.52% cases and incidental in nature in 46.478% cases.

A higher occurrence of diverse affection in males as compared to the females points to the relevance with similar population ratio also. There is growing tendency to keep a male pet in the society also attributes to the higher number of male as seen in animals of group I and II in present study where out of 71 cases, males were 42 and females were 29. It was interesting to note that males had 10 folds more occurrences in affections of urinary system as compared to the females. It could be due to the fact that mate is sexually more active, it has long and narrow urethra as compared to female and among the population of pets and stray dogs the males are in abundance. It is a well known fact that the urinary calculi are usually passed out with urine in females, which have short and dilated urethra, hence females had less occurrence of affections of urinary system in animals of present study.
Out of the diagnosed genital affection of the females the diagnostic ultrasound appeared to be most suited for pregnancy diagnosis because number of females was highest which were diagnosed for pregnancy in animals of present study. However, the incidence of mammary gland tumor and pyometra was found to be 3.571% and 2.142%, respectively, which was lower than incidence of pregnancies. Both the affections are usually seen in aged bitches and have a great clinical significance because they endanger the pet life. However, the incidence of ovarian cyst and venereal granuloma was appreciably low. Among the genital affections of male enlarged prostate had highest incidence. Other affections like monorchid and hydrocele had appreciably low incidence.

The digestive system affections were found in, equal incidence in both the sexes. However, the incidence of liver cirrhosis was 4 fold in females as compared to males, whereas the incidence of foreign body in stomach was 4-fold in males as compared to females. This could be attributed to the fact that in animals of present study only clinical cases evidenced this affection and these animals were usually pets, which have a playful attitude and predispose them for foreign body ingestion. The occurrence of ascites was found 3 times more in females as compared to males.

**DIGESTIVE SYSTEM**

**Foreign bodies in stomach**: Radio-opaque and radiolucent foreign bodies were found in animals of present study. The radio-opaque foreign body appeared to be metallic. Archibald (1974) reported that dog ingests a variety of metallic object, stone, rubber balls, toys, or small article of cloth. The foreign bodies such as needle, golf balls, sponge, rubber balls and piece of cloth have been demonstrated radiographically in the stomach of dog. However, gastric foreign bodies were successfully demonstrated...
radiographically in animals of present study. The shape, size and numbers of foreign bodies can be demonstrated more clearly on radiograph than sonograph as has been observed in present study. Contrary to this Tidwell and Pinninck (1992) reported that ultrasonography of stomach is helpful in diagnosing foreign bodies.

Liver affections: Liver was scanned through the ventral midline immediately caudal to the xiphoid ventral midline region with a 4.5 MHz output of convex sector probe in animals of present study. However, Bhadwal et al (1999) scanned the liver from a point just caudal to the xiphisternum with the sound beam directed craniodorsally. The area of liver not accessible from xiphisterum was scanned through 12th intercostals space close to the sternal margin.

Nyland and Gillett (1982) found canine liver with much more difficulty to scan than the human liver because it is located further cranially under the rib cage and is oriented in an upright position. Bhadwal et al (1999) encountered difficulty with a 7.5 MHz transducer in scanning the farthest part of liver close to the diaphragm in dog weighing above 20 kg. However, with 3.5 MHz transducer both liver and diaphragm are easily scanned though the resolution was compromised. The architectural details were better visible with 7.5 MHz than with 3.5 MHz transducer (Bhadwal et al, 1999). However, in animals of present study a 4.5 MHz transducer was used with satisfactory sonographic details.

An occasional unsatisfactory image of liver is ascribed to the inadequately prepared animals because the xiphisternum area covered by the gas containing stomach resulted in reverberation artifact (Bhadwal et al, 1999).
Sonographic appearance of normal liver resembled to that reported by Selecser (1995). Nyland and Hager (1985) also found that the normal liver parenchyma produced a uniform echo pattern except for vascular structure whereas Barr (1992) described normal liver as relatively echolucent. The entire liver cannot be evaluated in one scan (Bhadwal et al, 1999). However, in animals of present study a uniform echopattern was seen in liver parenchyma, particularly in cases where liver pathology was not involved.

Alteration in the size of the liver may be associated with a number of liver diseases in dogs (Godshalk et al, 1988 and Barr 1992). However, liver size was not considered as criterion for detecting liver pathology in animals of present study. These were basically diagnosed on the basis of echogenic pattern which were compared with normal sonographic appearance of liver. Barr (1992) considered ultrasound as a means of assessing liver architecture which is potentially accurate, quantitative and without non-biological hazards.

In animals of present study liver cysts and cirrhosis were diagnosed ultrasonographically, however, hepatic abscess (Schwarz et al, 1988), tortion of liver lobe (Sounenfield et al, 2001), hepatic neoplasia and generalized mycosis (Voros et al, 1991) were not observed. Focal alterations and hepatic cirrhosis, as observed in animals of present study were also reported by Voros et al (1991). Although intrahepatic portosystemic shunt and chronic active hepatitis were not detected in animals of present study, but were reported by Johnson et al (1987). They also reported occurrence of cirrhosis in dogs which were diagnosed in present study. The ultrasonographic signs were found quite similar.

The hepatic cyst as observed in 2 animals of present study is of rare occurrence. Cystic hepatic masses can be benign and malignant and may
be revealed on ultrasonography, but these may be slow growing and has been described in old cat (Trout et al, 1995). Hepatic cysts were also found to be anechoic and incidental by Kealy and McAllister (2000). Sevelius and Johnson (1998) described that ultrasonography is a valuable aid in evaluating focal liver disease. Objective criteria are lacking for evaluating liver size. Space occupying lesions like tumors, cysts, abscesses and granulomas can be observed. According to Lamb (1990a) ultrasonographic examination is a poor technique for demonstrating generalized or diffuse hepatic cellular disease as the various echo patterns are hard to separate from each other.

