CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS

BY

M.DURGA PRASAD BABU
B.V.Sc. & A.H.
ID.No: GVM/2013 - 033

THESIS SUBMITTED TO THE

SRI VENKATESWARA VETERINARY UNIVERSITY

In partial fulfillment of the requirements

For the award of the degree of

MASTER OF VETERINARY SCIENCE

(VETERINARY SURGERY AND RADIOLOGY)

(IN THE FACULTY OF VETERINARY SCIENCE)

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY

NTR COLLEGE OF VETERINARY SCIENCE, GANNAVARAM, 521102

SRI VENKATESWARA VETERINARY UNIVERSITY
TIRUPATI – 517 502 (A.P) INDIA

NOVEMBER, 2015

CERTIFICATE

Dr. M.DURGA PRASAD BABU, ID**.No: GVM/2013-033** has satisfactorily prosecuted the course of research and that the thesis entitled "**CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS**" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university.

Date :

Place : Gannavaram

(Dr. V. DEVI PRASAD)
Major Advisor
Associate Professor
Dept. of Veterinary Surgery & Radiology
College of Veterinary Science
Proddatur – 516360 (AP)

CERTIFICATE

This is to certify that, the thesis entitled "**CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS**" submitted in partial fulfillment of the requirements for the degree of **Master of Veterinary Science** of **Sri Venkateswara Veterinary University, Tirupati** is a record of the bonafide research work carried out by **Dr. M.Durga Prasad Babu, ID.No: GVM/2013-033** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of investigation have been duly acknowledged by the author of the thesis.

(Dr. V. DEVI PRASAD)
Chairman of the Advisory Committee

Thesis approved by the Student Advisory Committee

CHAIRMAN: (**Dr. V. DEVI PRASAD)** _____
Associate Professor
Dept. of Veterinary Surgery & Radiology
College of Veterinary Science
Proddatur – 516360 (AP)

MEMBER : (**Dr. N.V.V. HARI KRISHNA)** _____
Assistant Professor and Head
Dept. of Veterinary Surgery & Radiology
N.T.R College of Veterinary Science
Gannavaram – 521101 (AP)

MEMBER : (**Dr. G.VENKATA NAIDU)** _____
Professor and Head
Dept. of Veterinary Gynaecology & Obstetrics
N.T.R College of Veterinary Science
Gannavaram – 521101 (AP)

MEMBER : **(Dr.V.VAIKUNTA RAO)** _____
Professor and Head
Dept. of Veterinary Medicine
N.T.R College of Veterinary Science
Gannavaram – 521101 (AP)

LIST OF CONTENTS

Chapter No.	Title	Page No.
I	**INTRODUCTION**	**1-3**
II	**REVIEW OF LITERATURE**	**4-34**
	2.1 Disorders of gastrointestinal system	4
	2.1.1 Clinical signs	4
	2.1.2 Haematological changes	6
	2.1.3 Biochemical alterations	7
	2.1.4 Radiographic findings	7
	2.1.5 Ultrasonographic features	8
	2.2 Hepatobiliary system	11
	2.2.1 Clinical signs	11
	2.2.2 Haematological changes	12
	2.2.3 Biochemical alterations	13
	2.2.4 Radiographic findings	16
	2.2.5 Ultrasonographic features	17
	2.3 Urinary system	20
	2.3.1 Clinical signs	20
	2.3.2 Haematological changes	21
	2.3.3 Biochemical alterations	22
	2.3.4 Radiographic findings	23
	2.3.5 Ultrasonographic features	24
	2.4 Genital system	27
	2.4.1 Female genital system	27
	2.4.1.1 Clinical signs	27
	2.4.1.2 Haematological changes	28
	2.4.1.3 Radiographic findings	28
	2.4.1.4 Ultrasonographic features	28
	2.4.2 Male genital system	29
	2.4.2.1 Clinical signs	29
	2.4.2.2 Radiographic findings	30
	2.4.2.3 Ultrasonographic features	30

	2.5 Miscellaneous disorders	31
	2.5.1 Clinical signs	31
	2.5.2 Haematological studies	32
	2.5.3 Biochemical alterations	32
	2.5.4 Radiographic findings	33
	2.5.5 Ultrasonographic features	33
	2.5.6 Histopathology	34
III	**Materials and methods**	**35-41**
	3.1 Selection of cases	35
	3.2 Clinical signs and physical examination	36
	3.3 Haematological and biochemical profile	36
	3.4 Radiography	37
	3.5 Real time B-mode transabdominal ultrasonography	38
	3.5.1 Ultrasound machine	38
	3.5.2 Preparation of animal for scanning	38
	3.5.3 Position of animal	38
	3.5.4 Selection of transducers	40
	3.5.5 Ultrasound scanning with selection of acoustic window	40
	3.6 Histopathological studies	41
IV	**RESULTS**	**42-83**
	4.1 Selection of cases	42
	4.2 Group I (Gastro intestinal system)	42
	4.2.1 Clinical signs and physical examination	42
	4.2.2 Haematological and biochemical profile	47
	4.2.3 Radiography	47
	4.2.4 Ultrasonography	49
	4.2.5 Treatment	49
	4.3 Group II (Hepatobiliary system)	52
	4.3.1 Clinical signs and physical examination	52
	4.3.2 Haematological and biochemical profile	54
	4.3.3 Radiography	54
	4.3.4 Ultrasonography	55

	4.3.5 Treatment	55
	4.4 Group III (Urinary system)	56
	4.4.1 Clinical signs and physical examination	56
	4.4.2 Haematological and biochemical profile	59
	4.4.3 Radiography	59
	4.4.4 Ultrasonography	60
	4.4.5 Treatment	61
	4.5 Group IV (Female genital system)	61
	4.5.1 Clinical signs and physical examination	61
	4.5.2 Haematological and biochemical profile	66
	4.5.3 Radiography	66
	4.5.4 Ultrasonography	67
	4.5.5 Treatment	70
	4.6 Group V (Male genital system)	71
	4.6.1 Clinical signs and physical examination	71
	4.6.2 Haematological and biochemical profile	71
	4.6.3 Radiography	72
	4.6.4 Ultrasonography	72
	4.6.5 Treatment	76
	4.7 Group V (Miscellaneous disorders)	76
	4.7.1 Spleen	76
	4.7.1.1 Clinical signs and physical examination	76
	4.7.1.2 Haematological and biochemical profile	76
	4.7.1.3 Radiography	77
	4.7.1.4 Ultrasonography	77
	4.7.1.5 Cytological studies	77
	4.7.1.6 Treatment	77
	4.7.2 Herniation	79
	4.7.2.1 Clinical signs and physical examination	79
	4.7.2.2 Haematological and biochemical alterations	79
	4.7.2.3 Radiography	80
	4.7.2.4 Ultrasonography	80

	4.7.2.5 Treatment	83
V	**DISCUSSION**	**84-99**
VI	**SUMMARY**	**100-102**
	LITERATURE CITED	**103-112**

LIST OF ILLUSTRATIONS

Figure no.	Title	Page No.
1	500 mA X-ray machine	39
2	Ultrasound machine	39
3	Ultrasound machine	39
4	Linear and sector transducers	39
5	Prolapse of intestines	50
6	Skiagram showing intussusception	50
7	Skiagram showing gas filled intestines	50
8	Skiagram showing stacked intestinal loops	50
9	Sonogram showing typical bull's eye appearance in intussusception in horizontal plane	51
10	Sonogram showing alternative hypoechoic and hyperechoic streaks in sagittal plane	51
11	Sonogram showing hyperechoic intestinal foreign body	51
12	Sonogram showing intestinal foreign body with acoustic shadowing	51
13	Sonogram showing linear strong hyperechoic mucosal structure	51
14	Intra-operative photograph showing ileo-caeco-colic intussusception	51
15	Corn cob (intestinal foreign body)	53
16	Under wear (inset) intestinal foreign body	53
17	Note yellowish discoloration of skin in icteric dog	53
18	Dog with ascites	53
19	Note emaciation in hepatic neoplasia	53
20	Skiagram showing hepatomegaly	53
21	Skiagram showing hepatomegaly with calcification	57
22	Skiagram showing ground glass appearance in ascites	57
23	Skiagram showing increased opacity due to hepatoma	57
24	Sonogram showing rounded borders in hepatomegaly	57
25	Sonogram showing ascites in hepatomegaly	57
26	Sonogram showing freely floating abdominal organs in ascitic fluid	57

27	Note clear transudate in ascites	58
28	Liver tumor with a large hyperechoic lesion with distinct borders	58
29	Sonogram showing nodular hyperplasia	58
30	Sonogram showing sludge in the gallbladder	58
31	Gross specimen of liver tumor (hepatoma)	58
32	Photo micrograph showing normal liver sinusoids in hepatoma	58
33	Skiagram showing a large single cystolith in the urinary bladder	62
34	Skiagram showing numerous cysto-urethral calculi	62
35	Pneumocystograph showing chronic cystitis with calculi	62
36	Skiagram showing urethral stones with distended urinary bladder	62
37	Skiagram showing only distended urinary bladder in case of radiolucent calculi	62
38	Skiagram not showing intra luminal mass in the urinary bladder	62
39	Pneumocystograph showing filling defect in urinary bladder	63
40	Skiagram not showing any changes in polypoid cystitis	63
41	Pneumocystograph showing radiopacity mass in haemorrhagic cystitis	63
42	Sonogram showing a single large cystolith with acoustic shadowing	63
43	Small cystolith with acoustic shadowing	63
44	Note thickened bladder wall in cystolithiasis	63
45	Radiolucent calculi without acoustic shadowing	64
46	Cystitis with thickened & hyperechoic bladder wall	64
47	Hyperechoic structure in the urinary bladder with transitional cell carcinoma	64
48	Enlargement of prostate in transitional cell carcinoma	64
49	Polypoid cystitis with multiple growths in urinary bladder	64
50	Large pedunculated polyp in the urinary bladder	64
51	Note hyperechoic blood clots in haemorrhagic cystitis	65
52	Renal cyst with clear acoustic enhancement	65
53	Hydronephrosis	65
54	Photograph showing multiple cystoliths	65

55	A single large cystolith in a bitch	65
56	Large clumps of transitional epithelial cells with moderate degree of pleomorphism	65
57	Skiagram showing coiled and distended uterus in pyometra	68
58	Skiagram showing spalding's sign of dead fetuses in the uterus	68
59	Stump fibroid depicted as a radiopaque mass between urinary bladder and colon	68
60	Skiagram showing stump granuloma at the neck of the bladder	68
61	Skiagram showing the bladder position at the rib cage after catheterization	68
62	Skiagram showing stump abscess as a radiopaque mass between bladder and colon	68
63	Note large thin walled sacculation in closed pyometra	69
64	Note adjacent, distended sacculations in closed pyometra	69
65	Hyperechoic fetal bones in macerated fetus	69
66	Note heteroechoic stump fibroid mass dorsal to the urinary bladder	69
67	Hyperechoic bladder wall with echogenic sediment in stump fibroid	69
68	Note a mixed echogenic mass adjacent to the bladder	69
69	Uterine stump abscess seen as an anechoic sac close to the bladder	74
70	Intra-operative photograph showing pyometric uterus	74
71	Cystic ovarian disease in pyometra	74
72	Photograph showing gross specimen of stump fibroid	74
73	Note adhesions of fibroid with urinary bladder and colon	74
74	Remnants of left uterine horn and ovary in stump fibroid	74
75	Note multiple fibrous growths with smooth surfaces in stump fibroid	75
76	Note adhesions between stump granuloma and urinary bladder	75
77	Stump abscess, resected by ligation at the base	75
78	Note the relative measurements of pelvic inlet and cranio-caudal region of prostate	75
79	Note nearly spherical prostate in sagittal section	75
80	Note asymmetrical enlargement in transverse plane of prostate	75
81	Note indentations of urethra due to hyperplastic prostate	78

82	Skiagram showing large radiopaque mass in centre of the abdomen	78
83	Skiagram showing splenic haemangiosarcoma, occupying most of the abdominal cavity	78
84	Note typical honey comb appearance in splenic haemangiosarcoma	78
85	Cytology of haemangiosarcoma Note increased N: C ratio	78
86 and 87	Photograph showing perineal herniation	78and81
88	Inguinal herniation in pup	81
89	Perineal haematoma in a Doberman dog	81
90	Note a radiopaque structure at the perineal region	81
91	Note the presence of urinary catheter in the perineal hernial sac	81
92	Note fluid density in the inguinal hernial sac	81
93	Note increased radiopacity at the perineal region in perineal haematoma	82
94	Pneumocystograph showing the normal location of bladder	82
95	Perineal hernial sac before catheterization	82
96	Perineal hernial sac after catheterization and drainage	82
97	Loops of intestine and urinary bladder in the inguinal hernial sac	82
98	Note central hypoechoic and peripheral hyperechoic regions in the haematoma	82

LIST OF TABLES

Table No.	Title	Page No.
1	Details of signalment, laboratory, radiographic, ultrasonographic and surgical findings in 54 animals under study	43-46
2	Values (Mean ± SE) of various (pre-operative) haematological and biochemical parameters in various groups of dogs	48
3	Calculation of volume of prostate gland using plain radiography and ultrasonography	73

ACKNOWLEDGEMENTS

I thank my ***major advisor and Chairman of my Advisory Committee, Dr. V. DEVI PRASAD, Associate Professor****,* ***Department of Veterinary Surgery and Radiology, College of Veterinary Science, Proddatur,*** *for accepting me as a post graduate student. He has been extremely loving, affectionate, kind and encouraging during the preparation of this thesis. I don't have words to fully register my gratitude to him. However, I feel beholden to him from the core of my heart. Under his guidance I successfully overcame many difficulties and learned a lot. I can't forget his hard times. His curiosity in subject and competitive thoughts will always inspire me, without whose support, I would have never succeeded in this effort and he treated me like a family member and I consider myself fortunate to work under his guidance.*

It gives me great pleasure to owe my deepest gratitude to ***Dr.N.V.V.Harikrishna, Assistant Professor & Head, Department of Veterinary Surgery & Radiology, NTR College of Veterinary Science, Gannavaram*** *member of Advisory committee for his help in writing dissertation, encouragement, constructive criticism, valuable suggestions and friendly approach that were profoundly fruitful in the evaluation of manuscript.*

I express my sincere thanks to, ***Dr. G. Venkata Naidu, Professor & Head, Department of Veterinary Gynaecology& Obstetrics, NTR College of Veterinary Science, Gannavaram****. He generously gave his time to offer me valuable comments in improving my work.*

I sincerely thank ***Dr. V.VaikuntaRao, Professor*** *&* ***Head Department of Veterinary Medicine****, NTR College of Veterinary Science, Gannavaram for his generous help and guidance in completing this piece of work.*

I am indebted to ***Dr. M. Raghunath, Associate Professor & Head, Teaching Veterinary Clinical Complex, NTR College of Veterinary Science, Gannavaram,*** *who had been a great source of inspiration. His concern, sensitivity, utmost patience and unusual way of appreciation laid the foundation on which this thesis is built.*

I would like to show my greatest appreciation to ***Dr. P. Ravi Kumar, Assistant Professor, Department of Veterinary Surgery and Radiology, NTR*** *College of Veterinary Science, Gannavaram, for his wise counsel, valuable ideas and suggestions during my research work.*

I would like to thank ***Dr. V.S.C. Bose retired professor*** *for his support and valuable suggestions. I take this opportunity to thank* ***Dr. P.VidyaSagar and B.Sailaja, Assistant Professors, of Surgery & Radiology,*** *for their help during my work.*

I would like to offer my special thanks to ***Dr.Makkena Srinu, professor and Head, Department of Veterinary Surgery & Radiology, College of Veterinary Science, korutla*** *for his valuable corrections regarding thesis work.*

I am extremely indebted to ***Dr. Sudharani chowdhary, Dr.Gangu Naidu and Dr. kalyani Assistant Professors*** *for their kind help in the estimation of serum biochemical parameters.*

I would like to offer my special thanks to ***Dr. K.S.R. Vital, Associate Professor of Library science and his Staff****, NTR College of Veterinary Science, Gannavaram for their help in literature collection.*

I owe my deepest gratitude to ***Dr.R.V.Suresh Kumar, Dr.R.Mahesh, Dr.Guru Vishnu, Dr. G.Kamalakar, Dr.J.DevaRatnam, Dr.N.Sumiran*** *faculty of college of veterinary science, Proddatur for their unselfish help during my stay at Proddatur.*

I express my special thanks from the bottom of my heart to my beloved friends and my M.V.Sc colleagues ***Dr.Panja (PradeepKumar), Dr.Nithin,C.J, Dr. Prasanna Swamy, Dr.Chaitanya Sankar, Dr. Ramu, Dr. Ramesh Chandra, Dr.Mohan Rao, Dr.Chaya Vinaya Devi, Dr.Srinvas Reddy, Dr.Madhu Babu, Dr. Rupakala, Dr.Satish, Dr. Praveen raj, Dr. Praveen Kumar, Dr.Srinivas Naik,*** *who have been with me in moments of happiness and grief and helped me a lot in completion of my work through their moral and physical support.*

I am very much grateful to my junior M.V.Sc students ***Dr.Subash Chandra Bose, Dr.Vamsi Krishna Yadav, Dr.M.S.Reddy, Dr.Stacy Daniella, Dr. Amulya,*** *for their candid cooperation and help during my research work.*

I am happy to express my sincere gratitude to, ***Sheshu, Kiran, Venky, Anji, Prasanna Laxmi and Indira,*** *non-teaching staff of Department of Veterinary Surgery and Radiology, NTR College of Veterinary Science, Gannavaram, for their co-operation and help throughout the research period.*

Finally, I would like to express my heartful gratitude to my parents and my brother ***Chanakya*** *for their love, patience, and understanding. I thank my parents for blessing* ***Srividya & Srilaxmi*** *as my sisters, whose undefiled and pure love made me virtually lucky. I would like to thank my brothers-in-law* ***Mohan Rao, Murali, Babji and Kishore*** *for their ever ready approach to help me. I also thank my nephew* ***Gandharv*** *and niece* ***Bilvani****, whose affectionate gestures made me comfortable in prosecuting this work.*

Place: Gannavaram
Date: ***(M.Durga Prasad Babu)***

DECLARATION

I, **Dr M. DURGA PRASAD BABU, ID.** No: **GVM/2013-33** hereby declare that the thesis entitled **"CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS"** submitted to Sri Venkateswara Veterinary University, Tirupati for the degree of MASTER OF VETERINARY SCIENCE is the result of original research work done by me. I also declare that the materials contained in this thesis have not been published earlier.

Date :

Place : Gannavaram

(M DURGA PRASAD BABU)

Name of the author : **M. DURGA PRASAD BABU**
Title of the thesis : **CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS.**
Degree to which it is submitted: **Master of Veterinary Science**
Faculty : **Veterinary Science**
Department : **Veterinary Surgery and Radiology,**
NTR College of Veterinary Science, Gannavaram.
Major advisor : **Dr. V. Devi Prasad,**
Associate Professor,
Veterinary Surgery and Radiology,
College of Veterinary Science, Proddatur.
University : **Sri Venkateswara Veterinary University, Tirupati.**
Year : **2015**

ABSTRACT

The present study entitled, "**CLINICAL STUDIES ON TRANSABDOMINAL ULTRASONOGRAPHY IN DIAGNOSING VARIOUS ABDOMINAL DISORDERS IN DOGS**" was undertaken to correlate the findings of ultrasonography with those of clinical, haematological, biochemical, plain and contrast radiographic techniques in the diagnosis of disorders of gastro- intestinal, hepatobiliary, urinary, genital, spleen, and abdominal wall of dogs. In all the animals, the symptoms were misleading.

Out of six cases of GIT involvement, two had intestinal obstruction and one had intussusception. The laboratory findings included leukocytosis with neutrophilia, elevated BUN and ALP levels. Radiography aided in the diagnosis of complete intestinal obstructions. Ultrasonography revealed the typical bull's eye sign in intussusception. The foreign bodies were seen as hyperechoic structures with acoustic shadowing. When compared to radiography, ultrasonography was conclusive in diagnosing intestinal obstruction or intussusception.

In hepatobiliary disorders, leukocytosis with neutrophilia, elevated AST and ALP, and decreased total protein, blood glucose and cholesterol values were

observed. Radiography could detect hepatomegaly, calcification, ascites, while failed to diagnose hepatoma, cyst, nodular hyperplasia, gall bladder sludge etc. Ultrasonography was more useful in the diagnosis of ascites, neoplasia, gall bladder sludge or nodular hyperplasia.

In obstructive urolithiasis and cystitis, significantly decreased Hb and PCV, elevated total leucocyte count with neutrophilia and elevated BUN were observed. Radiography revealed radio-opaque calculi, however, it failed to show radiolucent calculi. Transitional cell carcinoma, haemorrhagic cystitis, polypoid cystitis etc., were seen only on pneumocystography or ultrasonography. Calculi were seen with definite acoustic shadowing on ultrasonography.

In pyometra, stump granuloma and stump pyometra anaemia with decreased Hb, PCV and TEC, neutrophilic leukocytosis with shift to left and elevated BUN were observed. Closed pyometra, macerated foetus were readily diagnosed on radiography, while stump fibroid and abscess needed confirmation from ultrasonography. The latter helped in deciding the origin of mass and its relation to adjacent structures. Pyometra was diagnosed by sacculations, while the stump disorders by a hyperechoic structures with acoustic shadowing. In prostate hyperplasia, relative neutrophilia with normal total leucocyte count and elevated ALP were observed. The radiographic assessment of prostate hyperplasia correlated clinically and also with ultrasonography.

In splenic haemangiosarcoma a decreased Hb, PCV; elevated ALP, BUN, serum calcium and creatinine were observed. The lateral radiograph of the abdomen showed a large diffuse radio opaque mass in the abdomen. Ultrasonography confirmed the haemangiosarcoma with a typical honey comb appearance, which was further confirmed by cytology. Ultrasonography was more useful in diagnosing haemangiosarcoma while, haemato-biochemical profile supported, and fine needle aspiration cytology confirmed.

Hernial ring was palpable in all types of hernias encountered in the present study. Decreased Hb, total protein, leukocytosis with neutrophilia elevated BUN and serum creatinine were observed. However, to find out the nature of the contents, radiography was useful only when the intestines contained gas. In case of perineal swellings, ultrasonography helped significantly in identification of the lesion.

LIST OF SYMBOLS AND ABBREVIATIONS

%	-	per cent or percentage
/	-	per
@	-	at the rate of
±	-	plus or minus
µg	-	microgram
µl	-	microliter
ALP	-	Alkaline Phosphatase
BUN	-	Blood Urea Nitrogen
DLC	-	Differential Leukocyte Count
EDTA	-	Ethylene Diamine Tetra Acetic acid
et al	-	and others
etc	-	et cetera
FNAC	-	Fine Needle Aspiration Cytology
g/dl	-	grams per deciliter
GIT	-	Gastro Intestinal Tract
Hb	-	Haemoglobin
ie	-	that is
KV	-	Kilovoltage
mAs	-	Milliampere seconds
mg/dl	-	milligram per deciliter
MHz	-	Mega Hertz
N:C	-	Nuclear cytoplasmic ratio
No	-	number
PCV	-	Packed Cell Volume
SE	-	standard error
SGOT	-	Aspartate Aminotransferase
SGPT	-	Alanine Aminotransferase
TEC	-	Total Erythrocyte Count
TLC	-	Total Leukocyte count
viz,	-	namely

CHAPTER I

INTRODUCTION

In view of increasing urbanization, environmental pollution, unscientific feeding, stress and abuse of common therapeutic drugs, dogs are suffering from several diseases without any apparent symptoms for a long time. Added to this, the globally alarming lifestyle diseases have also been affecting the pet population. Hence, most of the dogs are referred to the college hospitals with non-specific clinical signs like anorexia, weight loss, pica, unthriftiness, lethargy, vomiting, diarrhea, anaemia, abdominal pain etc. thus making it difficult to the owners to appreciate the presence of a serious disease till it advances to a greater extent and frequently present a diagnostic challenge to veterinary clinicians (Braun, 2009 and Tantary *et al*., 2014). The clinical picture in some of the disorders of the abdomen is not clear due to involvement of other organs and overlapping clinical signs. Further, the compensatory function of paired organs like kidneys, adrenals etc. also defers the manifestation of the disease, thus obscuring the clinical signs.