**Gall bladder affection**: The gall bladder appeared full in two animals of present study because they were fasted for more than 12 hours and appeared as round to oval shape anechoic structure which is in confirmation with the observation of Nyland and Hagar (1985). The bile sludge detected with in gall bladder as hyperechoic sediment in animals of present study was also observed by Nyland and Hagar (1985). It could be due to a biliary stasis which is of no clinical significance unless an additional evidence of biliary obstruction is seen. Echogenic sludge which settles in the dependent aspect of the gall bladder is a very common finding of no apparent clinical significance (Murray et al, 1992). However, pathological thickening of the gall bladder wall sometimes reducing in a double or layered appearance may be due to cholecystitis or various non biliary diseases (Wegner et al, 1987 and Teefy et al, 1991). However, such pathologies were not encountered in animals of present study.

Sevelius and Johnson (1998) reported that ultrasonography is an excellent means of demonstrating radiolucent gall stone and represent a non-invasive way of diagnosis and localizing portosystemic shunt in those cases where the vascular anomalies can be visualized.
Distal acoustic enhancement is seen only in one case of present study but Bhadwal et al. (1999) found it consistent feature in all the animals. Selecter (1995) accounts a lower protein content in bile within gall bladder as a reason of enhancement.

Besso et al. (2000) observed 14 dogs with enlarged gall bladder and immobile stellate or finely striated bile patterns on ultrasound. All dogs were diagnosed with a gall bladder mucocele upon histologic and/or macroscopic evaluation. Rupture of gall bladder was also present in 15% dogs. However, such pathology was not observed in animals of present study.

**Splenic calcification**: A hyperechoic lesion designated as splenic calcification in one case of present study needed further investigation in terms of aspiration cytology or biopsy in order to confirm the diagnosis. However, Goddard (1995) pointed hyperechoic focal or multifocal lesions in chronic infract or metastasis or when fat is found around hilar vein and diffuse lesions are seen in cirrhosis. Other investigations also pointed out that focal abnormality of spleen are most often due to tumor or haematoma (Wrigley, 1991), splenic torsion (Konde et al., 1989), abscess (Konde et al., 1986a), infarcts (Schelling, 1988) and hyperplastic nodules. There is a considerable confusion in the ultrasonographic appearance of neoplasms, haematomas and abscesses in the spleen and even fine visible aspirates often cannot distinguish these lesions (Wrigley, 1991). When metastasis is suspected during ultrasonography a simultaneous thoracic radiograph should also be taken to rule out the pulmonary metastasis and if these studies are found negative, a splenectomy should be done for a histopathological diagnosis (Lamb, 1995). However, owing to only one case of splenic calcification in present study further investigation as pointed above could not be done.
URINARY SYSTEM

Renal Calculi: The 2 animals of either sex of present study were diagnosed renal calculi. The calculi were hyperechoic, discrete and caused marked acoustic shadowing. Similar finding in renal calculi were also observed by Kealy and McAllister (2000). They opined that small calculi may be difficult to differentiate from the normal hyperechoic pelvis and if the renal pelvis is dilated with fluid the calculi will be clearly seen. However, in cases of present study also the renal pelvis was dilated. The renal calculi was suspected to be triple phosphate and oxalate because these were radio-opaque. Poor image quality in fatty animals is probably due to the excess amount of subcutaneous fat and falciform fat giving rise to hyperechoic image between skin and hepatic parenchyma (Selecer, 1995). Hylus of kidney also contain fatty deposition hence may lead to poor visualization of kidney. Similar observations were recorded in one fatty animal of present study also and renal visualization was found better in lean animal.

Hydronephrosis: In animals of present study hydronephrosis was seen in 4 male animals. Lamb (1995) showed gross hydronephrosis secondary to obstructed ureter. Ultrasonographically the renal pelvis appears severely dialated and comprising the parenchyma into a thin rim of tissue. The pelvis remains partly divided by regular septa and this differentiates gross hydronephrosis from large renal cyst (Kealy and McAllister, 2000). During the present study similar ultrasonographic signs were observed but to a moderate level. Lamb (1995) reported hydronephrosis to be a cause of enlarged kidney in dogs and cats.
Kealy and McAllister (2000) observed an anechoic tubular structure running caudally from the renal pelvis in case of hydronephrosis. Mild pelvic dilatation and hydroureter may be seen with ureteral ectopia with a long term disease the renal architecture is progressively replaced by anechoic fluid.

**Cystic calculi**: Abnormalities of the urinary bladder that may be visible ultrasonographically include mural thickening due to cystitis or neoplasia (Biller et al., 1990; Leveille et al., 1992) and abnormal contents such as calculi, echogenic sediment or foreign body (Zanotti et al., 1989). However, cystitis and calculi were found in animals of present study.

Kealy and McAllister (2000) reported that most common calculi are triple phosphate (ammonium, magnesium and calcium phosphates) and oxalates and they are radio-opaque. Calcification within kidney parenchyma should not be mistaken for renal calculi. In animals of present study the calculi seen were radio-opaque, hence presumably were triple phosphate.

According to Kealy and McAllister (2000) the cystic calculi are frequently identified as hyperechoic foci and masses within the bladder lumen. Similar findings were observed in animals of the present study. The acoustic shadowing was seen only in one case of the present study. Kealy and McAllister (2000) reported that acousting shadowing can be marked particularly with high frequency transducer. The calculi gravitated to lie in the dependent position of the bladder and changed position during ballotment of the body wall or with the movement of the animals. Similar changes in position of calculi were also observed in the present study.

**Cystitis**: The diffusely thickened bladder wall in cases of cystitis in animals of the present study was an ultrasonographic finding observed previously by Kealy and McAllister (2000) also. They found that the
thickening was most obvious in the cranio-ventral region and found the wall as hyperechoic with irregular mucosal margin. They reported that in chronic polypoid cystitis small pedunculated mass project into the lumen and in emphysematous cystitis multifocal hyperechoic echogenicity seen in the wall with marked reverberation and acoustic shadowing caused by intramural gas.

Abnormalities of urinary bladder include mural thickening due to cystitis or neoplasia (Biller et al, 1990 and Leveille et al, 1992) and abnormal content such as calculi, echogenic sediment or foreign body (Zanotti et al, 1989). A large paraprostatic cyst (Stowater and Lamb, 1989) could be mistaken for the urinary bladder if the bladder is empty during the examination.

Kealy and McAllister (2000) reported that attached calculi are difficult to differentiate from dystrophic mineralization of the bladder wall, which also has a freed location. However, cystic calculus in one case of present study also looked similarly but was mineralized.

**Prostate gland affection**: The benign prostatic hyperplasia observed during the present study has been reported to be a common cause of an enlarged prostate. Kealy and McAllister (2000) also ascribed benign prostatic hyperplasia as the most common cause of an enlarged prostate. The echotexture is unchanged but the echogenicity is slightly more prominent. The hilus echo may no longer be appreciated. Small anechoic area representing small retention cyst may be seen paraprostatic cyst are also seen as large anechoic, well marginated, fluid filled structure in the caudal abdomen. The fluid may contain echogenic material that moves when agitated. Neoplastic disease causes an irregularly shaped gland with multiple coalescing hyperechoic foci resulting in mixed echogenicity. Stowater and Lamb (1989) diagnosed paraprostatic cyst in 9 dogs ultrasonographically. These were large echoic structures and contained
time. However, prostate evaluation was done by transabdominal B-mode ultrasonography, in animals of present study.

**Monorchid** : Monorchidism accounted for 0.714% incidence in present study. England (1995) reported canine monorchidism as common malady and opined that ultrasound is of value in locating the position of ectopic testes. Kealy and McAllister (2000) has also shown an ultrasonogram of a male dog presented with a retained testicle showing similar ultrasonic signs. Similar ultrasonographic changes were seen in one monorchid case of present study.

**Hydrocele** : The occurrence of Hydrocele as diagnosed in one case of the present study is reported to be infrequent in the dog and ultrasonographically echoic fluid accumulation with far enhancement is visible (Johnston *et al.*, 1991b). Hydroceles may occur secondary to neoplasia, traumatic injury or inflammatory disease of the testes or scrotum. Small volume of fluid is considered as a normal finding in the vaginal cavity (Pechman and Eills, 1987) and while this has not been reported in the dog. Pathological change should not be assumed in the absence of evidence of thickening of the scrotal skin or testicular or vaginal tunics. However, the etiology of hydrocele could not be established in an animal of present study. Bloom (1954) reported that hydrocele is being occasionally in the dog and extremely in the cat. In ascites of the dog bilateral accumulation of ascitic fluid may be present in the sacs in the tunica vaginalis. However, such changes were not seen in animals of present study.

**GENITAL SYSTEM**

**Pyometra** : Pyometra was diagnosed in 4 cases of present study and the ultrasonographic signs noted were in consonance to the signs describe by Kealy and McAllister (2000). They described uterus as a series of large
circular, thin walled structure. The caudal abdomen in cases of closed pyometra shows distended uterine loops appear adjacent to one another with flattening of the margin where the walls touches each other. The uterine lumen is mainly anechoic with a variable quantity to echogenic floccules. In the open pyometra the uterus is not as enlarged and may be mistaken for intestinal loops. However, peristalsis and intraluminal gas is absent. The uterus is identified immediately dorsal to the bladder. Differentiation between pyometra and other uterine fluid accumulation is not possible. A fluid filled colon can mimic pyometra hence a careful examination is necessary.

England (1995) described that pyometra is flow of the development of cystic endometrial hypoplasia unless it is the result of exogenous estrogen or progesterone therapy. However, detailed study were not done in animals of present study to establish the etiology.

The early ultrasonographic diagnosis of pyometra before the onset of clinical sign has been reported (Fayrer Hosken et al, 1991). According to England (1995) the uterus appears as folded upon itself with increased diameter and two or more sections of each wall of uterus are commonly increased in thickness and relatively hyperechoic with respect to the surrounding tissue. The lumen is dilated by anechoic fluid. The small echogenic particles and mass lesions may be identified which probably represent inflammatory debris or haemorrhage.

Pregnancy diagnosis : In animals of present study pregnancy was diagnosed by real time B-mode ultrasound which was in consonance with observation of Bonde Stam et al (1983), Cartee and Rowles (1984), Inaba et al (1984) and Toal et al (1986) who found B-mode ultrasound to be reliable and accurate.