Because of the above said reasons, diagnosis of diseases in small animal practice requires several clinical investigations. Up to the end of 20^{th} century, a tentative diagnosis was often made based on laboratory tests, physical examination and radiographic findings with confirmation possible only with exploratory laparotomy or postmortem (Schwarz *et al.*, 1998). Haemato biochemical findings in hepatopathies are many times deceptive leading to a diagnostic error (Chaudhary *et al.*, 2008). The poor diagnostic utility of plain radiography and the side effects of contrast radiography have limited their usage in the soft tissue disorders. Of late, diagnostic ultrasound has been gaining much popularity for its superiority as a non-invasive modality especially for investigation of disorders of abdominal soft tissues.

Ultrasonography is a rapid, non-invasive technique with superior contrast and without any ionizing radiation. When compared to radiography, it has several advantages like absence

of superimposition of structures or organs. This can be used to guide fine needle and tissue core biopsy procedures necessary in order to establish a specific diagnosis, which can avoid exploratory laparotomy in patients with poor surgical risk (Schwerk and Schmitz-moormann, 1981). Ultrasonography has totally replaced conventional radiology in the diagnosis of intestinal intussusception (Lee *et al.*, 1990). It has been exploited for diagnosis of intra-abdominal disorders (Barr, 1995 and Pillai *et al*., 2009), evaluation of thickening of stomach or intestinal wall and examination of peristaltic and intestinal movements in real time (Malancus *et al.*, 2010), life threatening complications like splenic torsion (Patil, 2011).

Moreover, the absence of ultrasonographic changes does not preclude the existence of disease (Nyland and Park 1983 and Freeny *et al*., 1987), as the ultrasound can detect only the echo textural changes, which may not be present in all the diseases. Further, presence of gas in the gastrointestinal tract may limit its utility. Ultrasonography is strongly operator dependent and hence cannot be relied in all the cases. Unlike other imaging modalities, interpretation must be completed at the time of study itself and it is nearly impossible to render a meaningful interpretation from another sonographer's static images or videotapes.

It can be asserted that, conventional radiography and ultrasonography are complementary to each other. These two imaging modalities merge the three dimensional data into two dimensional summation images. This picture has to be reversed by forming three dimensional impressions of underlying anatomy and disease (Molazem, 2010).

In nut shell, low level of pathognomonic signs and equivocal lab findings lead to a diagnostic paradox necessitating holistic and comprehensive studies for detecting disorders of abdominal organs. In India, application of ultrasonography has been restricted to teaching hospital/college (Tiwari *et al.*, 2005). During the previous 20 years, great advances in veterinary abdominal ultrasonography equipment and expertise have occurred however,

diagnostic utility of ultrasonography in correlation with other diagnostic modalities has not been reported fully (Leib *et al.,* 2010). The accuracies of ultrasonographic and radiographic diagnosis of soft tissues have been compared only to a very limited extent in dogs. Hence, the present study was undertaken to evaluate the relative value of transabdominal ultrasonography and to correlate with history, physical examinations, clinical pathology and radiography in arriving at final diagnosis with the following specific objectives.

1. To correlate the clinical, biochemical and radiographic findings in abdominal affections of dogs by transabdominal ultrasonography.
2. To stage the progression of the disease either by biopsy or histopathology wherever applicable.

CHAPTER II
REVIEW OF LITERATURE

The literature on ultrasonography of abdomen in dogs has been accumulating for the past two decades. It appears that, the information pertaining to abdominal ultrasonography correlated with haemato biochemical and radiographic changes is very much limited. However, the available literature on ultrasonography of various abdominal organs has been reviewed under the following subheads.

2.1 DISORDERS OF GASTROINTESTINAL SYSTEM

2.2 DISORDERS OF HEPATOBILIARY SYSTEM

2.3 DISORDERS OF URINARY SYSTEM

2.4 DISORDERS OF GENITAL SYSTEM

2.5 MISCELLANEOUS DISORDERS

2.1 DISORDERS OF GASTROINTESTINAL SYSTEM

2.1.1 CLINICAL SIGNS

Myers and Penninck (1994) felt that the symptoms of gastro intestinal tumors were nonspecific and included anorexia, weight loss, pica, unthriftiness and lethargy with frequent missing of hall mark signs of digestive tract like vomiting and diarrhoea.

Graham *et al.* (2000) opined that, the gastro intestinal form of pythiosis was typically characterized by non-specific signs referable to the gastro intestinal tract in dogs.

Penninck (2003) opined that, the major presenting clinical signs in dogs with enteritis were diarrhoea, vomiting, anorexia, lethargy; while in dogs with intestinal tumors, vomiting, diarrhoea, anorexia, weight loss, melena and palpable abdominal mass were the chief symptoms.

Jawre *et al.* (2008) reported diarrhoea, intermittent inappetence, polydipsia, depression, bloated tense abdomen etc. in a bull mastiff bitch with double ileo-caecal intussusception.

Diana (2009) reported that, the dogs with gastric polyps had only occasional or intermittent vomiting.

Pillai *et al*. (2009) noticed diarrhoea, vomiting, abdominal pain, depression, dehydration, emaciation, pale mucous membrane and a palpable sausage shaped mass in a pup with intussusception.

Cyrus *et al.* (2010) observed vomiting and absence of stools for four days in a dog affected with intestinal obstruction due to a mango kernel.

Kumar *et al.* (2010) recorded vomiting for four times, mild dehydration and normal vital signs in a pup that consumed a bottle cap.

Meshram and Kamble (2010) observed recurrent vomitings lasting for 5 days, anorexia, constipation, salivation, distention of abdomen, congested mucous membrane, elevated body temperature, increased heart and respiratory rates in a dog that swallowed a plastic ball.

Upadhye *et al.* (2010) recorded anorexia for 6 days, inability to pass faeces for eight days, arched back, dullness, tenesmus, scanty dark brown or black stools, dehydration, distended abdomen, marginally elevated body temperature, increased heart and respiratory rates in a dog affected with intussusception.

Atray *et al.* (2012) noticed anorexia, vomiting, bloody diarrhoea, dehydration, pale mucous membranes in three dogs with double intestinal intussusception.

Gupta *et al.* (2012) reported that, a dog with a known history of ingestion of a stone did not show any signs of pain, discomfort or gastrointestinal tract obstruction in a Labrador retriever dog.

Kim *et al.* (2012) documented abdominal discomfort, intermittent vomiting, bloody diarrhoea, mild depression etc. in a Shih – Tzu pup affected with double intussusception.

Parrah *et al.* (2013) observed underweight, pale mucous membrane, tachycardia from severe anaemia, pain on palpation of abdomen, vomiting, haemoptysis, melena, weight loss and haematemesis in dogs suffering from gastric ulceration.

2.1.2 HAEMATOLOGICAL CHANGES

Myers and Penninck (1994) recorded microcytic hypochromic anaemia, neutrophilic leukocytosis with a regenerative shift to left in dogs with gastro intestinal smooth muscle tumors.

Jawre *et al.* (2008) observed leukocytosis in a bull mastiff bitch with ileo-caecal intussusception.

Matthews *et al.* (2008) observed an increase in white blood cells a day after enterectomy and entero-anastomosis which restored to normal levels after six days. Elevated red blood cells persisted in one dog was attributed to incisional infection.

Cyrus *et al.* (2010) observed mild leukocytosis in complete blood count of a dog suffering from intestinal obstruction due to a mango kernel.

Atray *et al.* (2012) noticed anaemia, neutrophilic leukocytosis and normal platelet counts in three cases of double intestinal intussusception in dogs.

Kim *et al.* (2012) observed mild leukocytosis with neutrophilia in a Shih –Tzu pup with double intussusception.

Parrah *et al.* (2013) reviewed various aspects of gastric ulceration in dogs noticed neutrophilic leukocytosis was piroxicam associated gastric ulceration in dog.

Kumar *et al.* (2015) recorded moderate leukocytosis and neutrophilia in an adult Labrador retriever dog suffering from ileo-caeco-colic intussusception.

2.1.3 BIOCHEMICAL ALTERATIONS

Myers and Penninck (1994) reported hypoproteinemia and hypoalbuminemia with total serum protein less than 5.2g/dl, and elevated blood urea nitrogen and serum alkaline phosphatase levels in dogs with gastric smooth muscle tumors.

Jawre *et al.* (2008) observed elevated values of serum alkaline phosphatase in a Bull mastiff bitch with ileo-caecal intussusception.

Cyrus *et al.* (2010) recorded mild hypoproteinemia (4.9 g/dl) with mild hypoalbuminemia (2.3g /dl) in a dog suffering from intestinal obstruction due to a mango kernel.

Atray *et al.* (2012) noticed low plasma sodium and elevated lactate dehydrogenase and alkaline phosphatase levels in three cases of double intestinal intussusception in dogs.

Kim *et al.* (2012) observed hyponatremia and hypokalemia in a Shih-Tzu pup with double intussusception.

Kumar *et al.* (2015) recorded moderate hypoproteinemia and hypoalbuminemia in an adult Labrador retriever dog suffering from ileo-caeco-colic intussusception.

2.1.4 RADIOGRAPHIC FINDINGS

Felts *et al.* (1984) stated that, diagnosis of intestinal obstruction was confirmatory by radiography while rarely diagnostic by abdominal palpation.

Myers and Penninck (1994) detected the presence of a mass effect, loss of serosal detail suggesting peritoneal effusion and evidence of free abdominal gas on survey abdominal radiographs of dogs with gastro intestinal smooth muscle tumors.

Patsikas *et al.* (2003) observed reduced serosal detail and a rounded soft tissue edge within the intestine that corresponded with the leading edge of the intussusception on the abdominal radiographs of dogs.

Jawre *et al.* (2008) observed a gas filled shadow in a portion of dilated intestine with a mass in its anterior portion on a lateral abdominal radiograph of a bull mastiff bitch with ileo-caecal intussusception.

Kumar *et al.* (2010) detected a radio opaque round foreign body at the pyloric end of the stomach, on a lateral abdominal radiograph of a three months old German Shepherd pup.

Sharma *et al.* (2011) determined small intestinal mechanical obstruction, using radiography by measuring the height of the fifth lumbar vertebral body (L_5), maximal small intestinal diameter (S.I) and ratio of S.I/L_5 ; gastric dilatation, foreign body, small intestinal plication, decreased abdominal serosal detail and gravel sign.

Atray *et al.* (2012) observed ground glass appearance along with a radio-opaque tissue mass at the base of the tail, and uniform gas filled distended intestinal loops occupying the entire abdominal cavity on lateral abdominal radiographs of three dogs with double intestinal intussusception.

Gupta *et al.* (2012) noticed a single triangular radio-opaque mass visible near the pyloric end of the stomach in lateral abdominal radiograph of Labrador retriever dog. A survey radiograph taken after two days revealed the presence of stone at the same place.

Kim *et al.* (2012) observed areas of reduced serosal detail and increased soft tissue opacity in addition to gas distended loop of small intestine in a Shih –Tzu puppy with double intussusception.

2.1.5 ULTRASONOGRAPHIC FEATURES

Myers and Penninck (1994) concluded that, ultrasonography more sensitive than survey radiography in the detection of gastro intestinal smooth muscle tumors.

Hotz *et al.* (1996) recommended transabdominal gastric ultrasonography as a diagnostic technique in the evaluation of gastric neoplasia.

Patsikas *et al.* (2003) documented that, ultrasonography was a sensitive, specific and accurate method for the diagnosis of intestinal intussusception in young dogs. In transverse sections, the target like mass consisting of hyperechoic or anechoic centre surrounded by well or poorly differentiated concentric rings was observed. In longitudinal sections, the intussusception appeared as multiple hyperechoic and hypoechoic parallel lines, and tumor like or pseudo kidney mass or trident like configuration were also identified.

Penninck *et al.* (2003) opined that, ultrasonography was a useful technique for distinguishing enteritis from intestinal tumors with loss of normal wall layering having a strong predictive value in determining the presence of an intestinal tumor.

Jawre *et al.* (2008) recorded hypoechoic multi-layered concentric rings representing the layers of intussusceptum and intussuscipiens with anechoic lumen in the centre, ventral to the spine in a Bull Mastiff bitch with ileo-caecal intussusception.

Matthews *et al.* (2008) studied the ultrasonography appearance of uncomplicated enterotomy or enterectomy sites in dogs by recording the, length and maximal intestinal wall thickness and gastro intestinal wall motility.

Larson and Biller (2009) reported that, ultrasound was extremely helpful in the diagnosis of obstructive lesions with the bowel proximal to the obstruction usually dilated with gas or fluid appearance. While carrying out the ultrasonography of gastro intestinal tract, they recorded appearance of bulls eye or target like signs in intussusception; persistent echogenic linear structure extending through the plicated bowel representing the linear foreign body.

Pillai *et al.* (2009) observed multi layered concentric lesion with hyper echoic and hypoechoic rings and multiple layered lesion with alternating hyper echoic and hypo echoic lines in transverse and longitudinal planes respectively in a pup with intussusception. They

preferred abdominal ultrasonography as the most useful diagnostic technique for diagnosing intra-abdominal soft tissue abnormalities in small animals.

Cyrus *et al.* (2010) diagnosed a case of intestinal obstruction caused by a mango kernel in a dog by using ultrasonography which depicted a hyperechoic mass in the intestinal lumen.

Leib *et al.* (2010) concluded that abdominal ultrasonography did not substantially contribute to the clinical diagnosis in many dogs with chronic vomiting.

Malancus *et al.* (2010) felt that, ultrasound technique made a substantial contribution to the detection of diseases by being able to appreciate the thickness of the wall of the stomach or intestine and local or diffuse changes in such segments. They established the lesions of chronic enteritis as increased parietal thickness and maintenance of proportions between intestinal wall layers. Intussusception was diagnosed by target appearance with double the number of layers of the intestinal wall.

Sharma *et al.* (2011) compared radiography and ultrasonography and concluded that, both the techniques were good for diagnosing small intestinal mechanical obstruction in vomiting dogs and observed moderate agreement. Ultrasonography was considered more accurate providing a high level of diagnostic confidence in the evaluation of vomiting dogs. They suggested that, detection of an enlarged loop of jejunum (serosa to serosa diameter > 1.5cm) with normal wall layering should prompt the examiner to thoroughly evaluate the entire abdomen for a possible cause of small intestinal mechanical obstruction.

Atray *et al.* (2012) recorded a series of multiple hyperechoic and hypoechoic concentric rings with a hyperechoic centre in the transverse plane of ultrasonographic examination, consistent with intussusception. In transverse plane, ultrasonography disclosed a typical “triple circle sign” which was different from the target sign of classical single intussusception.

Kim *et al.* (2012) detected a mass that appeared as a series of concentric circles in transverse section and parallel lines in the longitudinal section, in a Shih-Tzu puppy with double intussusception. A cylindrical intestinal mass with a characteristic ring sign was thought to be specific for intussusception.

Kumar *et al.* (2015) observed a series of concentric and hypoechoic rings in an adult Labrador retriever dog suffering from ileo-caeco-colic intussusception. A cylindrical intestinal mass with a characteristic ring sign was felt as highly specific for intussusception. They felt that, ultrasonography was an accurate diagnostic method, which totally replaced conventional radiology in the diagnosis of intestinal intussusception.

2.2 HEPATOBILIARY SYSTEM

2.2.1 CLINICAL SIGNS

Schwarz *et al.* (1998) observed lethargy, vomiting, diarrhoea, trembling, polyuria, polydipsia, fever, colic, dehydration and tachypnea etc. in dogs with hepatic abscess.

Vijay kumar (2002) observed abdominal distention, breathing difficulty, abdominal discomfort, groaning while lying down, scrotal or penile oedema, weight gain, vomiting, cough, anorexia, lethargy, episodic weakness and fever in dogs with ascites.

Vijayanand and Nagarajan (2007) observed anorexia, lethargy, depression, weight loss, vomiting, diarrhoea, polyuria and polydipsia in a dog suffering from cirrhosis.

Chaudhary *et al.* (2008) recorded nausea, vomiting, mild anaemia, jaundice, ascites, constipation, polydipsia, pyrexia, polyuria, muscle tremors, weakness, debility, anorexia etc. in dogs with hepatic diseases. They opined that history of prolonged erratic anorexia and weakness aroused suspicion of liver involvement.

Mircean *et al.* (2008) reported inappetence, vomiting, lethargy, weight loss, abdominal distention, polydipsia, cutaneous lesions, fever etc. in dogs with hepatobiliary disease.

Salvekar *et al.* (2010) opined that, most of the symptoms of liver disorders were gradual and relatively nonspecific making it difficult for the owners to appreciate the pressure of a serious disease till it advances to a greater extent.

Saravanan *et al.* (2012) recorded anorexia, lethargy, distended abdomen in a dog with ascites. They considered these signs as non-specific due to variable causes of ascites.

Kumar *et al.* (2013) noticed depression, dullness, inappetence, anorexia, vomiting, diarrhoea, ascites, anaemia, abdominal pain, pedal edema, icterus and swollen lymph nodes in dogs with hepatobiliary dysfunction.

Kumar and Srikala (2014) observed abdominal distention, respiratory distress, lethargy, cyanotic tongue and cough in a dog with ascites due to right heart failure.

Elhiblu (2015) observed inappetence, halitosis, melena, hematoschezia, polyuria, polydipsia, dehydration, icterus, weight loss and abdominal distention in dogs with cirrhosis of liver.

2.2.2 HAEMATOLOGICAL CHANGES

Schwarz *et al.* (1998) documented neutrophilia with left shift, monocytosis, anaemia and thrombocytopenia in dogs with hepatic abscess.

Besso *et al.* (2000) observed elevated white blood cells with mature neutrophilia in a dog with gallbladder mucocele.

Kitchell *et al.* (2000) noticed leukocytosis with mature neutrophilia, monocytosis and eosinopenia in a dog with peliosis hepatis.

Arambulo *et al.* (2004) observed anaemia with decreased values of red blood cells, hemoglobin and packed cell volume etc. in a dog affected with malignant histiocytosis.

Tomar *et al.* (2011) observed decreased values of hemoglobin, packed cell volume, while elevated levels of total leucocyte count and neutrophils in dogs suffering from cholecystitis.

Kumar *et al.* (2013) reported that non regenerative anaemia was the most common finding in hepatic disease which was usually normocytic and normochromic and was often associated with insufficient use of systemic iron store. They found significantly lower values of total erythrocyte counts and lymphocytes; and significantly higher total leucocyte counts with neutrophilia in dogs suffering from hepatic dysfunction.

Tantary *et al.* (2013) found non significantly decreased hemoglobin, packed cell volume, total erythrocyte count and platelet count, unaltered total leucocytes and increased clotting time in dogs suffering from ascites due to chronic hepatitis.

Tantary *et al.* (2014) recorded decreased hemoglobin, packed cell volume, total erythrocyte and total platelet counts; significantly increased clotting time, non-significantly increased total leucocyte count and slightly increased neutrophilic counts in dogs with hepatic disorders.

Elhiblu *et al.* (2015) observed decreased values of hemoglobin, lymphocytes, packed cell volume, platelet count, fibrinogen and increased values of total leucocytic and neutrophilic counts in dogs affected with liver cirrhosis.

2.2.3 BIOCHEMICAL ALTERATIONS

Strombeck *et al.* (1988) studied the effect of corticosteroid treatment on survival time in dogs with chronic hepatitis and reported that, hypoglycemia due to impaired carbohydrate metabolism in the liver was a rare finding and glucose was a bad prognostic marker for liver diseases.

Sevelius and Anderson (1994) inferred that, the gamma glutamyl transferase activity was almost parallel with alkaline phosphatase activity in cholestasis and hypoalbuminemia could serve as indicator of liver function.

Solter *et al.* (1994) considered alkaline phosphatase as a selective marker for cholestasis in most mammalian species including dogs.

Schwarz *et al.* (1998) observed increased levels of alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase commonly along with occasionally increased total bilirubin concentration in 5 dogs with hepatic abscess.

Kitchell *et al.* (2000) observed elevated levels of alkaline phosphatase in a dog with peliosis hepatis.

Vijaykumar (2002) recorded decreased levels of albumin and cholesterol in impaired liver synthesis; elevated levels of alanine aminotransferase, aspartate transaminase, alkaline phosphatase, bilirubin and bile acids in liver diseases; elevated blood urea nitrogen and creatinine in renal failure and low level of glucose in hepatic disease of ascitic dogs.

Arambulo *et al.* (2004) recorded decreased levels of calcium, total protein and albumin; elevated levels of alkaline phosphatase and total bilirubin in a dogs affected with malignant histiocytosis, malignant histiocytoma and malignant fibrous histiocytoma.

Vijayanand and Nagarajan (2007) recorded increased levels of serum alanine amino transferase, alkaline phosphatase and decreased levels of albumin in a dog with cirrhosis.

Chaudhary *et al.* (2008) observed decreased levels of total protein, serum albumin, blood glucose and increased values of alkaline phosphatase, alanine aminotransferase in dogs diagnosed with hepatitis and cirrhosis.

Mircean *et al.* (2008) inferred that diffuse hepatic lesions such as cirrhosis and cholangio hepatitis were associated with similar enzymatic abnormalities and only ultrasonography could aid in differential diagnosis. Significant elevation of serum hepatic enzymes was observed in focal hepatic lesions such as hemangiosarcoma and hepatic abscess.

Salvekar *et al.* (2010) correlated the findings of ultrasonography with those of serum biochemical parameters and observed that liver specific enzymes were non significantly

increased and were with in normal physiological range in dogs suffering from various liver disorders in dogs.

Tomar *et al.* (2011) recorded elevated serum alanine aminotransferase and bilirubin levels in dogs suffering from cholecystitis.

Kumar *et al.* (2013) studied the therapeutic management of hepatobiliary dysfunction in canines and found significantly elevated alanine amino transferase, aspartate aminotransferase and gamma glutamyl transferase levels in dogs.

Salib *et al.* (2013) noticed normal serum levels of alanine amino transferase, aspartate amino transferase, and total and direct bilirubin in dogs affected with pseudo hepatic fasciola infestation.

Tantary *et al.* (2013) found significantly decreased total protein, albumin, globulin, albumin/globulin ratio, blood glucose and cholesterol levels; and significantly increased alanine amino transferase, aspartate amino transferase, alkaline phosphatase, gamma glutamyl transferase, blood urea nitrogen and bilirubin.

Kumar and Srikala (2014) found elevated levels of creatinine kinase, lactate dehydrogenase, alanine amino transferase, alkaline phosphatase with normal blood urea nitrogen and creatinine in a dog with ascites due to right heart failure.

Tantary *et al.* (2014) recorded significantly increased values of aspartate amino transferase, alanine amino transferase, alkaline phosphatase, total bilirubin and blood urea nitrogen, gamma glutamyl transferase and creatinine; and significantly decreased mean values of total protein, albumin, globulin, albumin/globulin ratio, plasma glucose, plasma cholesterol in dogs with hepatic disorders.