The pregnancy diagnosed in the present study could be beyond 32 days because according to Yeager et al (1992) the most rapid growth of
the foetus occurs between day 32 and 55 and before this time only the heart and a focal anechoic region within the cranial pole may be identified. However, from 32 days after the LH surge limb buds and the choroidal plexus of the brain may be imaged and from day 35 clear differentiation into head trunk and abdomen is detectable (England et al, 1990). The foetal skeleton becomes evident from 40 days onward when fetal bone appears as hyperechoic and casts acoustic shadow. At this stage the hyperechoic heart valves can be imaged including their movement. Generally from 40 days onwards the trunk diameter exceeds the head diameter (Yeager et al, 1992). Pulmonary tissue surrounding the heart is hyperechoic with respect to the liver and the line of the separation can easily be identified from 45 days onwards. It is possible to identify the anechoic stomach caudal to the liver in more than 90% of fetuses, and a few days later a bladder is identifiable in the caudal abdomen, with careful examination the uretus may be imaged. In the last 20, days of pregnancy the kidney can be imaged, these are frequently more echogenic than observed in the adult animals. In late pregnancy intestine may be detected (Yeager et al, 1992). However, kidney and intestines couldn't be visualized in animals of present study.

Certain organs were visible ultrasonographically in the fetus in pregnant animals of present study. This observation has provided a clue that animal was in advance pregnancy. According to England (1995) and Goddard (1995) the ultrasonographic appearance of certain organs may be useful for the prediction of gestational age, e.g. the fetal bladder is usually only imaged during the last 20 days of the gestation. Many studies which evaluated pregnancy an ultrasonographic change could not identify gestational age accurately (Bonde Stam et al, 1983; Cartee and Rowles, 1984).

Pregnancy was diagnosed by B-mode ultrasonography in animals of present study. Fung and Chang (1996) also used B-mode ultrasonography
for diagnosing pregnancy and predicting gestation in dog. The first sign confirming pregnancy was the detection of the gestational sac, at 15-20 days after the first mating when the embryonic heart beat could be detected. The accuracy of litter size examination was 88% at 21-28 days. The fetal crown rump length was about equal of the width of generic placenta at 21-24 days before parturition. Other ultrasonic signs/images such as the earliest detection time of the cardiac chamber, urinary bladder, stomach, liver, loss of round outline of gestational sac were also useful for predicting the day of parturition. However, these parameters were not taken into account in animals of present study.

In animals of present study the exact number of fetuses could not be determined. According to Toal et al (1986), England et al (1990) the accuracy of detecting absolute total number is poor. Recently, England (1992) suggested that for the bitch, the greatest accuracy was before day 30 after the L.H. surge when 38% of examination were successful in predicting total number. Generally the number of fetus is underestimated, the error being associated with overlooking fetuses or mistaking them as already counted or due to acoustic artifact. The accuracy is reduced for larger litters (Shille and Gontarek, 1985; England et al, 1990). For examination between 30-50 days of pregnancy England (1992) found the accuracy to be 18% and after 50 days of pregnancy it is 8%.

**Ovarian cyst**: Ovarian cysts were found in aged bitches in the present study. England (1995) also pointed the presence of ovarian cyst in older bitch and mentioned that cyst structure are variable in appearance and size and most commonly they contained anechoic fluid and have a thin
hypoechoic wall. Lesions which are adjacent to the ovary are usually significant while those originating from the ovary may be follicular or luteal cyst. In one animal of present study it was adjacent to the ovary. Dow (1960) said that true ovarian cyst are identified in upto 10% of bitches. Barr (1990) said that occurrence of polycystic ovaries is documented in dog by use of ultrasound. According to Kealy and McAllister (2000) ovarian cyst have thin wall with anechoic content and acoustic enhancement is a feature. Luteal cyst may have increased wall thickness which may help differentiate them from follicles.

**Mammary gland tumor:** The variable echotexture found in cases of present study is in consonance to the finding of Kealy and McAllister (2000) who also found mammary tumor to have variable echotexture. Acoustic shadowing as pointed by these authors could not be seen in cases of the present study. However, Kealy and McAllister (2000) pointed that gland may be increased in size when neoplastic and calcified opacities are sometimes seen within the substance of the gland. They are likely to be associated neoplasia. Malignant neoplasm metastasized to the draining lymph nodes and to the lungs where they may be seen as nodular infiltrate. However, the associated pathology to the mammary gland tumor was not ruled out in animals of present study.

**Venereal granuloma:** Venereal granuloma finds least space in the available literature because most of the European countries a planned mating is followed hence incidence of this disease is rare. Stray dogs are not seen in these countries which are main carriers of virus of this disease. However, two animals of either sex were diagnosed venereal granuloma
ultrasonographically in present study. In male dog mixed echogenicity and in female hyperechoic zone with anechoic irregular border were seen. This finding was in consonance to the Kealy and McAllister (2000) who observed a mixed echogenicity in vaginal mass and said that on ultrasonography differentiation between vaginal and uterus mass may not be possible. In animals of present study, it is felt that such a mass can well be differentiated because the transducer is directly placed on the swollen vagina or sheath and the tissue mass is greater in size hence can easily be evaluated ultrasonographically.

**MISCELLANEOUS AFFECTION**

**Ascites**: The increased quantity of ascites fluid in abdominal cavity helped visualizing the abdominal viscera in animals of present study as compared to the radiographic examination which is in consonance with findings of Kealy and McAllister (2000). They also opined that ultrasonography is more sensitive than radiography in detecting small volume of free fluid which is anechoic. This fluid permits margins of the organs to be examined as the fluid profiles organ edges. Fluids surrounding the bladder and gall bladder through the wall gives a benefit so that internal and external aspects can be identified. Abdominal organ appear more echogenic than usual when surrounded by abdominal fluid. Similar findings were observed in animals of present study also.