Elhiblu *et al.* (2015) documented significantly lower levels of albumin, total protein, glucose, albumin – globulin ratio and fibrinogen; significantly higher values of aspartate

amino transferase, alanine amino transferase, prothrombin time and activated plasma thrombin time in dogs affected with cirrhosis of liver.

2.2.4 RADIOGRAPHIC FINDINGS

England (1996) reported that, assessment of liver size was fraught with error and was at best inexact and subjective. Alteration in liver size required evaluation of the liver borders and the position of adjacent structures like costal arch, stomach, right kidney and duodenal flexure. It has been further suggested that, the radiographic measurement of liver length was a consistent parameter that might be used for the assessment of liver size by comparison with a standard anatomical land mark such as vertebral body length.

Schwarz *et al.* (1998) reviewed the ultrasonographic findings, clinical data and therapeutic options in dogs and observed caudal deviation of gastric axis supportive of liver mass, hepatomegaly, rounded liver margins, abdominal effusion and gas with in the liver parenchyma on the abdominal radiographs.

Vijaykumar (2002) observed hazy opaque abdominal cavity with a classic ground glass appearance on lateral abdominal radiographs of dogs suffering from ascites.

Chaudhary *et al.* (2008) detected hepatomegaly by protrusion of liver beyond the rib cage in dogs with hepatic diseases.

Adel (2012) recorded normal hepatic size without hepatobiliary calcification on a lateral abdominal radiograph of a dog with polypoid lesions in the gallbladder.

Kumar and Srikala (2014) diagnosed ascites with right heart failure in a dog and found the classical sign of ground glass appearance of abdomen in the lateral abdominal radiograph.

Elhiblu *et al.* (2015) could not get any information to diagnose cirrhosis in dogs through radiographs.

2.2.5 ULTRASONOGRAPHIC FEATURES

Carlisle (1995) noted no difference in the visibility of hepatic and portal vessels between dogs with a deep or shallow thorax or with different amounts of fat.

Schwarz *et al.* (1998) reviewed that, although liver abscessation was characterized by number, size, shape, echogenicity and location solitary lesions were more common than multiple ones.

Varshney and Hoque (2002) observed diffuse hyperechoic and bright echotexture of liver with prominent vasculature in dogs suffering from cirrhosis.

Vijaykumar (2002) worked on therapeutic management of ascites in dogs and reported hyper echoic to mixed echogenicity, nodular pattern or porto-caval shunt of liver in hepatic diseases, dilated hepatic vasculature in right congestive heart failure and floating abdominal organs in the ascitic fluid.

Vijayanand and Nagarajan (2007) reported micro hepatica, less distinct peri portal parenchymal echoes due to fibrosis, irregular hepatic margins, regenerative nodules, increased parenchymal echogenicity and ascites in a dog suffering from cirrhosis.

Chaudhary *et al.* (2008) diagnosed hepatic disorders like cyst, abscess, tumor, gallbladder distention, sludge in gallbladder, thickening of the wall of the gallbladder, choleliths and mucocele with changes in the echotexture of liver and gallbladder. Hepatic cysts were diagnosed by multiple focal anechoic changes in liver parenchyma.

Mircean *et al.* (2008) tested the comparative efficacy of ultrasonographic and laboratory findings in the diagnosis of hepatobiliary diseases in dogs and concluded that, the

intensity of the biochemical changes were not always correlated with the severity of liver lesions that were found during ultrasonography.

Salvekar *et al.* (2010) demonstrated that the ultrasonography was a valuable tool for correct diagnosis of liver diseases in dogs. Altered echotexture of liver parenchyma could be visualized to confirm various liver diseases like, hepatic abscess, cyst, fatty liver, cirrhosis and hepatic neoplasia. Ultrasonography was felt as a best tool to scan liver in presence of ascetic fluid. They suggested that best results could be obtained by combination of both clinico-pathological and ultrasonographic evaluation for the correct diagnosis of the liver diseases.

Tomar *et al.* (2011) noted double walled gallbladder, suggestive of increased thickness in dogs with cholecystitis.

Saravanan *et al.* (2012) confirmed ascites in dogs with anechoic areas and hyperechoic cirrhotic liver by abdominal ultrasound. They correlated the ultrasonographic findings of hyperechoic /cirrhotic liver with high gradient ascites with $\geq$1.1g/dl of serum ascites albumin gradient.

Kumar *et al.* (2013) reported hyperechoic bright liver with normal size in chronic hepatitis. However, bright and small liver with irregular margins in hepatic cirrhosis and diffuse hyperechoic liver parenchyma with less distinct portal vessels associated with accumulation of peritoneal fluid in chronic hepatic cirrhosis or hepatitis.

Salib *et al.* (2013) reported that the architecture of the liver tissue, common bile ducts, bile ductules and gall bladder with pseudofasciola infestation in German Shepherd dogs remained normal.

Tantary *et al.* (2013) found hepatomegaly associated with diffuse hyperechoic liver parenchyma with less distinct portal vessels and accumulation of peritoneal fluid, in dogs affected with chronic hepatitis.

Kumar and Srikala (2014) diagnosed ascites with right heart failure in a dog and found floating viscera in the anechoic effusion with engorged and distended hepatic vasculature, presence of areas of hyper echoic to mixed echogenicity and rounding of liver lobes indicative of hepatic disease.

Tantary *et al.* (2014) noticed reduced parenchymal echogenicity with enhanced visualization of portal vessels in acute hepatitis; hyper echoic bright liver with normal size in chronic hepatitis and bright and small liver with irregular margins in hepatic cirrhosis. They considered ultrasonography as a more reliable method in the diagnosis of liver disease in dogs.

Elhiblu *et al.* (2015) assessed the cirrhotic liver in dogs and found generalized and diffuse hyperechoic hepatic parenchyma, rounded and irregular liver margins, micro hepatica and distended gall bladder and lots of free anechoic fluids in the abdominal cavity as consistent ultrasongraphic features. It was concluded that, ultrasonography along with haemato-biochemical alterations might be used as a diagnostic tool for cirrhosis of liver in dogs.

2.3 URINARY SYSTEM

2.3.1 CLINICAL SIGNS

Nyland *et al.* (2002) observed stranguria, haematuria and pollakiuria in three dogs with presumed needle tract implantation of transitional cell carcinoma to the abdominal wall at 2-8 months following fine needle aspiration biopsy.

Petite *et al.* (2006) noticed pollakiuria, recurrent haematuria and stranguria in four non diabetic female dogs suffering from emphysematous cystitis.

Langston *et al.* (2008) observed haematuria, pollakiuria, stranguria, and dysuria in obstructive urolithiasis in dogs. Small uroliths could cause partial or complete urinary obstruction of the urethra, leading to bladder distention, abdominal pain, paradoxical incontinence, stranguria and signs of post renal azotemia (anorexia, vomiting, and depression). In unattended cases they noticed rupture of urinary bladder, resulting in uroabdomen.

Rousset *et al.* (2011) claimed that, hydronephrosis in dogs did not cause any clinical signs due to continuous dilation of renal pelvis.

Secrest *et al.* (2011) mentioned that marked haematuria and proteinuria were the only symptoms noticed in a dog suffering from bilateral orthotopic ureteroceles.

Paskalev *et al.* (2012) reported refusal of food but not water, fever, lethargy, constipation, distended abdomen and normal urination in a dog affected with solitary renal cyst.

Raposo *et al.* (2013) observed anorexia, restlessness, polydipsia, polyuria, dysuria, haematuria, swelling of the affected kidney, abdominal distention, external fistula in dogs with hydronephrosis due to abdominal trauma.

Hanazano *et al.* (2014) recorded pollakiuria, haematuria and dysuria in all the dogs affected with transitional cell carcinoma.

Mahesh *et al.* (2014) noticed dysuria, intermittent fever, anorexia, also recent episodes of haematuria and a palpable, hard, big lemon sized abdominal mass in a bitch with solitary cystic calculus.

Taylor *et al.* (2014) noticed polyuria, polydipsia, elevated serum creatinine and isosthenuria in dogs affected with renal lymphoma.

Mesquita *et al.* (2015) observed progressive weight loss, emesis, anorexia lasting for one month in a crossbred female dog suffering from bilateral hydronephrosis and hydroureter.

2.3.2 HAEMATOLOGICAL CHANGES

Barr *et al.* (1989) observed pancytopenia with shift to left in the blood picture of dogs with hypercalcemic nephropathy.

Langston *et al.* (2008) observed normal blood picture in dogs suffering from urolithiasis and simple cystitis; and leukocytosis in pyelonephritis.

Paskalev *et al.* (2012) observed marked leukocytosis with mild thrombocytopenia in a clinical case of solitary renal cyst in dog. Other hematological parameters like packed cell

volume, total erythrocyte, total leucocyte and platelet counts were well within the reference range.

Bradea *et al.* (2013) observed changes in red cellular series translated by hemoconcentration, hypochromic anaemia and in white cell series leukocytosis in dogs suffering from uretero hydronephrosis.

Raposo *et al.* (2013) recorded leukocytosis with left shift in a case of hydronephrosis in a dog.

Sravanthi *et al.* (2014) recorded normal total red blood cell count, total leucocyte count, and haemoglobin content in dogs with urolithiasis.

Mesquita *et al.* (2015) reported hypo chromic microcytic anaemia in a spayed crossbred female dog suffering from hydronephrosis and hydroureter. All other hematological parameters were found normal.

2.3.3 BIOCHEMICAL ALTERATIONS

Barr *et al.* (1989) reported very high serum calcium, urea and creatinine levels, raised serum liver enzymes and elevated serum total protein and globulin values in dogs with hypercalcemic nephropathy.

Hanson and Tidwell (1996) recorded extremely mild elevation of blood urea nitrogen and normal creatinine levels in dogs with urethral transitional cell carcinoma.

Langston *et al.* (2008) recorded normal biochemical profile in cases of urolithiasis. They further reported hypocalcaemia in calcium oxalate or calcium phosphate uroliths and azotemia with either upper or lower urinary tract obstruction.

Paskalev *et al.* (2012) observed moderately elevated liver transaminases, amylase and blood glucose in a clinical case of solitary renal cyst in a dog. Other biochemical parameters like blood urea nitrogen and serum creatinine were within the normal range.

Bradea *et al.* (2013) classified five degrees of uretero hydronephrosis in dogs and observed increased values in serum urea and creatinine levels and decrease of serum albumin specific in renal functional failure.

Raposo *et al.* (2013) recorded increased levels of total plasma protein and normal renal and hepatic functions in a case of hydronephrosis in a dog.

Sravanthi *et al.* (2014) found normal blood urea nitrogen and serum creatinine presurgical levels in dogs with urolithiasis.

Mesquita *et al.* (2015) recorded hypo chromic microcytic anaemia, elevated urea and creatinine levels in spayed crossbred female dogs with bilateral hydronephrosis and hydroureters. Serum creatinine and urea values were found to restore to normal levels following treatment for a prolonged period of forty days.

2.3.4 RADIOGRAPHIC FINDINGS

Hanson and Tidwell (1996) observed filling defects in the lumen of bladder during double contrast cystourethrogram, filling defects in urethral lumen and irregular urethral mucosa during positive contrast urethrogram; pulmonary metastasis, cystic calculi and prostatomegaly in dogs with urethral transitional cell carcinoma.

Heng *et al.* (2006) claimed that, survey radiography was not useful in diagnosing neoplasia of urinary bladder wall. Contrast radiography such as positive and or double

contrast cystography showed the presence of intraluminal filling defect caused by the mass that was not visible on survey radiography.

Petite *et al.* (2006) studied the radiographic findings of emphysematous cystitis in four non diabetic female dogs and noticed mottled gas opacities with in the wall of the urinary bladder.

Langston *et al.* (2008) suggested pneumocystography was more sensitive than survey radiography in detecting calculi, with a false-negative rate of 6.5%; while double-contrast radiography had diagnostic accuracy with a false-negative rate of 4.5%. They felt the latter as sensitive to count the number of calculi.

Paskalev *et al.* (2012) observed an abnormal apple sized shadow located in the middle of the abdominal cavity behind the stomach and over the spleen. Its structure was found homogenous with sharp and regular borders in a case of dog with solitary renal cyst.

Mahesh *et al.* (2014) diagnosed a large solitary cystic calculus in a bitch on survey radiography and pneumocystography of abdomen.

Sravanthi *et al.* (2014) noticed urethral calculi in different regions of urethra in dogs like, caudal to the ospenis, in the scrotal region, at the level of ischial arch, in the bladder, urethra left and kidney. Finally they inferred that, only plain radiography confirmed the diagnosis of uroliths leaving no scope for any further contrast radiographic examination.

2.3.5 ULTRASONOGRAPHIC FEATURES

Konde *et al.* (1984) felt that, ultrasound examination added a new dimension to treatment planning and prognostic determination of various kidney disorders in dogs.

Barr *et al.* (1989) observed both kidneys were of normal size, shape and had a smooth contour in dogs with hypercalcemic nephropathy. A distinct narrow echogenic line was

visible at the cortico-medullary junction and could be recognized in both longitudinal and transverse sections.

Hanson and Tidwell (1996) studied the ultrasonographic appearance of urethral transitional cell carcinoma in dogs and reported that the findings ranged from subtle thickening and hypoechogenicity of the proximal urethra with a faint and smooth hyperechoic line at the epithelium to a pebbly irregular hyperechoic luminal margin.

Lamb and Gregory (1998) mentioned that, ultrasonography enabled more accurate determination of normal ureteral anatomy in dogs.

Heng *et al.* (2006) diagnosed leiomyoma and leiomyosarcoma of urinary bladder wall in three dogs by ultrasonographic features like single, smoothly marginated, round hypoechoic to mixed echogenicity. The extent of involvement of urinary bladder wall could not be distinguished due to the origin of tumors from the lateral or cranial location where ultrasonographic detail of urinary bladder was poor.

Mantis *et al.* (2006) compared ultrasonography /radiography and exploratory surgery in the diagnosis of ectopic ureters in dogs and concluded that ultrasonography was the choice for the evaluation of the uretero-vesicular junctions and it said to have highest sensitivity, specificity and accuracy than other imaging methods. However, intravenous urography was thought to have mildly higher sensitivity in the examination of ureter.

Petite *et al.* (2006) recommended that, ultrasonography was more sensitive for detection of gas within the bladder at an early stage of emphysematous cystitis.

Langston *et al.* (2008) opined that, ultrasonography was better than survey radiography, with a false-negative rate of 3.5%; while it was similar to double-contrast radiography in detecting uroliths. They assessed the sensitivity of ultrasonography for detecting ureteral calculi as 77%, which could be increased to 90% by using a combination of ultrasonography and survey radiography.

Bokhari *et al.* (2012) reported that ultrasonographic changes in renal dimensions, particularly renal length, width and depth might successfully be used in dogs for prediction of changes in glomerular filtration rate without a need to perform complicated laboratory procedures.

Paskalev *et al.* (2012) observed a round anechoic area with smooth borders, linked to the cranial pole of left kidney in a case of solitary renal cyst in a dog. The affected kidney had only one third to one half of the normal renal structure.

Bradea *et al.* (2013) diagnosed five degrees of uretero hydronephrosis in dogs characterized by dilatation of basinet, ureter and calices with normal caliceal structure (first and second degrees); basinet, ureteral dilatation and reverse caliceal cup (third degree), obvious basinet, ureter and calices dilatation with reduction of parenchymal index (fourth degree) and extreme dilatation of urinary ways and lack of renal parenchyma (fifth degree).

Raposo *et al.* (2013) diagnosed a case of hydronephrosis in a dog by ultrasonographic features like a fluid filled sac in the anatomical position of the left kidney.

Gaber *et al.* (2014) concluded that, ultrasonography was a successful tool not only for diagnosis of urinary tract obstruction but also for the post-operative evaluation.

Hanazano *et al.* (2014) studied the involvement of wall of the urinary bladder in transitional cell carcinoma and polypoid cystitis in dogs and established that, involvement of bladder wall, heterogeneous mass and trigone location characteristics were significantly associated with shorter survival times and these characteristics were thought to act as reliable prognostic indicators in all such cases.

Sravanthi *et al.* (2014) detected the presence of hyperechoic focal echogenic spots accompanied with an acoustic shadow in cystic calculi and left kidney besides thickening of the urinary bladder wall. They inferred that, survey radiography and ultrasonography were proved to be helpful in diagnosing urolithiasis in dogs.

Taylor *et al.* (2014) felt that, additional advance imaging, repeated ultrasound and renal biopsy might be helpful, while fine needle aspirate cytology was a high yield test for diagnosing canine renal lymphoma in dogs.

Mesquita *et al.* (2015) confirmed bilateral renal enlargement with renal cortical atrophy, loss of cortico-medullary differentiation, dilated pelvis and dilation of both ureters suggestive of hydronephrosis and hydroureter by abdominal ultrasonography in a spayed crossbred female dog.

2.4 GENITAL SYSTEM

2.4.1 FEMALE GENITAL SYSTEM

2.4.1.1 CLINICAL SIGNS

Bru *et al.* (1998) reported that ascites was a common clinical finding in dogs with ovarian tumors. This was attributed to the tumor metastasis in peritoneal lymphatic vessels causing lymphatic obstruction.

Marin *et al*. (2011) observed polyuria and polydipsia syndrome in bitches affected with pyometra.

Gupta *et al.*(2012) observed dullness, depression, lethargy, poor general condition, grey to chocolate coloured, foul smelling vaginal discharge sticking to the hair of tail and perineum, distended abdomen, vomiting, polyuria, polydipsia, toxemia, etc. in pyometra bitches.

Marin *et al.* (2014) reported that uterine and ovarian remnants in an incorrectly spayed bitch did not show any clinical signs over a period of eight years after surgery. At the time of presentation, the bitch was said to have sanguineous vulvar discharge.

2.4.1.2 HAEMATOLOGICAL CHANGES

Marin *et al.* (2014) detected a slightly low red blood cell count and leukocytosis in a bitch which was spayed eight years before.

2.4.1.3 RADIOGRAPHIC FINDINGS

Matton and Nyland (1995) inferred that, in comparison with a lot of different diagnoses attributed to radiographic findings, ultrasonographic imaging of the uterus presented a much more specific technique which allowed not only the type of pyometra to be recorded (Showed whether it was localized, segmental or uniform tubular in nature) and also integrity of uterine wall and content type.

Valocky and Mojzisova (2006) opined that, radiographic imaging of uterus might be used as a diagnostic tool in the detection of pyometra. However, it should be backed up by other diagnostic procedures.

Marin *et al.* (2014) performed lateral abdominal radiography in a bitch which was spayed eight years before and could not find any pathological changes. They considered radiography to be useful only to rule out metastasis.

2.4.1.4 ULTRASONOGRAPHIC FEATURES

Valocky and Mojzisova (2006) recommended ultrasonography as a very important diagnostic procedure in the gynaecological disorders of bitches as it measures internal diameter of uterine horn, thickness of uterine horn wall and external diameter of uterine horn.

Marin *et al.* (2011) considered ultrasound diagnosis in cases of pyometra as an easily achievable modality with cent per cent accuracy and designated the technique as non-aggressive for the patient and the examiner. They observed round or ovoid shaped or oblong, large sacs containing anechoic fluid with artifactual distal enhancement and without parietal thickening. They described the characteristic “snow storm” appearance of the uterus due to particulate uterine matter together with abdominal wall movements.

Christensen *et al.* (2013) reported that, granulosa cell tumors, pyometra, mammary tumors and other diseases associated with the release of steroid hormones from ovarian remnants could be linked with improper removal of reproductive tissue.

Gupta *et al.* (2013) concluded that, the ultrasonography was a rapid, safe and an accurate diagnostic aid for the qualitative and quantitative evaluation of canine pyometra. They observed echogenic fluid and hypoechoic tubular uterus with enhancement effect due to large quantity of uterine fluid. The hypoechoic and enlarged uterus folded upon itself so that the sections of the both horns could be visualized in a single plane.

Marin *et al.* (2014) found a right ovary of normal size and an anechogenic spherical structure of about 1 cm in diameter located on its surface and an anechogenic structure of about 8x3 cm located in the caudo-abdominal region without any communication between vagina and bowel in an incorrectly spayed bitch.

2.4.2 MALE GENITAL SYSTEM

2.4.2.1 CLINICAL SIGNS

Bhadwal and Mirakhur (2000) reported constipation, haematuria, haemoglobinuria, foul smelling urine, incontinence, straining, a palpable mass at the level of pelvic brim and perineal hernia in dogs with prostatic diseases.

Prathaban (2002) asserted that, benign prostate hyperplasia might a sub clinical condition but occasionally characterized by symptoms, like tenesmus, haematuria, hemorrhagic urethral discharge in dogs. He felt that dyschezia was more common than dysuria and the stools were often ribbon shaped. An intermittent hemorrhage or clear to light yellow urethral discharge or persistent haematuria was also noticed in some dogs.

Santa *et al.* (2008) recorded intermittent severe haematuria and stranguria with episodes of anaemia, mild lethargy, pale mucous membrane, distended and painful urinary bladder, hemorrhage from the urethra etc. dog suffering from primary prostatic haemangiosarcoma.

Varshney *et al.* (2010) observed arched back, high temperature, marked haematuria, bold dropping from prepuce, micturition, uneasiness, increased frequency of urination with very small volume, depression, anorexia and vomiting off and on in Germen shepherd dogs affected with acute prostatitis.

2.4.2.2 RADIOGRAPHIC FINDINGS

Prathaban (2002) stated that, the size, location and contour of the prostate might be determined by radiography of the caudal abdomen. The prostate was often distinguishable on lateral or dorso-ventral survey views. A normal prostate was thought not to displace the colon or the bladder from its normal position. They felt that, survey radiographs were often of limited value in the diagnosis of specific prostatic diseases.

Santa *et al.* (2008) reported prostatomegaly with degenerative changes at the facet joints of the cranial and mid lumbar spine and ventral spondylosis at the level of sixth and seventh lumbar vertebrae in a dog with primary prostatic haemangiosarcoma.

2.4.2.3 ULTRASONOGRAPHIC FEATURES

Bhadwal and Mirakhur (2000) observed enlarged area of increased echogenicity at the level of the neck of urinary bladder in prostatomegaly; large anechoic area containing a mass of mixed echo patterns in prostatomegaly with prostate hyperplasia. They emphasized that, transabdominal ultrasonography presented a very safe, satisfactory and realistic image of the anatomical and pathological status of the canine prostate.

Prathaban (2002) reported that, prostatic size, volume and consistency could be evaluated better with ultrasonography than with radiography. Ultrasonography was felt useful even in the presence of abdominal fluid or loss of intra-abdominal fat. Increase in parenchymal echogenicity could be observed in any prostatic disease.

Santa *et al.* (2008) observed distended urinary bladder containing a large amount of mobile sediment which did not produce acoustic shadowing, and an intraluminal blood clot characterized by irregular shape and homogenous echotexture. The prostate appeared mildly rounded and had a mildly increased echogenicity with finely inhomogeneous echotexture and well defined margins.

Gadelha *et al.* (2009) inferred that, the dimensions of prostate varied according to age, being small in young animals and large in old ones and a therefore positive correlation could be noticed between prostatic dimensions and age.

Varshney *et al.* (2010) noticed increased prostate size with areas of increased echogenicity, diffusely increased hyperechoic area, untraceable prostatic urethra, thickened and irregular urinary bladder wall, with multiple discrete mobile hyperechoic foci etc. in two German Shepherd dogs suffering from acute prostatitis.

Ghadiri *et al.* (2013) compared transabdominal and transrectal ultrasonography of the prostate gland in dogs and concluded that, the latter was a simple, quick and noninvasive method while the former yielded useful information about prostate. It was further adjudged that, the calculated prostatic volume did not correlate correctly with that of the estimated volume and hence, needed to use equations produced by linear regression.

2.5 MISCELLANEOUS DISORDERS

2.5.1 CLINICAL SIGNS

Oksanen (1978) observed polydipsia, anaemia, cardiac insufficiency, cough, dyspnoea, edema of lungs, abdominal distention, extreme weakness, high temperature,

difficulty in swallowing and apathy in dogs that died of haemangiosarcoma of spleen. He noticed that, the incidence of tumor was more common in old dogs of 9 years of age without any specificity to breed or sex.

Guelbahar *et al.* (1998) noticed progressive weight loss, anorexia and indifference to surroundings for twenty days and marked skeletal muscle weakness in a dog affected with splenic haemangiosarcoma with abdominal dissemination.

Singh *et al.* (2012) observed constant straining to urinate with dribbling of urine in dogs with perineal hernia and lipoma. The development of hernia was noted to be slow in onset.

2.5.2 HAEMATOLOGICAL STUDIES

Guelbahar *et al.* (1998) recorded a total erythrocyte count of 4.25 x 10^6/µl, hemoglobin 10.4 g/dl, packed cell volume 33% and white blood cells 19.6 x 10^3/µl in a 12 year old male Germen Shepherd dog affected with splenic haemangiosarcoma with abdominal dissemination.

Watson *et al.* (2011) observed reduced levels of packed cell volume in a dog with splenic neoplasia.

Vijaykumar (2002) observed anaemia, neutrophilia with leukocytosis in dogs suffering from ascites.

Singh *et al.* (2012) observed decreased values of hemoglobin, packed cell volume and leukocytosis with neutrophilia in dogs affected with perineal disorders.

2.5.3 BIOCHEMICAL ALTERATIONS

Patil *et al.* (2011) recorded increased serum creatinine, blood urea nitrogen and aspartate aminotransferase in a dog suffering from splenic torsion.

2.5.4 RADIOGRAPHIC FINDINGS

Guelbahar *et al.* (1998) recorded numerous radio-opaque masses of varying sizes throughout the abdomen in a 12 year old male Germen Shepherd dog affected with splenic haemangiosarcoma with abdominal dissemination.

Patil *et al.* (2011) diagnosed an emergency case of splenic torsion in a dog and observed atypical radio - opaque mass just below the stomach, which extended beyond its normal location. The spleen was enlarged in size.

Singh *et al.* (2012) mentioned the radiological picture of the perineal swelling as a radiolucent shadow with a slight radio-opaque picture in the centre and in one female radio-dense material toward the base and soft tissue density around it.

2.5.5 ULTRASONOGRAPHIC FEATURES

Patil *et al.* (2011) reported enlarged spleen showing multiple areas of hypo and hyperechogenicity and dilated splenic vessels with coarse /lacy appearance in splenic infarction and necrosis due to splenic torsion in a dog.

Watson *et al.* (2011) felt that, needle core biopsy was complementary to ultrasonography in dogs with splenic neoplasia, which could improve detection of splenic neoplasia besides providing neoplastic sub classification.

Singh *et al.* (2012) compared the radiography and ultrasonography for their efficacies in the differential diagnosis of perineal swellings in dogs and concluded that ultrasonography was found to be better than radiography in differentiating perineal hernia from perineal lipoma and other lesions. They observed hyperechoic shadow of enlarged prostate gland putting pressure over the anechoic urethra resulting in distention of the anechoic urinary bladder, and hypoechoic image of the intestine in perineal swelling.

2.5.6 HISTOPATHOLOGY

Oksanen *et al.* (1978) diagnosed haemangiosarcoma in dogs and found much morphological variation even between tumors in the same dog. They noticed that the tumor was benign at some locations consisting of blood filled spaces lined by a single layer of maturing endothelial cells, white malignant at other locations, with a large rounded nucleus. The vascular spaces were found to be surrounded by large masses of sarcoma type cells with pleomorphic nuclei.

Guelbahar *et al.* (1998) observed diffuse necrotic and hemorrhagic areas between primary tumor tissue and normal tissue in the spleen; and neoplastic endothelial cells forming blood filled cavernous spaces and solid areas from splenic tumor mass in the sections of splenic tissue collected from a 12 year old male germen shepherd dog that had splenic haemangiosarcoma with abdominal dissemination.

CHAPTER III

MATERIALS AND METHODS

The present study entitled **"Clinical studies on transabdominal ultrasonography in diagnosing various abdominal disorders in dogs"** was undertaken to diagnose commonly reported conditions of various abdominal organs in dogs. Ultrasonography has been gaining popularity as it is completely non-invasive and hence allows repeated examinations in case of necessity. Even with the sophisticated equipment, diagnostic ultrasound can detect only altered tissue echotexture. But many diseases and disorders progress without any apparent changes in the echotexture. Hence, in the present study, an attempt is made to correlate the findings of ultrasonography with those of Clinical signs, clinical examination, haematological changes, biochemical alterations, radiographic findings, histopathological studies etc. for confirming the diagnosis of various disorders of abdominal organs.

3.1 Selection of cases:

This study was conducted on 54 dogs of either sex, belonging to all age groups and brought to the Department of Veterinary Surgery and Radiology, NTR College of Veterinary Science, Gannavaram with vague symptoms without confirming to a definitive diagnosis. Most of the dogs were brought after having been treated at various veterinary dispensaries, hospitals or polyclinics. None of the dogs was subjected for any clinical investigation, before presentation to the University teaching hospital.

All the animals have been divided in to the under mentioned groups with symptoms related to the following systems.

Group I: Gastro intestinal system (n=6)

Group II: Hepato biliary system (n=12)

Group III: Urinary system (n=12)

Group IV: Female genital system (n=12)

Group V: Male genital system (n=6)

Group VI: Miscellaneous conditions (n=6)

All the animals were thoroughly examined and the following investigations were carried out in order to confirm the nature of the disease

3.2 Clinical signs and physical examination

The animals were subjected for thorough clinical examination, after collecting detailed anamnesis. The vital signs like rectal temperature (^{0}F), pulse rate (number of beats per minute) and respiratory rate (number of breaths per minute) were recorded. All the animals were subjected for physical examination methods like palpation and percussion of the abdomen in order find out the nature of distention or abdominal masses if any.

3.3 Haematological and biochemical profile

In order to aid either in the final diagnosis or to give a statement of prognosis or to decide the anaesthetic or treatment protocols, the following laboratory investigations were carried out.

After properly restraining the animals, blood samples were collected from all the animals taking all aseptic precautions and avoiding haemolysis. An aliquot of approximately 6 milliliters of blood was collected into a sterile test tube by cephalic vein or saphenous vein puncture for the estimation of hematological and other biochemical constituents out of which 2ml of blood was collected into the heparinized vial for the estimation of haemoglobin (g/dl), packed cell volume (%), total erythrocyte count ($x10^6$/µl), total leucocyte count ($x10^3$/µl) and differential leucocyte count (%) as per the methods described by Jain (1986).

From the hitherto collected and remaining 4 ml of blood, 1 ml of blood was utilized for estimation of blood glucose and from the rest of 3 ml; plasma was separated by centrifugation at 3000 rpm for 15 minutes as suggested by Barros *et al.* (2000). Then the separated plasma was stored at -20^oC in plastic bullets unit for the estimation of biochemical constituents like alanine amino transferase, aspartate aminotransferase, alkaline phosphatase, gamma glutamoyl transferase, glucose, cholesterol, total protein, bilirubin, blood urea nitrogen and creatinine spectrophotometrically.

3.4 Radiography:

Lateral and ventrodorsal survey radiographs were taken for animals in all the groups by using 500 mA X-ray machine (Fig. 1). The range of exposure factors employed was 40-50mAs and 50-60 KV for lateral views and 40-45 mAs and 50-55 KV for ventro dorsal views. In a few cases, Pneumocystography was performed in order to rule out a space occupying lesions in the urinary bladder.

3.5 Real time B-mode transabdominal ultrasonography

3.5.1 Ultrasound machine:

Transabdominal ultrasonography was carried out using ultrasound machines (Fig. 2 and 3) in B-mode with linear and sector transducers (Fig. 4). An acoustic gel was used as a coupling medium.

3.5.2 Preparation of animal for scanning

The dogs meant for transabdominal ultrasonography were directed for fasting for 12 hours prior to examination in all the elective cases. However, in cases of emergency, no time was allowed for fasting. The cranio-ventral abdomen was clipped from the costal arch cranial to the inguinal region caudally and laterally along the body wall. In case of problems associated with urinary system, the animals were made to drink plenty of water and scanning was carried out before it could urinate. In occasional instances like ascites, the animals were made to stand to complete the scanning procedure. None of the animal was sedated before scanning.

3.5.3 Position of Animal:

The ultrasound machine was placed in front of the sonographer, to the left of the animal. The animal was placed first in dorsal recumbency to the sonographer's right with the head facing the machine. Later, the animal was controlled in right and left lateral recumbency for better visualization of different abdominal organs.

39

Fig. 1 500 mA X-ray machine

Fig. 2 Ultrasound machine

Fig. 3 Ultrasound machine

Fig. 4 Linear and sector transducers

3.5.4 Selection of transducers

Transducers of 7.5, 5 and 3.5 MHz frequency were used in small (<10 Kg), medium (10-20 Kg) and large (>20 Kg) dogs respectively. To obtain better resolution, the transducers were switched from one frequency to the other in order to get better resolution.

3.5.5 Ultrasound scanning with selection of acoustic window:

After securing the animal either in lateral or dorsal recumbency, scanning was carried out by using a sector convex or linear probe placing in sagittal, longitudinal, oblique or dorsal manner in different regions to view various organs through proper acoustic windows as following and as suggested in BSAVA (British Small Animal Veterinary Association) Manual of canine and feline ultrasonography.

Organ or region	**Acoustic window**
liver	Caudal to xiphoid process, with cranial angulation of the ultrasound beam
	Left and right mid-abdominal to dorsal intercostal window.
Spleen	Along left costal arch.
	Left cranio ventral abdomen with sagittal beam angulation.
Stomach	Fundus and body: along the left costal arch
	Antrum and pylorus: ventral to the right of midline or right intercostal window
Left kidney	Left cranial mid-abdominal to dorsal sagittal window

Right kidney	Right cranial mid-abdominal to dorsal/sagittal window with cranio-dorsal beam angulation
Ileum	Right mid-abdominal to dorsal window with sagittal beam angulation (just medial and parallel to the descending duodenum)
Urinary bladder	Cranial to pubic bone
Prostate gland and urethra	Caudal abdomen, cranial to pubic bone with caudo dorsal beam angulation Perianal approach
Uterus	Body: caudal abdomen, cranial to pubic bone just dorsal to urinary bladder) Uterine horns: left and right mid-abdominal window with sagittal beam

3.6 HISTOPATHOLOGICAL STUDIES:

In cases of abdominal masses, stump granuloma, transitional cell carcinoma, haemangiosarcoma, samples of tissues were collected. Occasionally, microphotographs were obtained with respect to fine needle aspirate cytology. After collection, the tissues were, directly transferred to 10 per cent neutral buffer formalin. The tissues were processed through routine alcohol, benzene schedule for infiltration and embedding in paraffin. Sections of five micrometers thickness were made and stained with Harris haematoxylin and eosin (H & E) (Singh and Sulochana, 1997) and the same were subjected for microscopic examination.

CHAPTER IV
RESULTS

It would not be an irony to say that, ultrasonography as a non-invasive diagnostic modality, has been receiving utmost attention in the investigation of abdominal disorders for the past two decades. Although several investigative techniques have directly been extrapolated from human medicine, the pace at which these novel techniques are adopted appears slow. In the present study entitled, **"Clinical studies on transabdominal ultrasonography in diagnosing various abdominal disorders in dogs"** an attempt has been made to correlate the findings of ultrasonography with those of traditional investigative strategies like haematological, biochemical, plain and contrast radiographic techniques in order to establish confirmatory diagnosis of common abdominal disorders in dogs.

4.1 Selection of cases

Many of the animals were in causality at the time of presentation. In cases of intestinal obstruction, intussusception, pyometra, haemangiosarcoma, ascites, obstructive urolithiasis etc. the animals were moderate to severely dehydrated and toxemic. As there were no pathognomonic signs the following investigations were carried out in all the groups and the results are presented and discussed accordingly.

4.2 Group I (Gastro intestinal system)

Out of six cases, one was diagnosed as intussusception, while the other two had intestinal obstruction and three were negative for both the conditions.

4.2.1 Clinical signs and physical examination

The details of animals treated are given in table no. 1. All the six animals were weak and anorectic for more than 7 to 10 days. The animal with intussusception had an earlier

S.No	Signalment			Haematological profiles		Biochemical profiles		Radiographic findings (Plain and Contrast)	Ultrasonographic findings	Surgical findings/FNAC /HP	DIAGNOSIS
	Age (Y/M)	Breed	sex	Decreased	Elevated	Decreased	Elevated				
1	3m	GSD	M	Anaemia	TLC (n)	--	ALP TP	Gas filled and distended intestinal loops, radiopaque mass below L_3 and L_4	Target like mass or bulls eye lesion	Telescoping at ileo-caeco-colic junction	Intussusception
2	1Y	GSD	M	Anaemia	TLC (n)	Glucose	BUN ALP	Stacking of gas filled intestinal segments.	Linear hyperechoic structure was seen at mucosal interface	Under wear foreign body	Intestinal obstruction
3	6M	G R	F	Anaemia	--	TP Alb	BUN	Gas filled and distended intestinal loops	Dilated intestines in horizontal and hyperechoic f/b with acoustic shadow in sagittal sections.	Corn cob foreign body	Intestinal obstruction
4-6	7,7,8Y	MB	2M 1F	-	-	-	-	-	-	-	NAD
7-11	7,9,8,8, 10 Y	POM	3F 2M	Anaemia	TLC (n)	TP ALBU CHL GLU	ALP AST ALT BUN	Rounded liver lobes with displacement of related structures and hepatic calcification	Liver appeared enlarged with smooth margins.	---	Hepatomegaly
12-14	9,9,8Y	2LAB 1POM	2M 1F	Anaemia	--	TP ALBU CHL GLU	ALP AST ALT BUN	Hazy or ground glass appearance	Free fluid with floating of visceral organs	Free abdominal fluid on centesis	Ascites
15	10Y	DP	M	Anaemia	TLC (n)	TP ALBU CHL GLU	ALT AST	Not significant	presence of an anechoic area with clear acoustic enhancement	--	Hepatic cyst
16	12Y	MBD	F	Anaemia	TLC (n)	TP ALBU CHL GLU	ALP AST ALT BUN	Not significant	A large focal hyperechoic lesion was observed	Tumor mass	Hepatoma
17	12Y	POM	F	Anaemia	TLC (n)	TP ALBU CHL GLU	ALP AST ALT	Not significant	Peripheral hyperechoic rim surrounding a central hypoechoic structure	---	Nodular hyperplasia

18	12Y	LAB	M	Anaemia	Relative neutrophilia	TP ALBU	ALP ALT	Not significant	sludge was floating in the bile rather than settling at the bottom	---	NAD
19-23	18Y 15M 12Y 10Y(2)	POM2 MBD2 GSD1	M4 F1	Anaemia L & E (DLC)	TLC (n)	AST ALBU	BUN ALP	Radiopaque calculi in UB and urethra. Distended bladder with fluid density.	Calculi with acoustic shadowing were noticed in all the cases but not that much conspicuous in radiolucent calculi.	After hydro propulsion, calculi were retrieved through cystotomy	Cystourethral calculi
24-25	8Y 10Y	POM, LAB	F M	Anaemia	TLC (n)	--	BUN	Thickened bladder wall in cystitis (Pneumocystography).	Bladder wall diffusely thickened and hyperechoic	---	Cystitis
26	10Y	MB	M	Anaemia	TLC (n)	ALBU	BUN ALP GLU	Filling defect in the urinary bladder Pneumocystography with prostatomegaly.	Hetero echoic structure in the bladder	TCC on FNAC	TCC
27	8Y	PUG	F	--	Relative neutrophilia	ALBU	BUN CHOL GLU	Not significant	Thickening of the bladder wall with small growths projecting into the lumen.	---	Polypoid cystitis
28	9Y	DH	M	---	Relative neutrophilia	--	--	Blood clots were found on pneumocystography	Hyperechoic, non-shadowing blood clots were found	--	Haemorrhagic cystitis
29	5Y	DP	M	---	TLC (n)	--	BUN AST ALT GLU	Not significant	Anechoic renal cyst with acoustic enhancement.	Asymptomatic except abdominal distention.	Renal cyst
30	15Y	LAB	M	Anaemia	TLC (n)	--	TP		Dilated, anechoic renal pelvis with acoustic enhancement	Asymptomatic except abdominal distention	Hydronephrosis
31-38	6 7(2) 8(2) 10 12(2)	1LAB 2POM 2Spz 1DP 2 MB	F	Anaemia	TLC (n)	GLU CHOL	BUN, ALT, AST, SC, ALP and TP	Homogenous fluid type of opacity in the uterus with coiled uterine horns	Distended uterine loops with anechoic sacculations	Weight of the pus filled uterus ranged from 2 to 4 kg. One had ovarian cysts	Pyometra

39	8Y	MB	F	Anaemia	TLC (n)	---	BUN, ALT, AST,SC, ALP and CHOL	Radiopaque fetal bones with Spalding sign.	Hyperechoic fetal bones	Two macerated fetuses were delivered.	Macerated foetus
40	10Y	POM	F	Anaemia	TLC (n)	TP	BUN	Radiopaque mass between bladder and colon	A hypoechoic mass was demarcated against anechoic bladder	Stump fibroma measured 13 x 9 cm and weighed about 500 grams approximately	Stump fibroma
41	9Y	GR	F	Severe anaemia	--	TP	ALP BUN	Tip of the urinary catheter was found at the rib cage.	Mixed echogenic mass representing the fibroid was observed adjacent to the bladder	The tumor was very smooth. However there was a conglomeration of several fibroid like structures.	Stump fibroma
42	7Y	D H	F	--	Neutrophilia	--	ALP BUN	Radio opaque mass between descending colon and urinary bladder	Anechoic structure adjacent to the bladder.	Stump abscess was resected carefully after ligation at the base.	Stump abscess
43-44.	7Y 2Y	GSD MB	M	--	TLC (n)	--	ALP TP	Colon was compressed by enlarged prostate appearing as radiopaque mass, dorsal to bladder.	Gland appeared spherical in sagittal section and it was asymmetrical on transverse plane.	Symptoms resolved on castration.	Prostate hyperplasia
45-48	6, 7, 8, 8(Y)	Mongrel	M	--	TLC (n)	--	--	--	--	Symptoms of haematuria and constipation	NAD
49	10Y	D.H	F	Anaemia	Neutrophilia	--	Ca BUN ALP SC	Large diffuse radio opaque mass in the abdomen.	Spleen had a typical honey comb appearance	---	Haemangiosarcoma of spleen

50-51	8Y 9Y	Pom and Mongrel	M M	Anaemia	TLC (n)	TP ALBU	SC BUN GLU	On catheterization of bladder, the tube was found in the hernial sac	Anechoic fluid filled structure was identified at the perineal region	Urinary bladder was repositioned and herniorrhaphy was performed.	Perineal Hernia
52	4 m	MB	F	Anaemia	TLC (n)	TP	ALP	Fluid density in the hernial sac	Huge anechoic sac, within which the intestines were identified by their peristaltic motility	Performed inguinal herniorrhaphy	Inguinal hernia
53	6	Mongrel	F	Anaemia	TLC (n)	TP	--	Enormous radio opaque swelling at the inguinal region	Hernial sac contained intestinal loops and urinary bladder	Performed inguinal herniorrhaphy	Performed inguinal herniorrhaphy
54	6	Mongrel	M	Anaemia	TLC (n)	--	--	Radio opacity at the perineal region	Clear anechoic to hypoechoic structure	Blood clots were observed during drainage	Perineal haematoma

LAB – Labrador retriever, POM – Pomeranian, DP - Doberman pincher, DH-Dasch Hound, GSD – German Shepherd, GR – Golden Retriever, GD – Great Dane, MB: Mixed breed, m=months, Y=years, TP: Total Protein, SC: Serum creatinine, (n): Neutrophilia, Chol: Cholesterol.

episode of enteritis and prolapse of intestines through anus (Fig. 5). It was erroneously diagnosed as a pure case of prolapse of rectum and it was repositioned and retained by applying a purse string suture by the attending veterinarian. Vomiting was reported in all the three animals with greenish vomitus of frothy consistency. The visible mucous membranes were pale.

The symptoms of intestinal obstruction were more or less similar to those of intestinal intussusception. However, vomiting was more frequent in the intraluminal obstruction. Palpation revealed a hard mass at the caudal aspect of the tensed abdomen in both the cases. Another three cases with similar signs were not found to have any specific lesions.

4.2.2 Haematological and biochemical profile

The values of various (pre-operative) haematological and biochemical parameters were given in table no. 2. Among various haematologic parameters, a non significant decrease in haemoglobin, total erythrocyte count was observed. Leukocytosis (20.13 ± 0.72) with neutrophilia (79.50 ± 5.07) was noticed. Among the biochemical parameters, blood urea nitrogen (40.46 ± 11.13) and alkaline phosphatase (178.83 ± 49.31) were found significantly elevated.

4.2.3 Radiography

The lateral plain radiograph of abdomen disclosed gas filled and distended loops of intestines. The magnitude of distention was well above the stipulated range i.e. greater than those of height of central portion of fifth lumbar vertebra and twice that of width of last rib. The prolapsed segment of intestines showed varying radio-densities i.e. being more radio-opaque at the cranial portion which was well delineated by a comparatively less radio-opaque

Table 2: Values (Mean **±** SE) of various (pre-operative) haematological and biochemical parameters in various groups of dogs.

Parameter	Group 1	Group 2	Group 3	Group 4	Group 5	Reference
Haemoglobin (g %)	11.66 ± 1.14	8.06 ± 0.65	10.83 ± 0.47	9.23 ± 0.84	11.50 ± 0.98	12 – 18
Packed Cell Volume (%)	37.83 ± 3.07	26.67 ± 1.99	34.83 ± 1.35	29.83 ± 2.63	35.83 ± 2.87	37 – 55
Total erythrocyte count ($X10^6$/ µl)	16.13 ± 0.72	15.98 ± 0.75	16.18 ± 0.55	18.03 ± 0.86	16.7 ± 1.02	5.6 – 17
Total leucocyte count ($X10^3$/µl)	20.13 ± 0.72	38.42 ± 0.75	36.18 ± 0.55	37.03 ± 0.86	6.23 ± 0.33	6 – 8
Neutrophils (%)	79.50 ± 5.07	85.58 ± 1.12	89.33 ± 1.45	90.50 ± 2.25	83.5 ± 2.90	60 – 77
Lymphocytes (%)	14.66 ± 3.05	13.00 ± 1.04	8.83 ± 0.98	8.58 ± 2.09	13.16 ± 2.23	12 – 30
Eosinophils (%)	5.83 ± 2.42	1.50 ± 0.40	1.83 ± 0.60	0.92 ± 0.36	3.33 ± 0.95	2 - 10
SGOT (U/L)	50.75 ± 3.63	80.80 ± 2.25	45.55 ± 5.42	51.83 ± 3.84	47.58 ± 2.81	16–60
SGPT (U/L)	38.83 ± 5.02	61.73 ± 6.36	34.88 ± 4.34	51.53 ± 5.90	39.83 ± 3.71	5–65
Blood urea nitrogen (mg/dl)	40.46 ± 11.13	27.33 ± 2.90	50.70 ± 8.38	36.63 ± 3.55	19.48 ± 1.48	6–29
Creatinine (mg/dl)	1.41 ± 0.32	0.90 ± 0.08	1.10 ± 0.14	1.42 ± 0.15	1.06 ± 0.10	0.6–1.6
Alkaline phosphatase (U/L)	178.83 ± 49.31	160.15 ± 15.52	81.85 ± 9.91	109.41 ± 25.78	95.58 ± 11.67	10–84
Total protein (g/dl)	5.45 ± 0.41	4.02 ± 0.16	6.46 ± 0.19	7.62 ± 0.38	6.85 ± 0.40	5.4–7.6
Albumin (g/dl)	2.71 ± 0.33	1.97 ± 0.12	2.39 ± 0.11	2.74 ± 0.25	3.38 ± 0.16	2.3–4.0
Glucose (mg %)	88.78 ± 11.07	60.35 ± 4.64	120.18 ± 20.14	72.99 ± 5.73	105.33 ± 2.99	65–130
Cholesterol (mg/dl)	206.00 ± 10.00	106.68 ± 7.52	180.12 ± 12.59	175.17 ± 15.35	206.50 ± 14.16	150–275

lower portion, suggesting increased thickness due to intussusception at the cranial portion. Demarcation of serosal surface was well appreciated (Fig. 6).