In animals of present study the ascites fluid caused gross abdominal distention hence animal felt discomfort during ultrasonographic examination. Therefore, abdominocentesis was done to make the
procedure less stressful and these findings are in consonance to the finding of Kealy and McAllister (2000).

Henley et al (1989) compared two dimensional ultrasonography and radiography for detection of small amount of free peritoneal fluid in the dog. Ultrasonography detected fluid in one animal at 2 ml/lb and in all other animals 3 ml/lb whereas radiography could detect the fluid with a high degree of accuracy at 4 ml/lb. The lateral view was more accurate than the ventral dorsal view in detecting fluid. The authors concluded that ultrasonography is more sensitive than radiography and method of choice to detect the small amount of free peritoneal fluid. In animals of present study there was associated liver cirrhosis together with Ascites. Sevelius (1995) also opined that ascites is the most common clinical finding in chronic hepatitis predominantly associated with cirrhosis and chronic progressive hepatitis (Sevelius and Johnson, 1998).
CONCLUSIONS

1. One Hundred and Forty dogs were scanned ultrasonographically and 71 dogs had diverse affections or pregnancy and diverse affections were found in 42 males and 29 females.

2. Majority of affections were related to digestive system, urinary system and genital system. Genital system had maximum incidence of affections.

3. Out of the diverse affections and pregnancy diagnosis made in present study 53.52 cases were found to be clinical and 46.478% were incidental.

4. The diverse affections of digestive system diagnosed were foreign body in stomach (2.857%), liver cyst (2.142%), liver cirrhosis (3.571%), gall bladder sludge (2.142%) and splenic calcification (0.712%).

5. The diverse affections of urinary system diagnosed were renal calculi (1.428%), hydronephrosis (2.857%), cystic calculi (7.857%) and cystitis (2.857%).

6. The diverse affections of genital system were enlarged prostate (7.857%), monorchid (0.712%) and hydrocele (0.712%), pyometra (2.142%), mammary gland tumor (3.571%), ovarian cyst (0.712%) and Venereal granuloma (1.428%).

7. Ultrasonography of abdomen revealed ascites (2.857%) and pregnancy (4.285%).

8. A sector convex probe with a range of 2.5-5 MHz and a constant output of 4.5 MHz proved satisfactory in scanning the canine abdomen.

9. Looking towards a higher incidence of incidental diagnosis the ultrasonography has proved to be a useful tool to scan the abdomen for diagnosis of asymptptomatically growing or impending diseases.
SUMMARY

The present study was conducted on 140 dogs. The animals were studied in two groups. In group I the clinical cases of dogs were scanned and ultrasonography of the canine abdomen was done. In group II the dogs of ABC programme were scanned and a survey ultrasonography of the canine abdomen was done. The ultrasonographic scanning was done on Schimadzu's ultrasound machine in B-mode with a 2.5 - 5 MHz sector convex transducer with a constant output of 4.5 MHz. The ultrasonograms obtained were interpreted and diverse affections were diagnosed based on their echogenic pattern and compared these with normal ultrasonic appearance of a particular abdominal organ.

Diverse affections were diagnosed in 71 dogs. Out of these 30% were males and 20.71% were females. The diverse affections were clinical in nature (53.52%) in animals of group I and were incidental in nature (46.478%) in animals of group II. The diagnosed affections were seen in 24 (33.80%) males and 14 (19.718%) females in animals of group I whereas these were 18 (25.352%) in males and 15 (21.126%) in females in animals of group II. In both the groups of the present study the incidence was found more in males as compared to females. It was further observed that incidence of urinary system was found more in males whereas incidence of affections of genital system was found more in females.

The affections related to genital system were 21.428% and were found in 14 (10%) male and 16 (11.428%) female dogs. The diagnosed affections were pyometra (2.142%), pregnancy diagnosis (4.285%), mammary gland tumor (3.571%), ovarian cyst (0.714%) venereal granuloma (1.428%), enlarged prostate (7.857%), monarichic (0.714%) and hydrocele (0.714%).
The affections related to urinary system were 15% and were found in 19 males and 2 female. Various affections recorded were renal calculi (1.428%), hydronephrosis (2.857%), cystic calculi (7.857%) and cystitis (2.857%).

The affections related to digestive system were 11.428% and were found in 8 male and 8 female dogs. Diverse affections diagnosed were foreign body in stomach (2.857%), liver cyst 2.142%, liver cirrhosis (3.571%), gall bladder sludge (2.142%) and splenic calcification (0.714%).

Ascites was diagnosed in 4 dogs out of which 3 were females which constituted 2.857% of total diagnosed cases.

Diagnosed foreign bodies in the stomach belonged to group I and were clinical cases out of which three had radio-opaque and one had radiolucent foreign body. The metallic foreign bodies were identified as hyperechoic structure in the lumen of stomach in animals of present study.

In male dog liver cyst appeared as small circular anechoic zone and was located dorsal to the diaphragm and ventral to the hepatic portal vein. Ultrasonogram of a female dog revealed a well circumscribed rounded anechoic area suggestive of a hepatic cyst and was located anterior to the gall bladder.

Liver cirrhosis was observed in 3 cases. The ultrasonogram revealed a diffuse increase in the echogenic pattern in the liver parenchyma which appeared to be hyperechoic in majority of cases.

Gall bladder sludge was observed in one male of group I and 2 females of group II. Bile sludge appeared as mildly echogenic sediment with an appreciable acoustic shadowing in one case only.