The lateral abdominal radiograph the dogs with intestinal obstruction showed multiple loops of gas filled intestines of varying diameters (Fig. 7). Between these two cases, the radiograph of the dog which had more frequency of vomiting showed stacking of gas filled intestinal segments (Fig. 8). The magnitude of distention of the intestinal loops was higher in the dog with corn cob as foreign body. The gas filled intestines in the remaining three cases had normal measurements.

4.2.4 Ultrasonography

In horizontal plane, the typical appearance of concentric hypoechoic and hyperechoic rings caused by invaginated layers of hyperechoic intussusceptum and hypoechoic intussuscipiens, known as “bull’s eye” or “ring” sign was clearly seen (Fig. 9). In sagittal plane intussusception appeared as linear hyperechoic and hypoechoic streaks (Fig. 10).

The ultrasonography in case of intestinal obstruction due to a corn cob revealed dilated lumina of intestines and the hyperechoic foreign body in horizontal plane (Fig. 11). In sagittal section, presence of a foreign body was clearly evident with strong acoustic shadow behind. Proximal to the obstruction an anechoic area suggesting fluid filled segment of intestine was discernible (Fig. 12). However, a linear strong hyperechoic structure was seen in horizontal plane (Fig. 13). In the remaining three cases, no abnormality could be observed.

4.2.5 Treatment

The three animals with intussusception and intestinal obstruction were stabilized, rehydrated and subjected for exploratory laparotomy following standard anaesthetic and

50

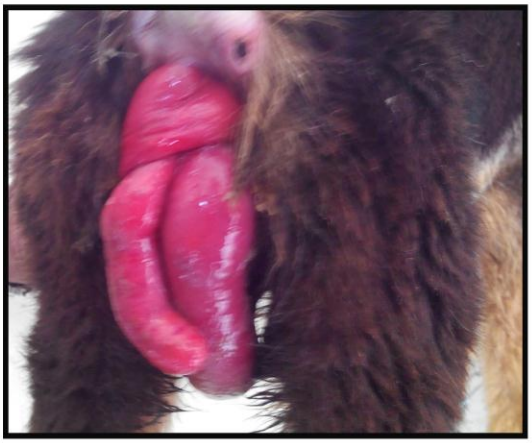

Fig. 5 Prolapse of intestines

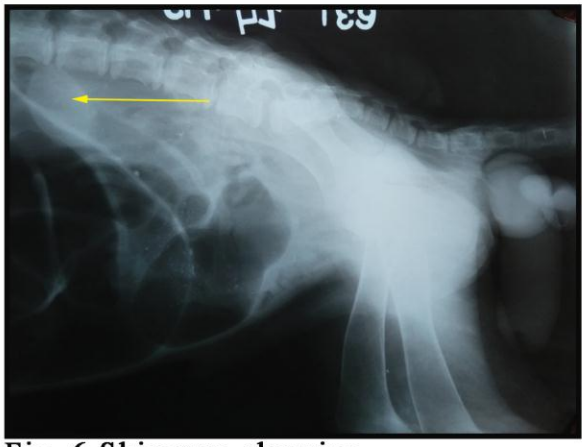

Fig. 6 Skiagram showing intussusception

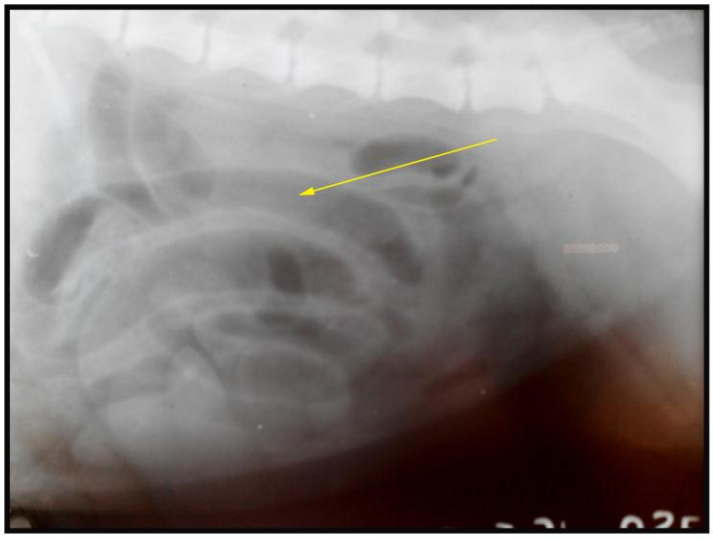

Fig. 7 Skiagram showing gas filled intestines

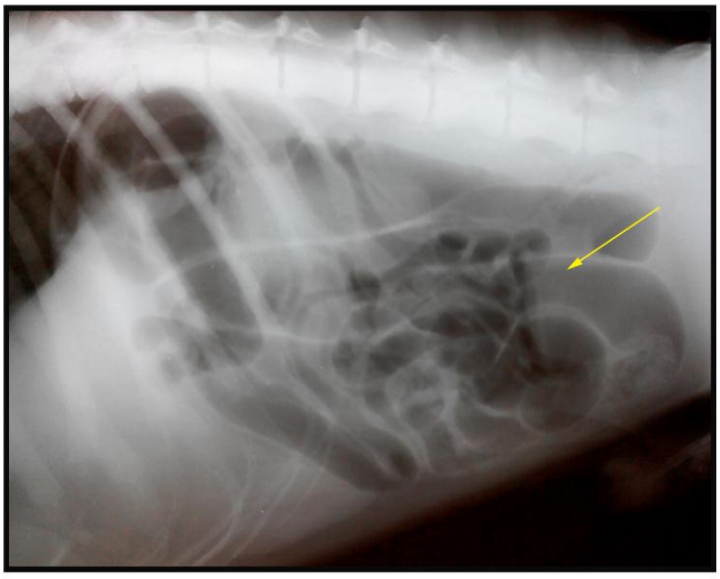

Fig. 8 Showing stacked intestinal loops

51

Fig. 9 Sonogram showing typical bulls eye appearence in intussusception in horizontal plane

Fig. 10 Sonogram showing alternative hypoechoic and hyperechoic streaks in sagittal plane

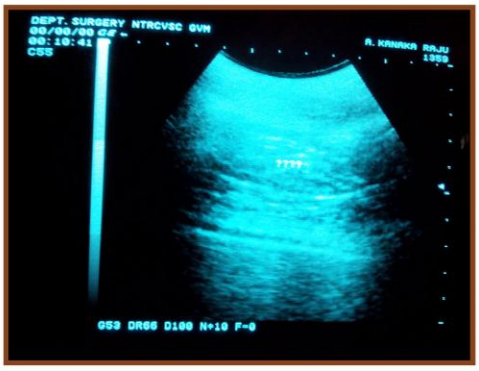

Fig. 11 Sonogram showing hyperechoic, intestinalforeign body

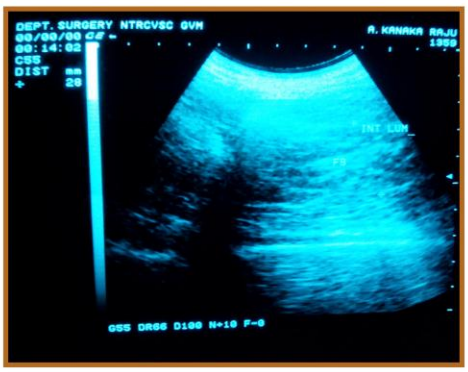

Fig. 12 Sonogram showing intestinal foreign body with acoustic shadowing

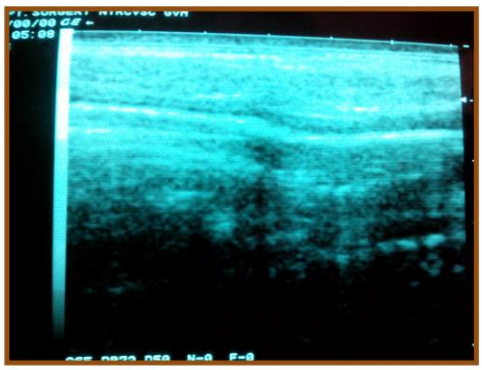

Fig. 13 Sonogram showing linear strong hyperechoic mucosal structure

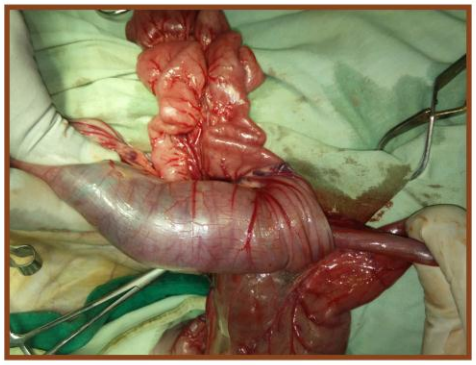

Fig. 14 Intra-operative photograph showing ileo-caeco-colic intussusception

surgical protocols. In one case, intussusception at the ileo-caeco-colic junction was identified (Fig. 14) which could be resolved manually. However a small area of discontinuity at the serosal layer was sutured by simple continuous suture. In the other two cases of intestinal obstruction, two foreign bodies viz a portion of corn cob (Fig. 15) and an under wear (Fig. 16) were retrieved after performing enterotomy. After completion of surgical manoeuvre, the laparotomy wound was closed in routine manner. The remaining three cases with no identifiable pathology were treated using prokinetic drugs and fluid therapy, which responded without any further exigencies.

4.3 Group II (Hepatobiliary system)

4.3.1 Clinical signs and physical examination

A total of twelve animals of both sexes and aged above 7 years were presented with vague symptoms of digestive system and the details of animals treated were given in table no. 1. Five animals had hepatitis/hepatomegaly with symptoms of chronic and intermittent vomiting abdominal discomfort, lethargy, weakness, occasional diarrhoea, polydipsia, etc. One animal was extremely icteric to such an extent that its skin was yellowish (Fig. 17).

Three animals were reported to have ascites characterized by severe abdominal distention (Fig. 18), dyspnea, groaning while lying down, weight gain, vomiting, weakness etc. One animal with hepatic cyst showed more inconsistent signs like lethargy, trembling, polyuria, polydipsia etc. One dog had distended abdomen, melena, hide bone condition which was later diagnosed as hepatic tumor (Fig. 19). The dog with sludge in the gall bladder had inappetence with intermittent vomition and the dog with nodular hyperplasia in the hepatic parenchyma, had anorexia, decreased demeanor, alopecia, anaemia and occasional vomiting.

53

Fig. 15 Corn cob
(intestinal foreign body)

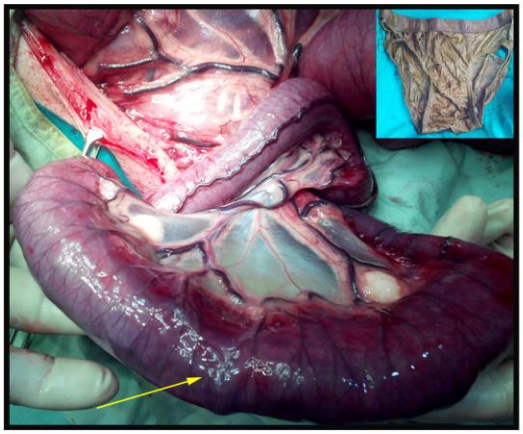

Fig. 16 Under wear (inset)
(intestinal foregn body)

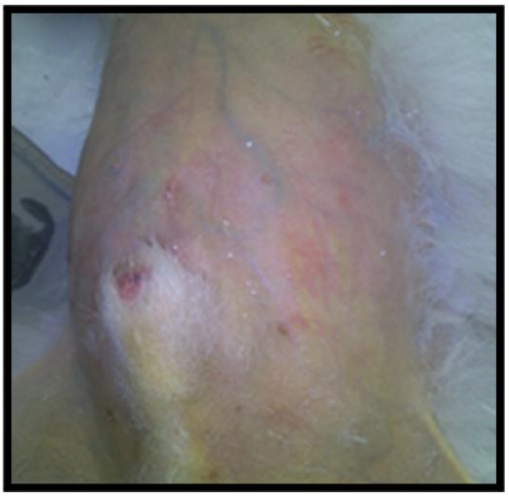

Fig. 17 Note yellowish discoloration of skin in icterus dog

Fig. 18 Dog with ascites

Fig. 19 Note emaciation in hepatic neoplasia

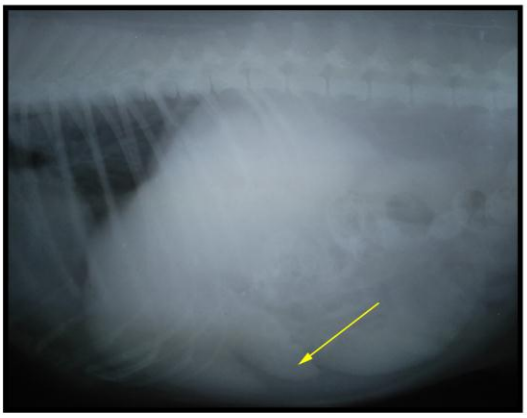

Fig. 20 Skiagram showing hepatomegaly

In all the animals symptoms could not contribute to the establishment of the diagnosis. More or less, the symptoms were overlapping leading to a diagnostic paradox.

4.3.2 Haematological and biochemical profile

The values of various (pre-operative) haematological and biochemical parameters were given in table no. 2. Haemoglobin and total erythrocyte counts decreased non-significantly. Leukocytosis (38.42 ± 0.75) with neutrophilia (85.58 ± 1.12) was observed.

Aspartate aminotransferase (80.80 ± 2.25) and alkaline phosphatase (160.15 ± 15.52) levels increased significantly. Total protein (4.02 ± 0.16), blood glucose (60.35 ± 4.64) and cholesterol (106.68 ± 7.52) values decreased significantly.

4.3.3 Radiography

In hepatomegaly, the liver was diffusely enlarged with displacement of structures related to liver. There was increased opacity of liver pushing the stomach dorso cranially and the small intestine caudally (Fig. 20). In another animal, one of the liver lobes became rounded in outline with significant hepatic calcification (Fig. 21). The radiological signs in ascites included over all hazy or ground glass appearance with clear visualization of vertebral column. The details of serosal surface of intestines, urinary bladder etc. were completely lost. The visceral organs were found to have displaced cranially and dorsally (Fig. 22).

The radiographic findings could not elicit any useful diagnostic information in hepatic cyst, except for a diffuse and significant opacity of liver (Fig. 23). The hepatic tumor was represented only as an irregularly round radio-opaque region. The nodular hyperplasia that was readily recognized during ultrasonography could not be identified during radiography. Similarly gall bladder sludge had no corresponding radiographic findings.

4.3.4 Ultrasonography

In hepatomegaly, the liver appeared enlarged with rounded margins. There was diffusely increased echogenicity with indistinctly defined hepatic vasculature. In three cases, ascites was a concomitant finding (Fig. 24 & 25). Moderate to massive accumulation of free fluid was identified by large anechoic spaces. The visualization of visceral organs was highly remarkable due to the presence of free fluid. The serosal surface of the visceral organs was readily visible. The loops of small intestine were found freely floating in the peritoneal fluid. The nature of the fluid was mostly of transudate type with occasional modified transudate type (Fig. 26 & 27). Hepatic cyst was characterized by presence of an anechoic area with clear acoustic enhancement.

Ultrasonography was found successful in the diagnosis of liver masses i.e. either a neoplastic growth or nodular hyperplasia, where radiography failed to yield any conclusion. A large focal hyperechoic lesion with clear borders was observed in a dog with liver tumor (Fig. 28). In nodular hyperplasia, lesions were characterized by a peripheral hyperechoic rim surrounding a central hypoechoic structures in hepatic parenchyma (Fig. 29). Gall bladder sludge was identified as an incidental finding in many asymptomatic dogs. The content of the sludge was floating in the bile rather than settling at the bottom (Fig. 30).

4.3.5 Treatment

The cases of hepatomegaly and ascites were treated at medical ward successfully. The owners of the animals with hepatic cyst and nodular hyperplasia were reluctant for further investigative procedures like exploratory laparotomy and drainage. These were treated empirically with fluids liver tonics, restricted diets etc.

Lobectomy was performed on the dog, that had hepatic tumor following standard anaesthetic and surgical protocols and the entire lobe affecting tumor was excised and the mass was sent for histopathology examination. The tumor was reddish brown, hard and arising from one of the liver lobes. It measured 7.3 x 5.4 weighing about 0.853 kilograms. The margins were smooth and there was no bleeding or ulceration. On cut section, it resembled the structure of liver. However, as it was not embedded in the hepatic parenchyma, exteriorization of the tumorous mass was possible (Fig. 31). Histologically the tumor contained well differentiated sinusoids. Portal triads were not seen in any of the fields examined. Mitotic activity was minimal. The histologically it was very much similar to that of its parent tissue. Based on the above findings it was diagnosed as hepatoma (Fig. 32).

4.4 Group III (Urinary system)

4.4.1 Clinical signs and physical examination

Twelve animals of both sexes were presented with signs of disorders of urinary system, the details of which were presented in table no.1. Five animals had cystoliths with symptoms of dysuria for several days, dribbling of urine, anuria etc. Two animals with cystitis had pollakiuria, dysuria, haematuria etc. Two animals with intraluminal masses in the urinary bladder had similar signs. Between these two, one was diagnosed as transitional cell carcinomas while the other as haemorrhagic cystitis.

The dog with polypoid cystitis had symptoms of distended abdomen, frequent vomiting, anorexia, polydipsia, polyuria etc. Two animals with severe abdominal distention were scanned for detecting the cause. Virtually there were no clinical signs that were suggestive of any disease. However, these were later diagnosed as hydronephrosis and a solitary renal cyst.

57

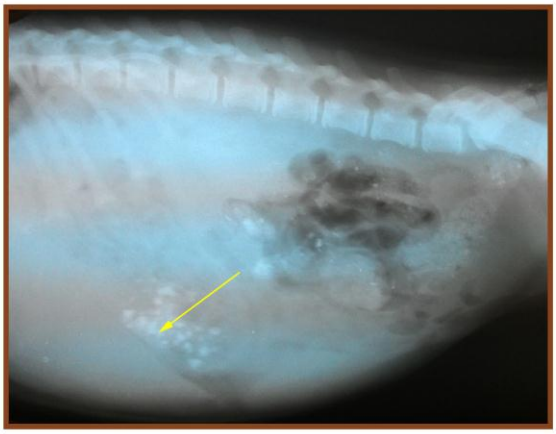

Fig. 21 Skiagram showing hepatomegaly with calcification

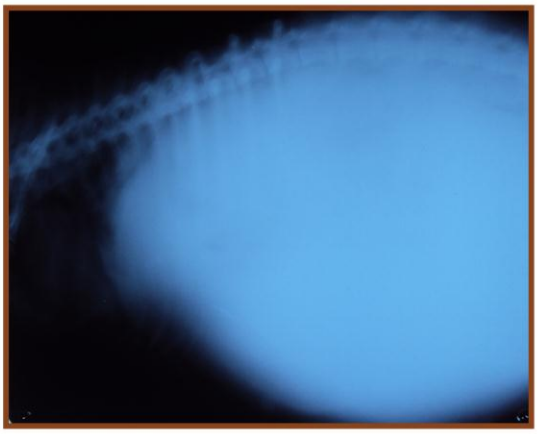

Fig. 22 Skiagram showing ground glass appearance in ascites

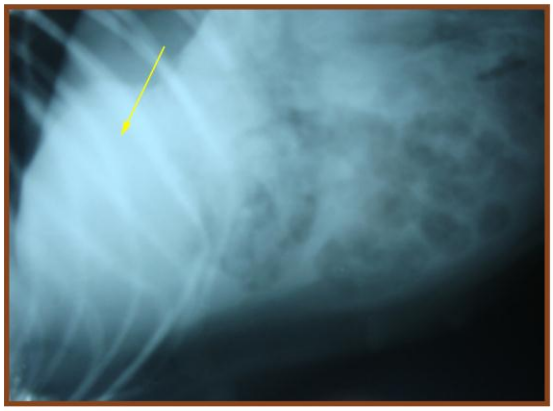

Fig. 23 Skiagram showing increased opacity due to hepatoma

Fig. 24 Sonogram showing rounded borders in hepatomegaly

Fig. 25 Sonogram showing ascites in hepatomegaly

Fig. 26 Sonogram showing freely floating abdominal organs in ascitic fluid

58

Fig. 27 Note clear transudate in ascites

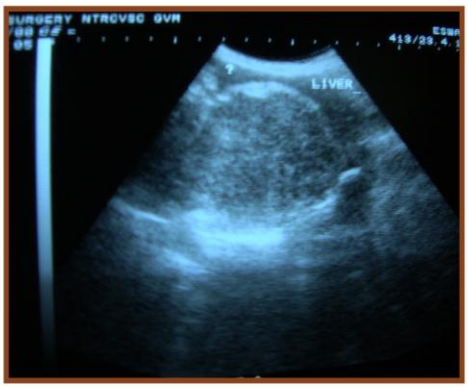

Fig. 28 Liver tumor with a large hyperechoic lesion with distinct borders

Fig. 29 Sonogram showing nodular hyperplasia

Fig. 30 Sonogram showing sludge in the gall bladder

Fig. 31 Gross specimen of liver tumor (Hepatoma)

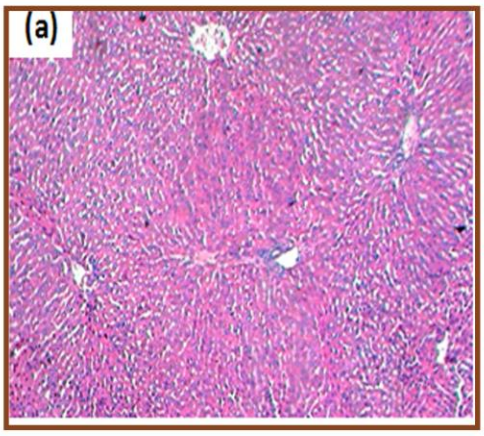

Fig. 32 Photo micrograph showing normal liver sinusoids in hepatoma

4.4.2 Haematological and biochemical profile

The values of various (pre-operative) haematological and biochemical parameters are given in table no. 2. Total erythrocyte count (5.88 ± 0.23) non-significantly; Haemoglobin (10.83 ± 0.47) and packed cell volume (34.83 ± 1.35) significantly decreased. Elevated total leucocyte count (36.18± 0.55) with neutrophilia (89.33 ± 1.45) was recorded. Blood urea nitrogen (50.70 ± 8.38) was observed to increase significantly.