Splenic calcification appeared as a hyperechoic lesion in its right half upon ultrasonography.
Renal calculi appeared as hyperechoic discrete structure with marked acoustic shadowing in renal pelvis. Mild hydronephrosis was also associated in cases of this study.

Hydronephrosis was characterized by marked dilatation of renal pelvis by an anechoic region.

Cystic calculi was evaluated in urinary bladder after an injection of furosemide 20 mg intramuscularly. Cystic calculi were identified ultrasonographically as hyperechoic concretions in seven cases and hypoechoic sediments were seen in 4 cases.

Cystitis was diagnosed in 3 dogs of group I and 1 dog of group II. Ultrasonographically it was characterized by diffusely thickened wall which had hyperechoic with irregular mucosal edges. Urine contained suspended particles of variable echogenicity.

Enlarged prostate gland was seen ultrasonographically in 4 males of group I and 7 males of group II. The prostatic tissue showed slightly more prominent echogenicity with small anechoic areas representing retention cyst on ventral aspect.

Monorchidism was manifested ultrasonographically by absence of testicular echotexture in one scrotal sac.

Hydrocele was diagnosed in 1 clinical case of group I was characterized ultrasonographically by the presence of anechoic fluid between testicular parenchyma and scrotal wall.

Pyometra was diagnosed in 3 females of group I. Distended uterus with flattened margin and anechoic fluid were diagnosed as closed pyometra cases. Several portions of the anechoic fluid dilated uterus were seen ultrasonographically and the organ was coiled upon itself.

Pregnancy diagnosis was done in 6 bitches. Ultrasonogram revealed foetal head and spine in the posterior abdominal region in a
bitch. Foetal head, spine, stomach and heart were also visible ultrasonographically indicating it to be a foetus of advance gestation. In animals of present study the radiography gave a better detail of foetal number, position, developmental stage etc.

The ovarian cyst ultrasonographically revealed as a circumscribed structure with thin hypoechoic wall and anechoic fluid in cranial portion of the ovary.

Mammary gland tumor ultrasonogram of one bitch revealed a variable echotexture with a distinct zone of hyperechoic structure. Ultrasonogram of other bitch revealed a non-homogenous tissue with varying and mixed echogenicity.

Venereal granuloma, ultrasonogram of a swollen vagina revealed a hyperechoic zone with irregular anechoic borders and few anechoic zones. Ultrasonogram of a male sheath revealed a mass of mixed echogenicity over the ospenis.

The ultrasonogram of an ascitic male dog revealed a hyperechoic tissue which was cirrhotic liver (ventrally) and anechoic zone (dorsally) representing the ascitic fluid.
LITERATURE CITED


The present study was conducted on 140 dogs. The animals were studied in two groups. In group I the clinical cases of dogs were scanned and ultrasonography of the canine abdomen was done. In group II the dogs of ABC programme were scanned and a survey ultrasonography of the canine abdomen was done. The ultrasonographic scanning was done on Schimadzu's ultrasound machine in B-mode with a 2.5 - 5 MHz sector convex transducer with a constant output of 4.5 MHz. The ultrasonograms obtained were interpreted and diverse affections were diagnosed based on their echogenic pattern and comparing these with normal ultrasonic appearance of a particular abdominal organ.

Diverse affections were diagnosed in 71 dogs. Out of these 30% were males and 20.71% were females. The diverse affections were
clinical in nature (53.52%) in animals of group I and were incidental in nature (46.478%) in animals of group II. The diagnosed affections were seen in 24 (33.80%) males and 14 (19.718%) females in animals of group I whereas these were 18 (25.352%) in males and 15 (21.126%) in females in animals of group II. In both the groups of the present study the incidence was found more in males as compared to females. It was further observed that incidence of urinary system was found more in males whereas incidence of affections of genital system was found more in females.

The affections related to genital system were 21.428% and were found in 14 (10%) male and 16 (11.428%) female dogs.

The diagnosed affections were pyometra (2.142%), pregnancy diagnosis (4.285%), mammary gland tumor (3.571%), ovarian cyst (0.714%), venereal granuloma (1.428%), enlarged prostate (7.857%), monorchid (0.714%) and hydrocele (0.714%).

The affections related to urinary system were 15% and were found in 19 males and 2 females. Various affections recorded were renal calculi (1.428%), hydronephrosis (2.857%), cystic calculi (7.857%) and cystitis (2.857%).

The affections related to digestive system were 11.428% and were found in 8 male and 8 female dogs. Diverse affections diagnosed were foreign body in stomach (2.857%), liver cyst 2.142%, liver cirrhosis (3.571%), gall bladder sludge (2.142%) and splenic calcification (0.714%).