4.4.3 Radiography

A large single radio opaque calculus with rounded borders, located in the most dependent part of the bladder and almost occupying the two thirds of the urinary bladder was observed in a bitch (Fig. 33). The second dog had a group of radio opaque cysto-urethral calculi in the bladder and along the course of the penile urethra. The bladder was enormously distended owing to the urethral obstruction, extending up to the cranial abdomen and rib cage with pushing of intestinal loops cranially and kidneys dorsally (Fig. 34). In the third dog, chronic cystitis with thickened bladder wall at its cranio ventral aspect, along with cystic calculi were demonstrated by pneumocystography (Fig. 35). In the fourth dog a series of calculi were noticed only along the course of penile urethra (Fig. 36) while in the fifth dog, the urinary bladder was distended without any apparent calculi. These calculi were thought to be radiolucent which were taken at the time of surgery (Fig. 37).

The dog with intra luminal mass in the urinary bladder did not show any radiographic signs on the plain radiographs (Fig. 38). A filling defect at the neck and caudo ventral region of the urinary bladder was comprehended by the pneumocystography. Cranial displacement of the bladder with moderate widening of the prostatic urethra was also discernible on this radiograph. A considerable enlargement of prostate gland was also observed that was

thought to have descended from the pelvic cavity (Fig. 39). The radiography was not at all conclusive in diagnosing polypoid cystitis as there were absolutely no roentgen signs. In the dog with haemorrhagic cystitis, blood clots were found on pneumocystography (Fig. 40 and 41).

4.4.4 Ultrasonography

In all the cases of cystoliths, calculi were visible as hyperechoic structures on a dark background of anechoic urine with distinct acoustic shadowing. Thickening of the urinary bladder was also observed (Fig. 42, 43 and 44). Radiolucent calculi were seen only on ultrasonography, in which, the acoustic shadowing was not conspicuous (Fig. 45). In cystitis, wall of the urinary bladder was diffusely thickened and hyperechoic with an irregular mucosal margin. Urine was echogenic giving a swirling effect (Fig. 46).

In transitional cell carcinoma, a hetero echoic structure in the urinary bladder was identified with significant acoustic shadowing. The growth has been irregular in outline and appeared to originate along the mucosa at the ventral aspect. Enlargement of prostate was also observed in the same dog (Fig. 47 and 48). In polypoid cystitis, thickening of the bladder wall was accompanied by multiple small growths that projected into the lumen. The large polyp had a pedunculated base at its attachment (Fig. 49 and 50). In the dog with haemorrhagic cystitis, blood clots appeared as hyperechoic, non-shadowing echogenicities with irregular shape that settled to the dependent portion of the bladder lumen (Fig. 51).

One of the kidneys (left) in the animal with abdominal distention was found to have a single large cyst. The contents of the cyst were clear with anechoic fluid with distinct outline. A strong echo enhancement was observed distal to the cyst (Fig. 52). There was a marked dilatation of the kidney, by an anechoic area of considerable size. The renal architecture was

completely lost. The cortical and medullary regions were inseparable. However, the other kidney was completely normal. This animal had only distended abdomen clinically (Fig. 53).

4.4.5 Treatment

The urethral calculi were pushed in to the urinary bladder by hydro propulsion. The cystic calculi were retrieved surgically in two cases (Fig. 54). A single large cystolith was isolated from the urinary bladder of a bitch (Fig. 55). Post-operatively the animals were given crystalloid solutions, broad spectrum antibiotics, analgesics etc. In all the cases of cystitis, pH of urine was assessed through pH indicator strips. These were treated with antibiotics, neuro tonics intra venous infusions, analgesics etc. till recovery.

The case of transitional cell carcinoma was confirmed by cytology with large clumps of transitional epithelial cells with moderate degree of pleomorphism seen in urine sediment (Fig. 56). The owner of this dog was unwilling for any invasive procedures like biopsy, chemotherapy or surgery. The case of polypoid cystitis was treated as that of cystitis and the animal was alright after ten days. The cases of hydronephrosis and renal cyst were absolutely unexpected and incidental findings at the time of ultrasonography that was carried out to investigate the causes of abdominal distention. Moreover, the conditions were affecting only one kidney in both the cases and the clients were not at all convinced for a second screening.

4.5 Group IV (Female genital system)

4.5.1 Clinical signs and physical examination

A total of twelve animals were presented with clinical signs corresponding to problems of female genital system. The details of which are given in table no .1. Out of these, eight animals aged about 6 -12 years had pyometra with a history of not being spayed, severe abdominal distention, frequent vomiting, toxaemia, congested to petechial mucous

62

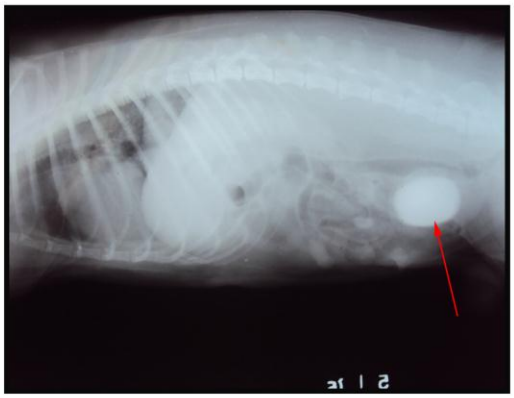

Fig. 33 Skiagram showing a large single cystolith in the urinary bladder of a bitch

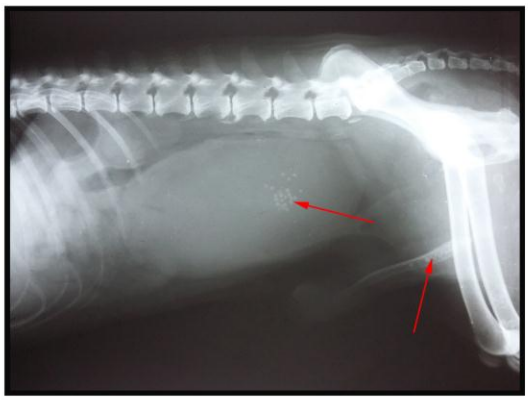

Fig. 34 Skiagram showing numerous cysto-urethral caliculi

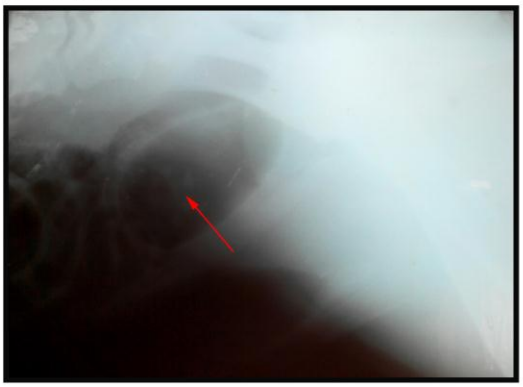

Fig. 35 Pneumocystograph showing chronic cystitis with calculi

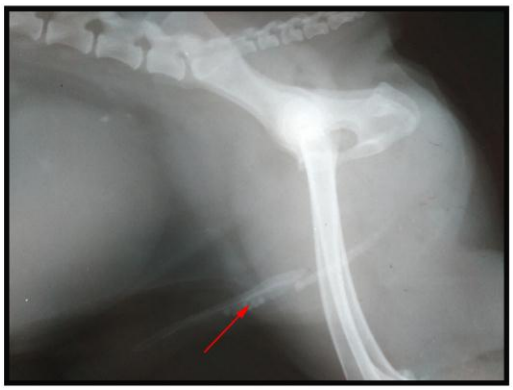

Fig. 36 Skiagram showing urethral stones with distended urinary bladder

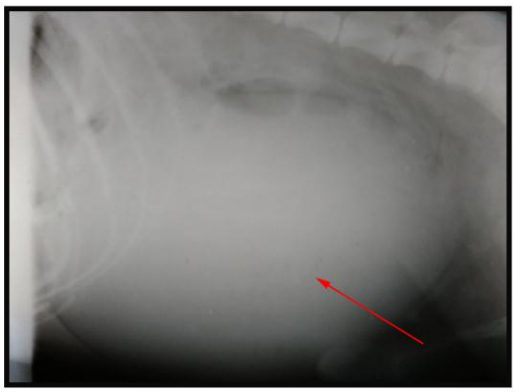

Fig. 37 Skiagram showing only distended urinary bladder in case of radiolucent calculi

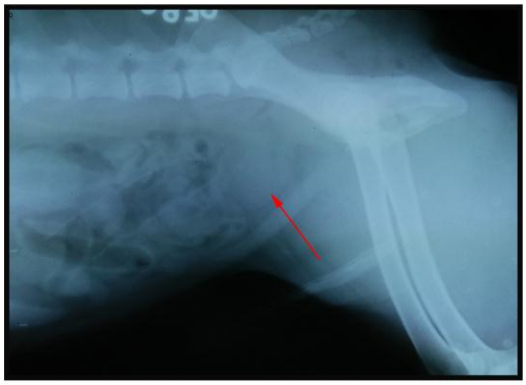

Fig. 38 Skiagram not showing intra luminal mass in the urinary bladder

63

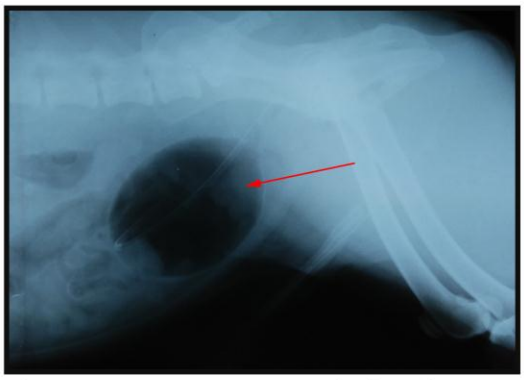

Fig. 39 Pneumocystograph showing filling defect in urinary bladder

Fig. 40 Skiagram not showing any changes in polypoid cystitis

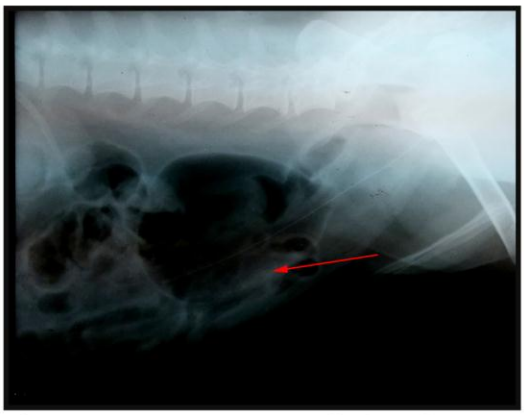

Fig. 41 Pneumocystograph showing radiopacity mass in haemorrhagic cystitis

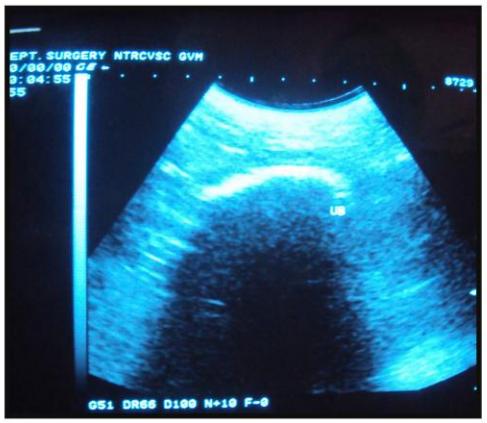

Fig. 42 Sonogram showing a single large cystolith with acoustic shadowing

Fig. 43 Small cystolith with acoustic shadowng

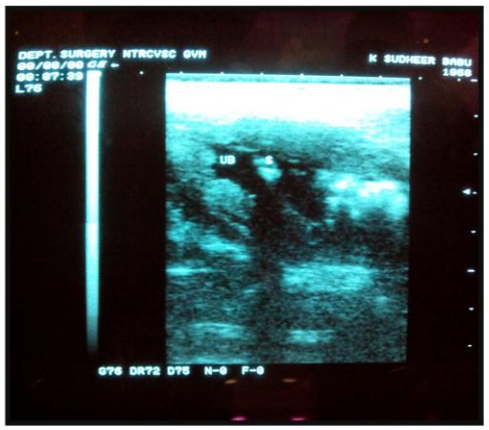

Fig. 44 Note thickened bladder wall in cystolithiasis

64

Fig. 45 Radiolucent calculi with out acoustic shadowng

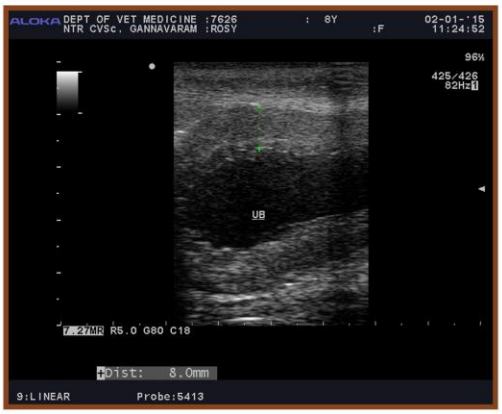

Fig. 46 Cystitis with thickened and hyperechoic bladder wall

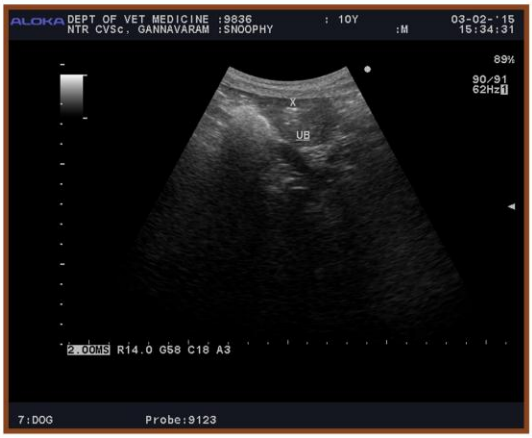

Fig..47 Hyperechoic structure in urinary bladder with transitional cell carcinoma

Fig. 48 Enlargement of prostate in transitional cell carcinoma

Fig. 49 Polypoid cystitis with multiple growths in urinary bladder

Fig. 50 Large pedunculated polyp in the urinary bladder

65

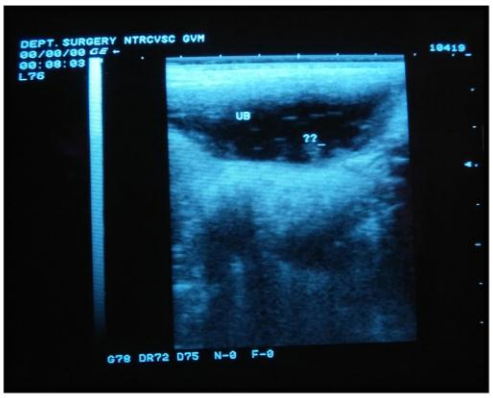

Fig. 51 Note hyperechoic blood clots in haemarrhagic cystitis

Fig. 52 Renal cyst with clear acoustic enhancement

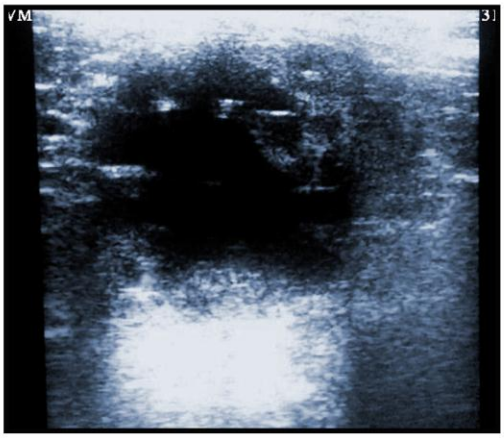

Fig. 53 Hydronephrosis

Fig. 54 Photograph showing multiple cystoliths

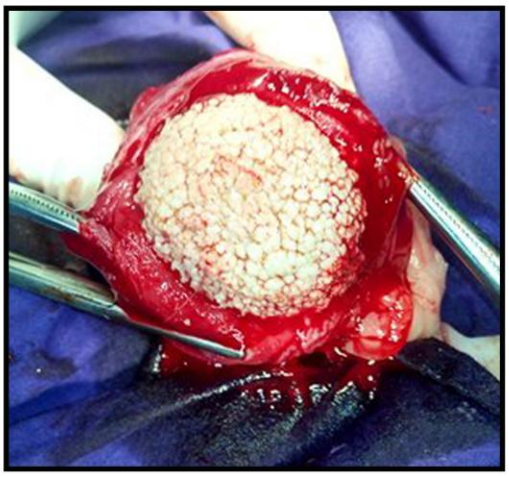

Fig. 55 A single large cystolith in a bitch

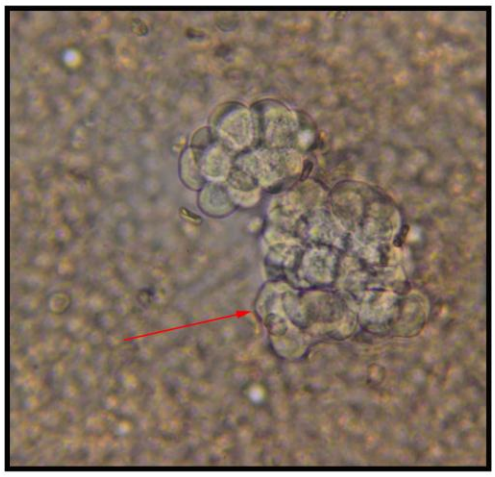

Fig. 56 Large clumps of transitional epithelial cells with moderate degree of pleomorphism

membranes, anorexia tense abdomen, respiratory discomfort etc. General condition of these animals was poor to good. Temperature was either normal or subnormal. There was matting of hairs due to uterine discharge being stuck to the perineal region in one case of open pyometra. The bitch with macerated foetus had a history of being crossed three months earlier and was presented as whelping was overdue with mild discharge with offensive smell.

Three bitches had a similar history of having been crossed three to four years before. Symptoms were noticed just 15 -20 days before the date of presentation. The latter included dysuria, anorexia, distended abdomen, mild to foul smelling vaginal discharges etc. Vomiting was observed in only one animal. Palpation of the abdomen disclosed a hard mass at the caudal abdomen. These were diagnosed to have uterine stump abscess in one case and uterine stump granuloma in the other two. However, these three exhibited signs of estrum occasionally.

4.5.2 Haematological and biochemical profile

The values of various (pre-operative) haematological and biochemical parameters were given in table no. 2. Haemoglobin (9.23 ± 0.84), packed cell volume (29.83 ± 2.63) and total erythrocyte counts (4.52 ± 0.29) were found to decrease significantly. Significant leukocytosis (37.03 ± 0.86) with neutrophilia was observed. Shift to left was more conspicuous. Blood urea nitrogen (36.63 ± 3.55) was observed to be significantly elevated.

4.5.3 Radiography

All the dogs with closed pyometra had homogenous radio opacity with coiled uterine horns with increased fluid density (Fig. 57). The bitch with macerated foetus showed more radio-opaque and compact foetal bones. Fetal death was observed within the uterus and overlapping of foetal skull bones called “Spalding’s sign” (Fig. 58) was noticed.

Stump fibroid was diagnosed in two bitches that were spayed two years and four years earlier. In the first case, the growth was observed as a radio opaque mass between descending colon and urinary bladder, pressing the colon and overlapping the urinary bladder (Fig. 59). In the second dog with stump granuloma, an abnormally distended and fluid filled urinary bladder extending up to the cranial abdomen and rib cage was noticed. A radio dense structure was evident at the pelvic inlet beyond the neck of the bladder (Fig. 60). Lateral radiograph of the abdomen of the same dog after catheterization revealed catheter extending up to the rib cage suggestive of non-contractility of the urinary bladder, in spite of urine drainage. The stump granuloma was represented by a large soft tissue radio density dorsal to the urinary bladder (Fig. 61). The bitch that was spayed five years earlier, had uterine stump abscess appearing as a radio opaque mass between descending colon and urinary bladder pressing the colon and overlapping the urinary bladder (Fig. 62).

4.5.4 Ultrasonography

In dogs with closed pyometra (n=8), uterus and horns were recognized as large, circular, thin walled sacculations. Distended uterine loops were adjacent to one another, with flattened margins where the walls touch each other (Fig. 63 and 64). Sacculations of uterus were observed cranial to the urinary bladder in these cases. On ultrasonography, the bitch with macerated foetus showed hyperechoic fetal bones. The foetal bones did not have any soft tissue structures around them (Fig. 65). In one bitch with uterine fibroid, a heterogeneous mass dorsal to the urinary bladder was observed. The hypoechoic mass could be demarcated against anechoic bladder (Fig. 66). The bitch that had adhesions of the urinary bladder with the body wall and viscera depicted, distended urinary bladder with hyperechoic wall and echogenic sediment (Fig. 67). A mixed echogenic mass representing the fibroid was

68

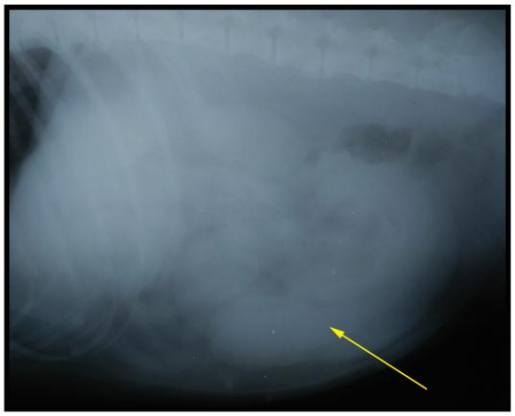

Fig. 57 Skiagram showing coiled and distended uterus in pyometra

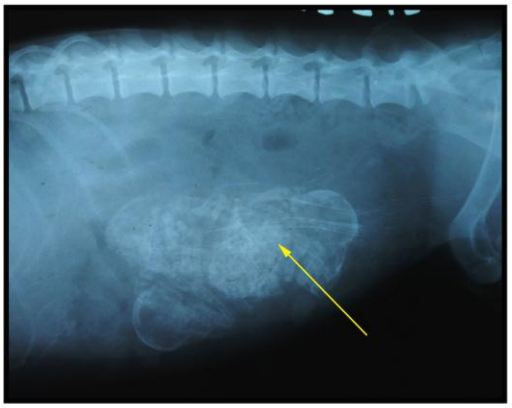

Fig. 58 Skiagram showing spalding's sign of dead fetuses in the uterus

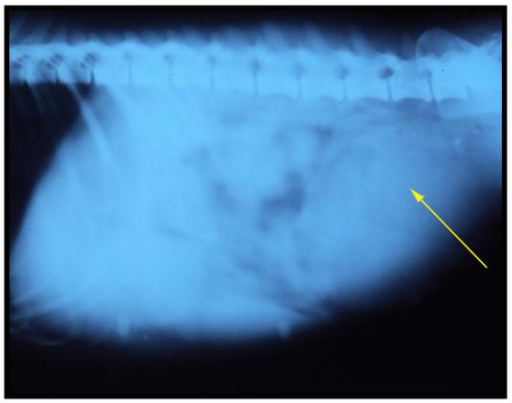

Fig. 59 Stump fibroid depcted as a radiopaque mass between bladder and colon

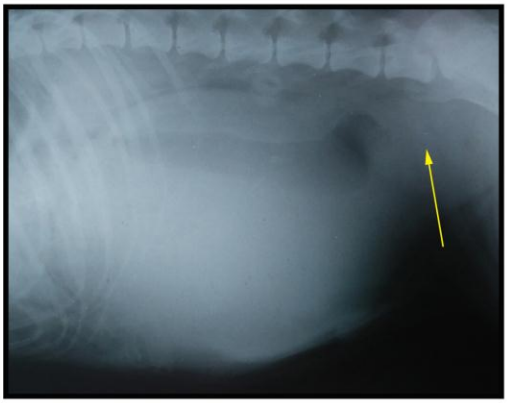

Fig. 60 Skiagram showing stump granuloma at the neck of the bladder

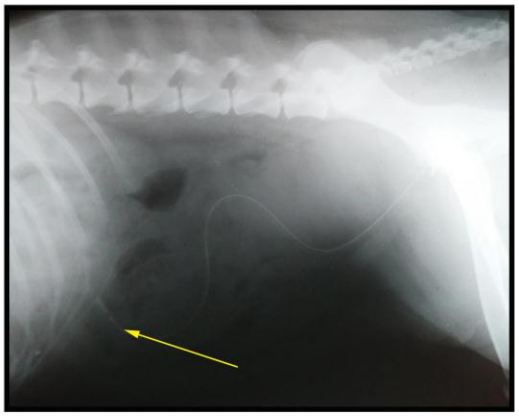

Fig. 61 Skiagram showing the bladder position at the rib cage after catheterisation

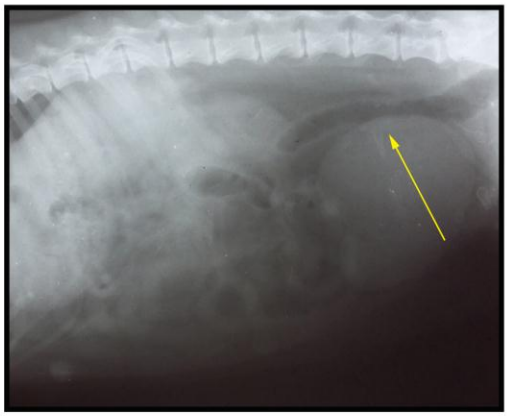

Fig. 62 Skiagram showing stump abscess as a radiopaque mass between bladder and colon

Fig. 63 Note large thin walled sacculation in closed pyometra

Fig. 64 Note adjacent,distended sacculations in closed pyometra

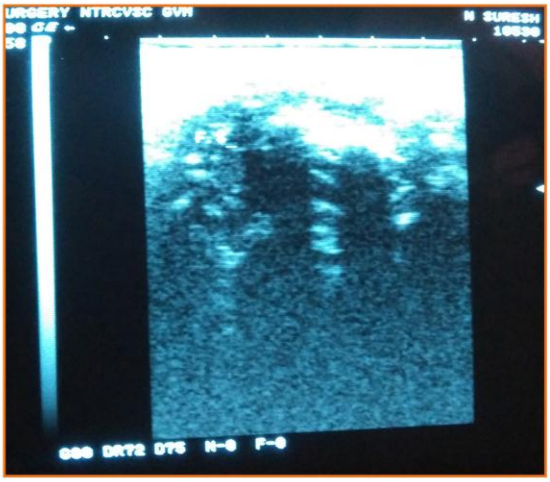

Fig. 65 Hyperechoic fetal bones in macerated fetus

Fig. 66 Note heteroechoic mass dorsal to the urinary bladder in stump fibroid

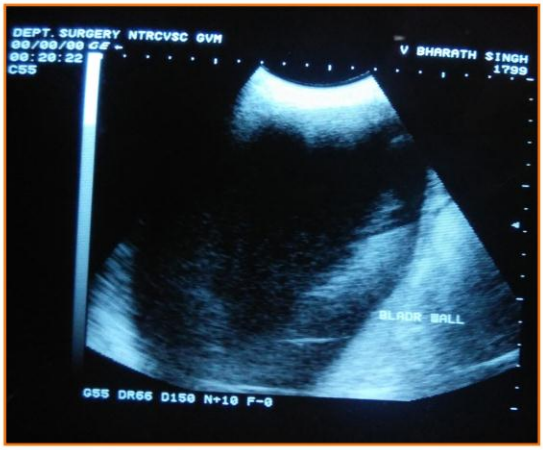

Fig. 67 Note hyperechoic bladder wall with echogenic sediment

Fig. 68 Note a mixed echogenic mass adjacent to bladder

observed adjacent to the bladder (Fig. 68). The uterine stump abscess (n=1) was visualized as a sac like structure filled with anechoic fluid adjacent to the bladder (Fig. 69).

4.5.5 Treatment

The pyometric bitches were more toxemic with severe abdominal distention causing respiratory embarrassment. Ovariohysterectomy was carried out in all the bitches with pyometra using standard anaesthetic and surgical protocols, after stabilization of the patients. In some cases, the distended uterus was 30-40 per cent of the total weight of the animal (Fig. 70). The macerated foetus was retrieved by performing laparohysterotomy.

The operative procedure was similar to that of pyometra, in all cases of stump granuloma and abscess up to laparotomy. In these cases, the implicating structures like the fibroid, abscess and granuloma were carefully identified, isolated and resected after meticulous ligation. Post-operative care was followed according to standard protocols. Two cases survived and one case in which the bladder was found attached to the body wall and viscera collapsed on the same day of surgery.

The distended and pyometric uteri varied in the size of the tract and quantity of the discharge. In cases of closed pyometra, the weight of the uterus ranged from 2 kg to 4 kg approximately. In one animal, cystic ovarian disease was an incidental finding (Fig. 71). This could not be detected through any of the diagnostic modality used in the study. The cyst was multiple in nature with clear fluid.

The stump fibroma measured 13 x 9 cm and weighed about 500 grams approximately (Fig. 72). This had adhesions with adjoining structures like colon and urinary bladder (Fig. 73). The surface was smooth mostly except at places of foci of abscessation. A part of left horn with ovarian bursa was also resected along with the stump (Fig. 74). The granuloma in

the second bitch measured, 8x4 cm and weighed 550 grams in one bitch. However, there was a conglomeration of several fibroid structures with smooth surfaces (Fig. 75). This growth had several adhesions with the urinary bladder (Fig. 76). The stump abscess in the third case was resected carefully after ligation at the base, so as to arrest the spillage of its contents in to the abdominal cavity (Fig. 77). Approximately 50 ml of pus was drained from the stump abscess.

4.6 Group V (Male genital system)

4.6.1 Clinical signs and physical examination

In the present study, six male dogs were investigated with a history of constipation, haematuria, mild lethargy, pale mucous membrane, high temperature, increased frequency of urination with a little volume of urine, occasional vomiting etc. The details of which were given in table no .1. Ribbon shaped stools and a smooth mass palpable at the brim of the pelvis on rectal examination, were observed in one dog. Based on clinical signs these were tentatively diagnosed as a case of prostate hyperplasia and the dogs were subjected for further evaluation.

4.6.2 Haematological and biochemical profile

The values of various (pre-operative) haematological and biochemical parameters are given in table no. 2. A non significant decrease in haemoglobin (11.5 ± 0.98) and packed cell volume (35.83 ± 2.87); relative neutrophilia (83.5 ± 2.90) with normal total leucocyte count (16.7 ± 1.02) were observed. Alkaline phosphatase was observed to increases significantly (95.58 ± 11.67).

4.6.3 Radiography

The lateral radiograph of abdomen and pelvis showed displacement of bladder cranially and ventrally in one dog. Colon was observed to be slightly compressed by the prostate. The radio density of prostate gland appeared uniform. The distance between the sacral promontory and pubis was measured to be 7.195 cm. The cranio-caudal dimension of the gland in this animal was measured to be 6.160 cm while the dorso ventral dimension or the depth was 6.911 cm. In this animal, the length of the gland was 85.61 per cent of the pelvic inlet, while the height was 96.05 per cent of the pelvic inlet. Thus in both the instances, it was above 70 per cent of the stipulated distance and hence considered as prostatic hyperplasia (Fig. 78). While in the other animals, the gland was observed to be only 32.53 to 44.13 per cent and hence these were diagnosed as negative for prostate hyperplasia. The values in these animals were given in table no. 3. Radiography was thought to provide a simple and basic idea to diagnose a case of prostate hyperplasia.

4.6.4 Ultrasonography

In sagittal section, the gland appeared spherical in outline with smooth margins (Fig. 79). It measured 4.1 X 3.5 X 2.7 cm. On transverse plane, the enlargement was asymmetrical (Fig. 80), which caused the pelvic urethra to show indentations at some places (Fig. 81) The echotexture of the gland appeared homogeneous with hypoechoic shadows.

The following formula was used to determine the volume of the prostate V = 0.524 X L X B X D, and the value was 20.30 which appears to be greater than the reference value (18.9 ± 15.5) given by Ruel *et al.* (1998). The values in remaining animals were within the normal limits. The values in other animals were given in table no.3. Ultrasonography was felt useful in assessing the prostate hyperplasia.

Table no.3 Calculation of volume of prostate gland using plain radiography

Dog No	Radiographic measurements Distance between					Inference	Volume measured through ultrasonography*				Inference
	Sacral promontory to pubis	Cranio-caudal dimension	Ventrodorsal dimension	Relative % of gland in			L (cm)	B (cm)	D (cm)	V (cm^3)	Inference (Ref value =18.9 ± 15.5)
				Cranio-caudal dimension	Ventrodorsal dimension						
1	7.19	6.16	6.91	85.61	96.05	Hyperplasia	4.1	3.5	2.7	20.30	Hyperplasia
2	8.27	3.47	3.65	41.95	44.13	N	2.9	2.1	1.9	6.063	N
3	6.87	3.84	2.98	55.89	43.37	N	3.2	1.3	2.1	4.577	N
4	7.47	4.21	2.43	56.35	32.53	N	2.8	1.9	2.2	6.133	N
5	7.59	3.64	2.91	47.95	38.33	N	2.5	1.3	2.87	4.887	N
6	6.86	2.94	2.29	42.85	33.38	N	3.1	1.9	2.6	8.025	N

*V = 0.524 X L X B X D [following Ruel *et al.* (1998)].

N= normal dimensions, A = age in years (rounded off to nearest whole year), B = Body weight in kg and V= volume in cm^3

74

Fig. 69 Uterine stump abscess seen as an anechoic sac close to the bladder

Fig. 70 Intra-operative photograph showing pyometric uterus

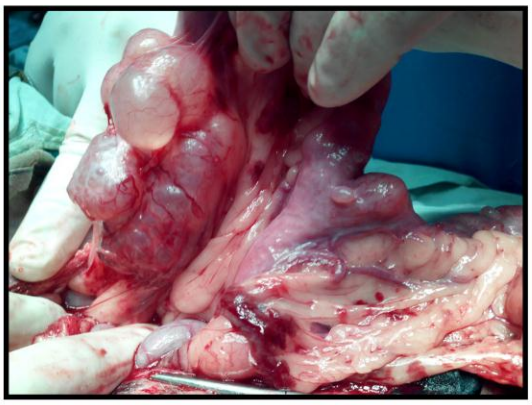

Fig. 71 Cystic ovarian disease in pyometra

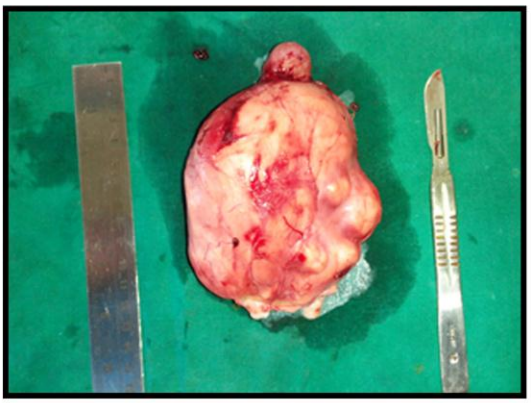

Fig . 72 Photograph showing gross specimen of stump fibrod

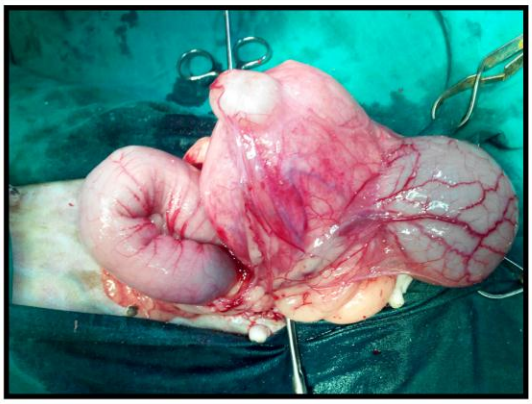

Fig. 73 Remnants of left uterine horn and ovary in stump granuloma

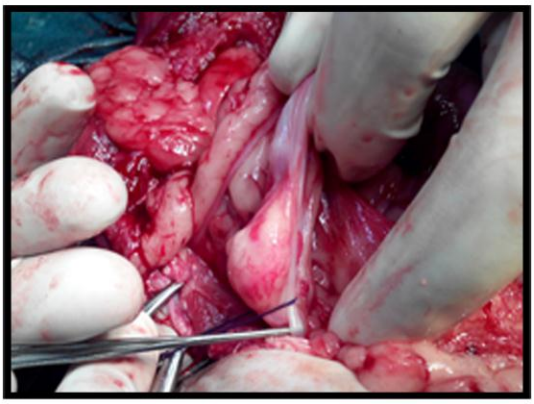

Fig. 74 Multiple fibrous growths with smooth surface in stump fibroid

75

Fig. 75 Note multiple fibrous growths with smooth surfaces in stump fibroid

Fig. 76 Note adhesions between stump granuloma and urinary bladder

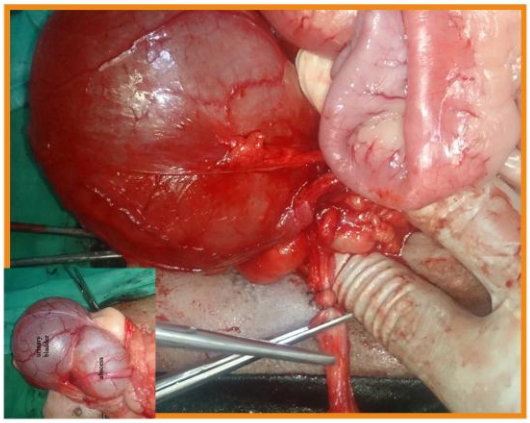

Fig. 77 Stump abscess (inset) stump abscess resected by ligation at the base

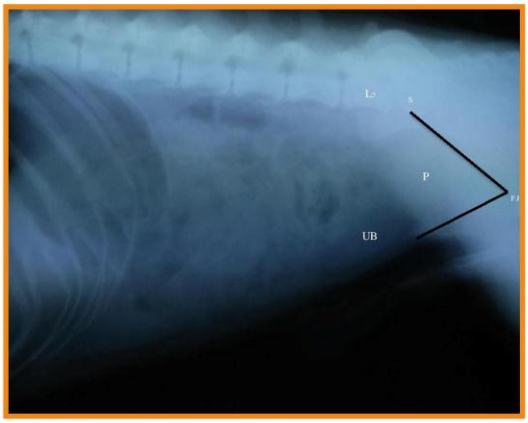

Fig. 78 Note the relative measurements of pelvic inlet and craniocaudal length of prostate

Fig. 79 Note nearly spherical prostate in sagittal section

Fig. 80 Note asymmetrical enlargement in transverse plane of prostate

4.6.5 Treatment

The animal that was diagnosed with prostate hyperplasia was treated by performing castration using standard procedures. The dog was found to be clinically normal after a period of one month. After ruling out prostatic disease, other animals were treated at medical ward.

4.7 Group VI (Miscellaneous disorders)

4.7.1 Spleen

4.7.1.1 Clinical signs and physical examination

In the present study, only one male dog aged about 10 years was presented with signs of abdominal distention, complete anorexia, lethargy, vomiting etc. The details of which are given in table no .1. However, the animal was active. Palpation of abdomen did not reveal any fluid thrill or abdominal effusion. This was thought to be an intra-abdominal mass and hence, subjected for further evaluation.

4.7.1.2 Haematological and biochemical profile

In haemangiosarcoma of spleen, there was a significant decrease in haemoglobin (7.8 g/dl), and packed cell volume (25 per cent). The alkaline phosphatase (260 U/L), blood urea nitrogen (70 mg/dl), serum calcium (18.9 mg/dl) and serum creatinine (2 mg/dl) were found to be elevated significantly.

4.7.1.3 Radiography

The lateral radiograph of the abdomen showed a large diffuse radio opaque mass in the abdomen (Fig. 82). When viewed unscrupulously, it looked as a case of ascites with ground glass appearance. However, when viewed carefully, displacement of intestines was seen dorsally, caudally and cranially. The outline of the splenic shadow was nearly circular. On ventro dorsal view, the spleen occupied major part of the abdomen displacing the intestines to sides (Fig 83). Stomach was found displaced more cranially and dorsally.

4.7.1.4 Ultrasonography

Diffuse swelling of the spleen as confirmed by visualization of splenic echotexture when the transducer was placed even at the pubic region. Multi locular and septated mass occupying most of the abdominal cavity was diagnosed as haemangiosarcoma of spleen. Spleen had a typical honey comb appearance (Fig. 84).

4.7.1.5 Cytological studies:

Fine needle aspiration cytology revealed a large number of erythrocytes. A few malignant cells were seen with a typically increased N: C ratio (Nucleus to cytoplasmic ratio). In all the cells cytoplasmic basophilia was found. A few acanthocytes were also noticed during FNAC studies (Fig. 85).

4.7.1.6 Treatment:

Based on the above findings, the case was diagnosed as haemangiosarcoma of spleen. No treatment was possible.

78

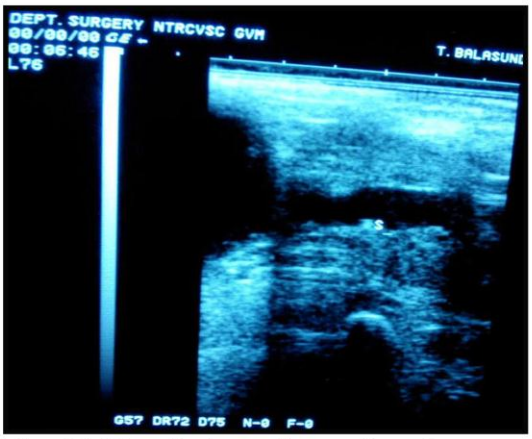

Fig. 81 Note indentations of urethra due to hyperplastic prostate

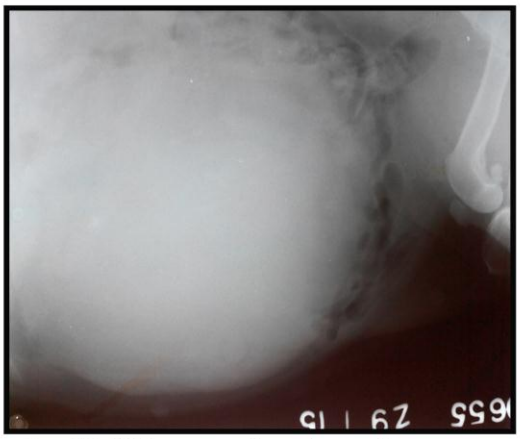

Fig. 82 Skiagram showing a large radiopaque mass in centre of the abdomen

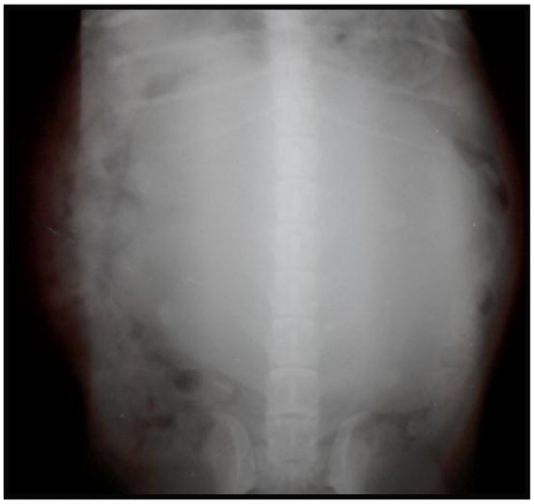

Fig. 83 Skiagram showing splenic haemangiosarcoma occupy most of the abdominal cavity

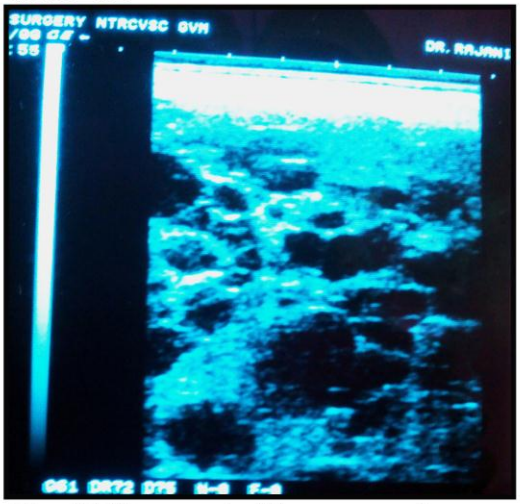

Fig. 84 Note typical honey comb appearence in splenic haemangiosarcoma

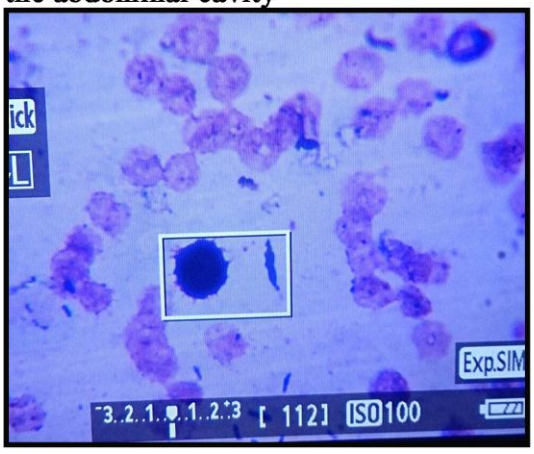

Fig. 85 Note increased N:C ratio in cytology of haemangiosarcoma

Fig. 86 Photograph showing perineal herniation

4.7.2 Herniation

4.7.2.1 Clinical signs and physical examination

In the present study, an attempt was also made to find out the nature of the contents of various hernias. A total of five dogs were treated for various types of hernias and haematoma. The details of which are given in table no .1. Out of these, perineal hernia, inguinal hernia, and perineal haematoma were diagnosed and treated.

Both the dogs with perineal hernia were uncastrated and old. They had signs of rectal prolapse, constipation with occasional dysuria. There was a reducible swelling at the perineal region (Fig. 86 and 87). The dogs with inguinal hernia showed a swelling at the inguinal region. Broad stepping gait was noticed in inguinal hernias. The pup with inguinal hernia showed an enormous swelling at the inguinal region (Fig. 88). The swelling was soft in consistency. Hernial ring was palpable in all types of hernias encountered in the present study. Perineal swelling in a Doberman dog was thought to be a case of perineal hernia. The swelling was doughy in consistency, which was later diagnosed as haematoma (Fig. 89). There were no other appreciable clinical signs in this animal. All the animals had history of a traumatic insult prior to occurrence of herniation.

4.7.2.2 Haematological and biochemical alterations

Out of two cases of perineal hernia, reduced haemoglobin (7.8 g %) leukocytosis (17, 000/µl with neutrophilia (90%), were observed only in one case. In the same case, blood urea nitrogen (71.75 mg/dl) and serum creatinine (3.83 mg/dl) were found to increase significantly; while total protein content was significantly decreased (3.2 g/dl).

4.7.2.3 Radiography

The lateral radiographs of animals with perineal hernia showed a radio opaque structure at the perineal region (Fig. 90). Upon retrograde catheterization of the urinary bladder using an infant feeding tube, entire catheter was found in the hernial sac and hence the hernial content was diagnosed as urinary bladder (Fig. 91). In the mongrel dog with inguinal hernia, radiograph did not revealed any structure at the inguinal region. There was no gas in the intestinal loops to differentiate the hernial contents.