Ascites was diagnosed in 4 dogs out of which 3 were females which constituted 2.857% of total diagnosed cases.
श्वानों में शायनिक एवं भूमिति उदरीय पराध्वनिक चित्रण

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सारांश

प्रस्तुत शोध कार्य 140 श्वानों पर किया गया था एवं जानवरों को दो समूह में विभाजित किया गया। प्रथम समूह में बीवालिक रोगी कुलों के उदर का क्रमविश्लेषणी का तथा पराध्वनिक चित्रण किया गया। दूसरे समूह में पशु जन्म दर निर्माण कार्यक्रम के तहत कुलों के उदर का क्रमविश्लेषणी का सर्वेक्षण पराध्वनिक चित्रण किया। पराध्वनिक चित्रण शीमात्जु पराध्वनिक मशीन में बी-नोड पर 2.5-5 मेगा आवृति के साथ लैंड टॉंस्ट्रॉयर से किया गया जिससे कि लगातार 4.5 मेगा हर्टज आवृति की तरह के निकली। पराध्वनिक चित्रण का विस्तारण एवं विभिन्न रोगों का निदान उनके पराध्वनिक चित्रण के प्रतिरूपों का सामान्य चित्रण से तुलना करके की।
विभिन्न रोगों का निदान 71 कुलों में किया गया जिनमें 30 प्रतिशत नर तथा 20.71 प्रतिशत मादा थे। विभिन्न रोग प्रश्न, समूह में 53.52 प्रतिशत वैज्ञानिक अवस्था में थे तथा दूसरे समूह में 46.478 प्रतिशत आकर्षक अवस्था में थे।

प्रथम समूह के विभिन्न रोगों में 24 (33.80%) नर तथा 14 (19.718%) मादा जबकि दूसरे समूह के विभिन्न रोगों में 18 (25.352%) नर तथा 15 (21.126%) मादा कुले थे। दोनों समूह के वर्तमान अध्ययन में पाया गया कि मादा कि तुलना में नरों में रोग दर अधिक था। आपे यह भी देखा गया कि नरों में मृत्यु तंत्र के रोग पाये जाने की दर तथा मादा में जनन तंत्र के रोग पाये जाने की दर अधिक थी।

विभिन्न पाये जाने रोगों में से जनन अंग से सम्बंधित 21.428% थे तथा इनमें से 10% नर तथा 11.428% मादा कुले थे।

निदान किये हुए रोगों में से पूर्णगर्भशयन 2.142%, सहगर्भशयन 4.285%, रननयंद्रि अरुंद 3.571%, दिबंदवंती पृंथि 0.714%, रनत्र कजिकस्तुम 1.428%, विष्कर्ण पूर्ण: सथ बाँधी 7.857%, एकल पृष्ण 0.714% तथा जलावृषण पाये गए।

मृत्यु तंत्र से संबंधित रोग 15% थे जिनमें से 19 नर तथा 2 मादा में थे। इनमें से 1.428% बुधक पथरी, 2.857% जलवृषण, 7.857% मृत्यु शयन की पथरी तथा 2.857 मृत्युशयनश्रोध थे।

विभिन्न रोग निदान विद्यालय में से आमाशय में बाहरी वस्तु 2.857%, यकृत पृथि 2.142%, यकृत सिरोप्रेस 3.571%, पिताशय आपंक 2.142%, वीणा कैचीयां 0.714% पाये गए थे।

जलावृषण का निदान 4 कुलों में किया गया जिनमें से 3 मादा थी जो कि सभी निदानों में से 2.857% थे।
Fig 1. A schematic picture of dog in dorsal recumbency showing various sites for placement of probes to see different organs. **Left side:** S-Spleen, ST-Stomach, LK-left kidney, M-Mammary gland, NGU-Nongravid Uterus, V-Vagina; **Right side:** RK-Right Kidney, L-Liver, GB-Gall bladder; GU-Gravid Uterus, UB-Urinary Bladder

Fig 2. A schematic picture of dog in lateral recumbency showing various site; for placement of probe to see different organs. 1. Left kidney, 2. Ureter 3. Urinary Bladder, 4. Prostate, 5. Scrotum, 6. Ospenis, 7. Right kidney
Fig 3. Lateral radiograph of thoraco abdominal region of a dog showing three radio-opaque rounded foreign bodies in the stomach in a dog.

Fig 4. Lateral radiograph of a dog abdomen showing 4 rounded radio-opaque, foreign bodies in the stomach.
Fig 5. Lateral radiograph of abdomen of a dog showing a small rod shaped radio-opaque foreign body measuring about 2-2.5 cm in the stomach.

Fig 6. Lateral radiograph of thoraco abdominal region showing a radiolucent foreign body with irregular margin and shape in the stomach of a dog.
Fig 7. Ultrasonogram of a dog taken at left post xiphoid area; dog was offered water before sonography; stomach appeared distended with anechoic pattern in the lumen. However, two rounded hyperechoic foreign bodies were visible in the stomach. The mild acoustic shadow is visible.

Fig 8. Ultrasonogram showing three rounded foreign bodies with a rounded hyperechoic pattern. Stomach appears to be a mildly distended. All foreign bodies are showing acoustic shadowing.
Fig 9. Ultrasonogram of abdomen taken left to the postxiphoid region shows the stomach imposed between liver dorsally and diaphragm ventrally. A hyperechoic foreign body with distended acoustic shadow is visible.

Fig 10. Ultrasonogram of abdomen taken left to the post xiphoid region shows the stomach imposed between liver dorsally and diaphragm ventrally. A hyperechoic foreign body with distended acoustic shadow is visible.
Fig 13. Ultrasonogram showing cirrhotic liver characterized by diffuse increase in the echogenic pattern irregular margin. A significant amount of ascitic fluid is also visible as anechoic zone dorsal to the cirrhotic liver. A shrunken gall bladder (G.B.) is also visible amid hyperechoic shadow of cirrhotic liver.

Fig 14. Ultrasonogram showing hyperechoic pattern in cirrhotic liver which is surrounded by anechoic fluid pattern depicting a simultaneous presence of ascites.
Fig 15. Ultrasonogram showing bile sludge as hyperechoic sediments with mild acoustic shadow in anechoic gall bladder.

Fig 16. Ultrasonogram showing bile sludge as hyperechoic sediment without showing acoustic shadowing in anechoic gall bladder.
Fig 17. Ultrasonogram showing hyperechoic pattern in splenic parenchyma which is suggestive of splenic calcification.

Fig 18. Ultrasonogram revealed a hyperechoic zone suggestive of renal calculus with an acoustic shadow is visible at pelvis of left kidney in a dog.
Fig 19. Ultrasonogram reveals a small calculus showing mild echogenicity, in the pelvis of left kidney in a dog. The anechoic zone surrounding the calculus represents fluid filled pelvis which makes appearance of calculus more marked.

Fig 20. Lateral radiograph of canine abdomen showing presence of radio-opaque calculus in kidney and urinary bladder.
Fig 21. Ultrasonogram reveals hydronephrosis characterized by fluid filled anechoic region in the dilated pelvis of the right kidney.

Fig 22. Ultrasonogram of urinary bladder shows mineralized calculi with associated acoustic shadowing is visible on the floor of urinary bladder.
Fig 23. Ultrasonogram reveals hypoechoic concretions (arrows) in urine filled bladder.

Fig 24. Ultrasonogram reveals a cluster of hypoechoic cystic calculi on the floor of mildly urine filled bladder.
Fig 25. Ultrasonogram reveals mildly distended urinary bladder with hyperechoic thickened and irregular wall. The urine in the bladder shows certain suspended particles of variable echogenicity.

Fig 26. Ultrasonogram reveals completely evacuated bladder of the case explained in previous sonogram. Note the thickened wall with increased echogenicity of the empty urinary bladder suggestive of cystitis.
Fig 27. Ultrasonogram reveals an irregular and rough mucosa of bladder, mildly distended bladder shows suspended particles with marked echogenicity suggesting inflammatory or exudate in a case of cystitis in a dog.

Fig 28. Lateral radiograph of canine abdomen shows enlarged prostate as a mild radiolucent zone just caudal to the neck of the urinary bladder.
Fig 29. Ultrasonogram reveals enlarged prostate caudal to the neck of bladder. The prostate tissue shows slightly more prominent echogenicity. Small anechoic area is visible representing a retention cyst on ventral aspect.

Fig 30. Ultrasonogram reveals increased echogenicity of the hyperplastic prostatic tissue. Few focal areas of hyperechoic nature represent calcification of the prostatic tissue.
Fig 31. Ultrasonogram reveals monorchidism characterized by presence of a single echogenic mass in scrotal sacs. The acoustic shadowing of this mass is also visible.
Fig 32-33. Ultrasonogram reveals Hydrocele in male dog which is characterized by presence of anechoic shadow surrounding the mildly echogenic testis. The distention of scrotal sacs with fluid (anechoic) is visible.
Fig 34. Ultrasound image of the uterus of a bitch with pyometra, several portions of the anechoic fluid dilated uterus have been imaged. The uterus has a thin echogenic wall and the organ in coiled upon itself.

Fig 35. Ultrasound image of the uterus of a bitch with pyometra, the uterus is positioned below to the urine filled anechoic bladder. Uterus appears as relatively anechoic and dilated tube with a thin hyperechoic wall.
Fig 36. Ultrasonogram reveals fetal head and spine in the posterior abdominal region in a bitch.

Fig 37. Ultrasonogram reveals fetal head, spine, stomach and heart indicating it to be a foetus of advance gastration.
Fig 38. Ultrasonogram reveals fetal spine and ribs in posterior abdominal region.

Fig 39. Ultrasonogram reveals fetal mass with a long bone and amniotic fluid is clearly visible surrounding the fetal mass.
Fig 40. Lateral radiograph of abdomen of a bitch shows three well developed fetal skeleton. The bitch appears to be advance gestation because the fetal skeleton was fully developed showing long bone, ribs, vertebra and head.

Fig 41. Ultrasonogram shows a circumscribed structure with this hypoechoic wall and anechoic fluid in the cranial portion of the ovary which is suggestive of an ovarian cyst in right ovary.
Fig 42. Ultrasonogram of a mammary gland reveals a variable echotexture. A distinct zone of hyperechoic structure is suggestive of fatty tissue in the tumours mass.

Fig 43. Ultrasonogram of a mammary gland reveals a nonhomogenous tissue with varying and mixed echogenicity. The acoustic shadowing is absent.
Fig 44. Ultrasonogram of a vagina reveals a hyperechoic zone with irregular anechoic borders and few anechoic zones were located within the hyperechoic tissue mass.

Fig 45. Ultrasonogram of a male sheath reveals a mass of mixed echogenicity over the ospenis which is suggestive of presence of venereal granuloma, which was present clinically too.
Fig 46. Ultrasonogram of ascitic abdomen revealed distinctly visible anechoic areas representing peritoneal fluid and separating the visceral organs like liver. A mildly echogenic liver parenchyma is visible.

Fig 47. Ultrasonogram of ascitic abdomen reveals a well demarked left kidney with a surrounding anechoic zone caused by ascitic fluid
Fig 48. Ultrasonogram of ascitic abdomen reveals a clearly suspended urinary bladder in the anechoic zone of ascitic fluid. The thick hyperechoic wall of urinary bladder indicate cystitis which was clinically evident too.

Fig 49. Ultrasonogram of ascitic abdomen reveals a hyperechoic tissue which is cirrhotic liver (ventrally) and anechoic zone (dorsally) representing the ascitic fluid.
Fig 50. Lateral radiograph of canine abdomen showing a uniform opacity of abdomen which is characteristic of ascitic fluid.