The lateral abdominal radiograph of the mixed breed pup with inguinal hernia showed an enormous radio opaque swelling at the inguinal region. Several loops of intestines were displaced by the distended urinary bladder (Fig. 92). However, in perineal haematoma, a large radio opaque mass was diagnosed as perineal hernia which, however, was diagnosed as haematoma at the time of aspiration. The radio-opaque structure at the perineal region was suspected for bladder herniation (Fig. 93) but after pneumocystography performed, bladder was observed in normal position (Fig. 94).

4.7.2.4 Ultrasonography

An anechoic fluid filled structure was identified at the perineal region (Fig. 95). This was however, anticipated as urinary bladder and the same was diagnosed. Upon draining of the bladder through catheterization, swelling could be resolved and the same was visible on ultrasonography by a reduction in the anechoic area (Fig. 96).

In inguinal hernias, the content was thought to be urinary bladder due to the presence of an anechoic area in the region of herniation. This was later diagnosed as a loop of intestine. The more typical inguinal hernia in the pup had a huge anechoic sac, within which

81

Fig. 87 Photograph showing perineal herniation

Fig. 88 Inguinal hernia in a pup

Fig. 89 Perineal haematoma in a doberman dog

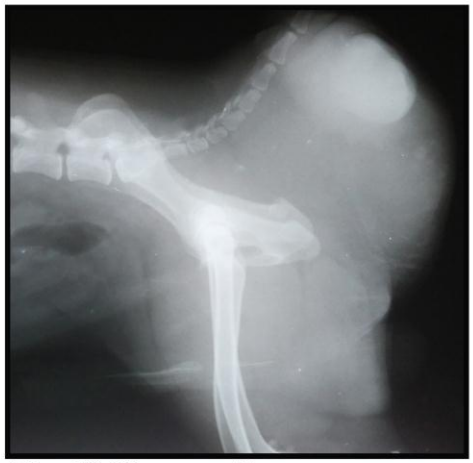

Fig. 90 Note a radiopaque structure at the perineal region

Fig. 91 Note the presence of urinary catheter in the perineal hernia sac

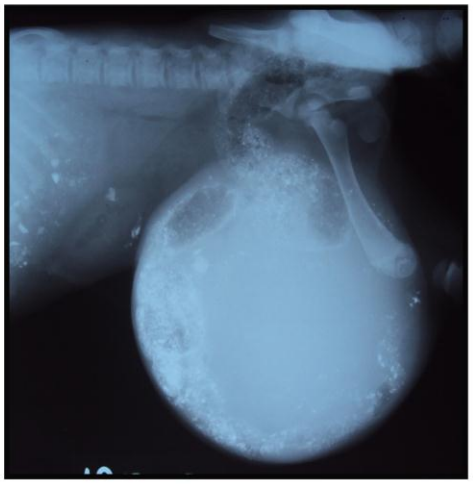

Fig. 92 Note fluid density in the inguinal hernial sac

82

Fig. 93 Note increased radiopacity at the perineal region in perineal haematoma

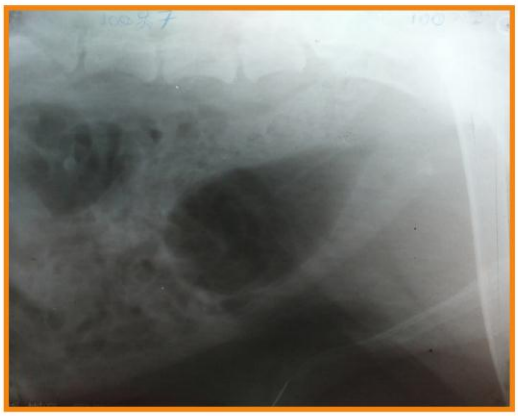

Fig.94 Pneumocystograph showing the normal location of urinary bladder

Fig. 95 Perineal hernial sac before catheterisation

Fig. 96 Perineal hernial sac after catheterisation and drainage

Fig. 97 Loops of intestine and urinary bladder in the inguinal hernial sac

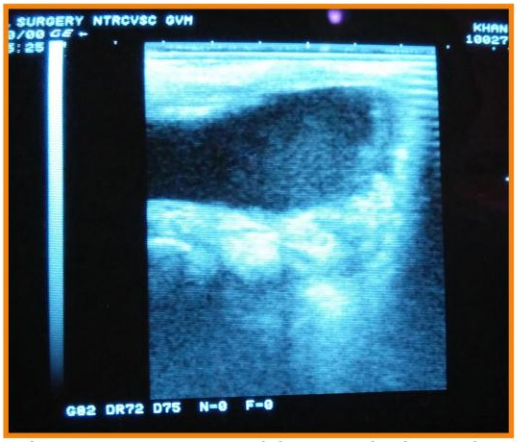

Fig. 98 Note central hypoechoic and peripheral hyperechoic regions in the haematoma

the intestines were easily identified by their peristaltic motility (Fig. 97). The same was confirmed at the time of surgery. In perineal haematoma, there was a clear anechoic to hypoechoic structure in the centre and a hyperechoic area in the periphery which was initially regarded as a case of perineal hernia. This finding was erroneous, as it was a case of haematoma (Fig. 98).

4.7.2.5 Treatment

The perineal hernia was treated in two phases. Castration was carried out in the first phase. In the second phase, perineal herniorrhaphy was performed using standard anaesthetic and surgical protocols. These animals recovered well. In inguinal hernias, herniorrhaphy was done using standard anaesthetic and surgical procedures. In perineal haematoma, the haematoma was opened and drained and was kept on antibiotics, styptics and analgesics.

CHAPTER V
DISCUSSION

An accurate diagnosis of abdominal disorders, in small animals often appears difficult due to absence of specific signs and subtle or misleading signs at the time of presentation, besides incorrect or distorted history. It is a disgusting fact that, the incidence of such diseases in pets has been increasingly reported at the same speed with which the technology is advancing. Henceforth, a strong need is felt by the small animal clinicians to evolve diagnostic strategies to arrive at an early and correct conclusion. The more sophisticated equipment like Computed Tomography (CT), Magnetic Resonance Imaging (MRI) etc. has not yet been popularized in Veterinary Surgery due to their exorbitant prices. Hence, veterinary clinicians have been depending on traditional diagnostic procedures. Each of the methods of investigation has its own advantages and disadvantages and there is a dire need to use two or more tests in a single case. A bird's eye view on the available literature reveals that, there are a very few reports, about comprehensive studies on comparative usage of various investigative procedures for diagnosing abdominal disorders in dogs.

With this reason, the present study entitled "Clinical studies on trans abdominal ultrasonography in diagnosing various abdominal disorders in dogs" was undertaken to use clinical examination, haematologic and biochemical profiles, radiography (plain and contrast) and ultrasonography with a view to correlate these findings to arrive at a comprehensive diagnosis of various abdominal disorders in dogs.

In the present study, animals were examined and treated for various disorders pertaining to gastro intestinal tract, hepatobiliary system, urinary system, female genital system, prostate, spleen and abdominal wall. They varied significantly in their health status, clinical signs at the time of presentation, prognosis etc. The results of the present study have been discussed system vise,

Gastrointestinal system:

Out of six cases with signs of disorders of gastro intestinal system, one was diagnosed as intussusception, while two had intestinal obstruction and the remaining three had no disorder of surgical interest. All the cases were treated for gastritis for more than a week before being presented. The dog with intussusception was brought earlier due to the prolapsed segments of intestines. The symptoms of intestinal obstruction were more or less similar to those of intestinal intussusception. Acute enteritis or gastroenteritis has been demonstrated as the most likely predisposing cause of intestinal intussusception in dogs (Rallis *et al.*, 2000). In the present study also the dog with intussusception had an immediate previous history of parvo viral gastroenteritis.

Subtle signs noticed in the present study, were also recorded by several researchers like Jawre *et al.* (2008), Pillai *et al.* (2009), Atray *et al.* (2012) and Kim *et al.* (2012) in cases of intussusception and Meshram and Kamble (2010) and Gupta *et al.* (2012) in cases of intestinal obstruction in dogs. Myers and Penninck (1994) and Graham *et al.* (2000) also felt that, the symptoms of gastro intestinal tract disorders were non specific.

Patsikas *et al.* (2003) asserted that, intussusception in young dogs was usually suspected on the basis of abdominal palpation. Contrary to this finding, abdominal palpation in case of intussusception could not give any clue in the present study, perhaps due to the fact that, identification of intussusception in the prolapsed mass of intestines prevented further scrutiny. Palpation revealed a hard structure at the caudal abdomen in obstruction cases.

In cases of intussusception and obstruction, leukocytosis with neutrophilia was noticed. This could be attributed to bacterial sepsis caused by release of pro inflammatory mediators, activation of the cytokine cascade, (Swann and Hughes 2000). These findings are

in agreement with those of Jawre *et al.* (2008), Matthews *et al.* (2008), Atray *et al.* (2012) and Kumar *et al.* (2015).

Among the biochemical parameters, blood urea nitrogen and alkaline phosphatase were found significantly elevated. The most commonly reported biochemical abnormality is azotemia due to multiple organ dysfunction syndrome (Evans *et al.*, 1994). Similar to the findings of present study, Myers and Penninck (1994) also observed elevated blood urea nitrogen levels.

The lateral plain radiograph of abdomen in the dog with intussusception, disclosed gas filled and distended loops of intestines with its diameter far higher than height of central portion of fifth lumbar vertebra and twice the width of last rib. Jawre *et al.* (2008), Atray *et al.* (2012) and Kim *et al.* (2012) also recorded similar findings in dogs with intussusception. Patsikas, *et al.* (2003) also inferred that, radiographic signs were often non specific in diagnosing intestinal intussusception.

The radiographs of the dogs with intestinal obstruction were not directly conclusive except that, they showed multiple loops of gas filled intestines of varying diameters. Kim *et al.* (2012) mentioned that, radiographic sings of complete obstruction were usually present and more pronounced with complete obstruction. Whereas, Felts *et al.* (1984) opined that, diagnosis of intestinal obstruction was confirmatory by radiography while rarely diagnostic by abdominal palpation.

In horizontal plane, the typical appearance of concentric hypoechoic and hyperechoic rings caused by invaginated layers of hyperechoic intussusceptum and hypoechoic intussuscipiens which is known as “bull’s eye” or “ring” sign was identified. In sagittal plane intussusception appeared as linear hyperechoic and hypoechoic streaks. Similar observations were also made by Patsikas *et al.* (2003)**,** Jawre *et al.* (2008), Atray *et al.* (2012) and Kumar

et al. (2015). The ultrasonographic patterns of intestinal intussusception i.e. the target sign result from the juxtaposition of the walls of the inner and outer intussusceptum and the walls of the intussuscipiens (Lee *et al.*, 2005).

In the present study, ultrasonography in case of intestinal obstruction revealed dilated lumina of intestines in horizontal plane; while in sagittal section, presence of a foreign body was clearly evident with strong acoustic shadow behind. A linear strong hyperechoic structure was seen representing the foreign body (underwear). Cyrus *et al.* (2010) also diagnosed a case of intestinal obstruction caused by a mango kernel in a dog by using ultrasonography which depicted a hyperechoic mass in the intestinal lumen. Larson and Biller (2009) also reported that, ultrasound was extremely helpful in the diagnosis of obstructive lesions with the bowel proximal to the obstruction usually dilated with gas or fluid appearance

By the above study, the following inferences can be made. At the time of surgery the observations made regarding the six cases correlated with clinical signs only in half of the cases (50 per cent accuracy). The dog with target sign had intussusception at the ileo -caeco-colic junction. In the other two cases of intestinal obstruction, two foreign bodies *viz*, a portion of corn cob and an under wear were retrieved after performing enterotomy. As the subject density of corn cob is more than that of underwear, the former could cause more dilatation of intestines by causing complete obstruction. As the underwear was swallowed as it is, it occupied the gut in a linear fashion, thus leaving less scope for the gas shadows to be cast. Radiography gives conclusion only when the obstruction is complete. Ultrasonography can detect the intussusception more accurately when compared to the radiography (cent per cent accuracy).

Hepatobiliary system:

In the present study, clinical signs were more misleading in disorders of hepatobiliary system, when compared to any other system. Out of twelve old dogs, five had hepatomegaly three animals had ascites, one had hepatoma. The disorders like hepatic cyst, nodular hyperplasia, gall bladder sludge etc had no specific signs. Similar signs in different conditions like hepatic abscess (Schwarz *et al.*, 1998), ascites (vijaykumar, 2002 and Saravanan *et al.*, 2012), cirrhosis (Vijayanand and Nagarajan, 2007) polypoid lesions in the gall bladder *(*Adel, 2012*)*, ascites due to right heart failure (Kumar *et al.*, 2014) and cirrhosis of liver (Elhiblu *et al*., 2015). As stated by Chaudhary *et al.* (2008), history of prolonged erratic anorexia and weakness should arouse suspicion of liver involvement. Palpation of abdomen also did not give any clue as to the nature of the disease. This could be attributed to the remarkable regenerative capacity of the liver, which did not cause any textural changes in the organ.

In the present study, leukocytosis with neutrophilia (with shift to left) was observed as reported by Kumar *et al.* (2013) and Elhiblu *et al.* (2015). However, contradictory to these findings, Tantary *et al.* (2013) observed unaltered leucocyte counts in chronic hepatitis. Aspartate aminotransferase and alkaline phosphatase levels increased significantly; while total protein, blood glucose and cholesterol values decreased significantly as observed by Sevilius and Anderson (1994), Vijaykumar (2002), Vijayanand and Nagarajan (2007), and Kumar *et al.* (2013). Mircean *et al.* (2008) and Salvekar *et al.* (2010) opined that, only ultrasonography could aid in differential diagnosis, when compared to haemato biochemical alterations.

In the present study, in animals that had hepatomegaly, the liver was diffusely enlarged with displacement of intestines and rounding of liver lobes, as observed by

Chaudhary *et al.* (2008). Caudal deviation of gastric axis as observed by Schwarz *et al.* (1998), Kitchell *et al.* (2000) could not be seen in the present study, which could be attributed to KVp settings. One of the animals with hepatomegaly had calcification as only an incidental finding. As observed by Kumar and Srikala (2014), the radiological signs of ascites included ground glass appearance with loss of serosal details. The radiographic findings could not elicit any useful diagnostic information as regards to hepatic cyst.

In hepatic neoplasia, in the place of gastric axis, a diffuse opacity was noticed, which was irregular in outline and not appreciable in ventrodorsal view. The position of the stomach is important in evaluating the tumors of liver. An empty stomach without any food or gas does not cast any shadow on a radiograph. Hepatic neoplasia, a common benign lesion in older dogs, is usually silent clinically but may result in elevations in serum alkaline phosphatase (Prause and Twedt, 2000). The nodular hyperplasia could not be identified during radiography, which might be due to absence of calcification. Elhiblu *et al.* (2015) stated that, radiographs do not provide any useful information as regards to hepatobiliary disorders.

Varshney and Hoque (2002), Vijayanand and Nagarajan (2007), Kumar *et al.* (2013) and Tantary *et al.* (2013) also observed changes which are in agreement with those of present study like, indistinct portal vasculature, abdominal effusions, ascites etc., in cirrhosis of in dogs. Ultrasonography was felt as a best means to scan liver in presence of ascetic fluid, as it clearly makes all viscera visible with remarkable serosal detail. As mentioned by Schwarz *et al.* (1998), a small and solitary hepatic cyst with echo enhancement was observed.

Ultrasonography was found successful in the diagnosis of liver masses i.e. either a neoplastic growth or nodular hyperplasia, where radiography failed to yield any conclusion. Upon laparotomy, the tumor was reddish brown and hard, arising from one of the liver lobes

and measured 7.3 x 5.4 weighing about 0.853 kilograms. Histologically the tumor was confirmed as benign liver tumor, hepatoma.

Similar to the present findings, Kitchell *et al.* (2000) and Arambulo *et al.* (2004) observed multiple, small nodular masses; Chaudhary *et al.* (2008) diagnosed tumor in liver. In contrast to the indistinct portal vessels in the present study, Kumar and Srikala (2014) noted engorged and distended hepatic vasculature in ascites with right heart failure in a dog. Gall bladder sludge was identified as an incidental finding in many asymptomatic dogs as observed by Bromel *et al.* (1998) and Chaudhary *et al.* (2008). As reported by Salib *et al.* (2013) and Choi *et al.* (2014) absence of echo textural changes cannot be considered negative for a hepatobiliary disease. Best results can be obtained by a combination of both clinico-pathological and ultrasonographic evaluation for the correct diagnosis of the liver diseases (Salvekar *et al.*, 2010).

The clinical signs are often misleading; the radiography is useful only for gross assessment of hepatomegaly, while ultrasonography can be best exploited in hepatobiliary disorders. The haemato-biochemical profile indicates the severity of ongoing disease.

Urinary system:

Among disorders of urinary system, cystoliths (5), cystitis (2), transitional cell carcinoma (1), haemorrhagic cystitis (1), polypoid cystitis (1), renal cyst (1) and hydronephrosis (1) were diagnosed. Similar clinical signs were also observed by Nyland *et al.* (2002) and Hanazano *et al.* (2014) in transitional cell carcinoma, Petite *et al.* (2006) in emphysematous cystitis. As observed by Rousset *et al.* (2011), there were no clinical signs in cases of hydronephrosis in dogs as the disease was progressing with continuous dilation of renal pelvis. However, Mesquita *et al.* (2015) observed more acute sings in bilateral

hydronephrosis and hydroureter. Contrary to the present findings, solitary renal cyst was serious as reported by Paskalev *et al.* (2012).

The observations in the present study like anaemia and decreased levels of packed cell volume were also observed by Bradea *et al.* (2013) and Raposo *et al.* (2013). However, Mesquita *et al.* (2015) observed normal haemograms in various disorders of urinary system. Increased blood urea nitrogen in the present study was attributed to dehydration in most of the patients with renal disease. Similar findings were also reported by Bradea *et al.* (2013).

In the present study, a solitary cystic calculus in a bitch as reported by Mahesh *et al.* (2014), cystic and urethral calculi, as observed by Sravanthi *et al.* (2014) with enormous distention of urinary bladder were observed. The radiolucent calculi observed in one dog were not diagnosed by plain radiography, but were confirmed by ultrasonography. The dog with transitional cell carcinoma did not show any radiographic signs on the plain radiographs. A filling defect in the urinary bladder, widening of the prostatic urethra and prostatomegaly were observed in pneumocystogram. These findings are in agreement with those of Heng *et al.* (2006). However, Hanson and Tidwell (1996) also observed pulmonary metastasis in addition. The radiography was not at all conclusive in diagnosing polypoid cystitis which was confirmed through ultrasonography. In the dog with haemorrhagic cystitis, blood clots were found on pneumocystography. Petite *et al.* (2006) also noticed mottled gas opacities with in the wall of the urinary bladder in a case of emphysematous cystitis. Cystic and urethral calculi with dilated lumina and clear acoustic shadowing were conclusive in the present study, as reported by Langstone *et al.* (2008) and Sravanthi *et al.* (2014). Contrary to the inference of present study, Nyland and Matton, (1995) opined that, identification of urinary calculi by ultrasonography is some times difficult since the intensity of acoustic shadowing varies depending upon the machine used and the transducer frequency used. On ultrasonography, Hanson and Tidwell (1996) and Hanazano *et al.* (2014) also diagnosed

transitional cell carcinoma with subtle thickening and hypo echogenicity of the proximal urethra with a pebbly irregular hyperechoic luminal margin. However, in the present study, the tumor was restricted only to the bladder. In polypoid cystitis, thickening of the bladder wall was accompanied by multiple small growths that projected into the lumen. In the dog with haemorrhagic cystitis, blood clots appeared as hyperechoic, non-shadowing echogenicities as observed by Petite *et al.* (2006).

As observed by Paskalev *et al*. (2012) one of the kidneys in a dog had a single large cyst with acoustic enhancement. The lesions in hydronephrosis with minor deviations like uretero hydronephrosis (Bradea *et al.*, 2013), hydronephrosis due to abdominal trauma (Raposo *et al.*, 2013) and bilateral hydronephrosis (Mesquita *et al.*, 2015), were also observed in dogs. With the advent of new machines with high resolution ultrasonography is a useful means of diagnosis of urogenital diseases and disorders (Halati *et al.*, 2012).

Unlike previous two systems, symptoms can be useful in this system. Only radio opaque calculi can be seen on radiographs and radiolucent calculi can be seen only on ultrasonography. All other disorders liken cystitis, haemorrhagic cystitis, polypoid cystitis, transitional cell carcinoma, hydronephrosis and renal cyst etc can be diagnosed only through ultrasonography. In these cases the haemato-biochemical profile appears not useful.

Female genital system:

Twelve animals were presented with clinical sings corresponding to problems of female genital system *viz*., pyometra (8), macerated foetus (1), stump granuloma (2), and stump abscess (1).

Hagman *et al.* (2011) and Gupta *et al.* (2012) also observed similar clinical signs in pyometric bitches like severe abdominal distension, toxaemia, respiratory discomfort etc. However, symptoms like polyuria, polydipsia etc., observed by Marin *et al.* (2011) and Gupta

et al. (2012), were not at all observed. One bitch with macerated foetus had a palpable hard mass at its caudal abdomen. Stump pyometra was also observed by Okkens *et al.* (1981), Hagman (2004) and Pretzer, (2008) which was thought to occur following ovariohysterectomy when a portion of the uterine horns or uterine body was not removed and when the animal had increased progesterone concentrations.

Increase in blood urea nitrogen in pyometric bitches could be attributed to poor renal perfusion, sepsis and dehydration. Smith (2006) also observed pre-renal azotemia and hypo proteinuria in pyometric bitches. Congruent to present findings, Marin *et al.* (2014) observed low red blood cell count and leukocytosis; and Feldman and Nelson (1989), Gandotra *et al.* (1994) and Pretzer (2008) observed leukocytosis with predominant shift to left in pyometric bitches

The uterus is not readily visualized unless it becomes enlarged. All the bitches with closed pyometra had homogenous fluid type of opacity in the uterus, coiled uterine horns with genital tract occupying one half to three fourths of the abdominal cavity. The high accuracy obtained through radiography could be attributed to the enormous distention of uterus with pus in all the delayed and referral cases. These observations are in corroboration with those of Marin *et al.* (2014) and Matton and Nyland (1995). The bitch with macerated foetus showed more radio opaque and compact fetal bones. As felt by Ackerman (1981), diagnosis of stump granuloma was difficult as it compressed the urinary bladder, pelvic urethra and colon. The fragments of ovarian tissue could become revascularized through the mesentery or omentum maintaining functional status indefinitely (Ball *et al*., 2010).

The uterus is not readily visualized by ultrasonography unless it becomes enlarged. The findings of ultrasonographic evaluation of uteri of bitches clinically suspected of having pyometra were confirmatory in all the cases. These findings are in agreement with those of Pretzer, (2008) and Baithalu *et al.* (2010). On ultrasonography, the bitch with macerated

foetus showed hyperechoic fetal bones. The foetal bones did not have any soft tissue structures around them. As reported by Campbell (2004), hypoechoic fluid found in association with the uterine stump mass was consistent with abscess formation. Boza *et al.* (2010) also observed the stump abscess between the colon and urinary bladder similar to the present study.

Radiography it self was sufficient to diagnose a case of macerated foetus. The stump granuloma and pyometra were visible on radiography, whereas their origin and location were better understood at the time of ultrasonography. The lesions were identified between the colon and urinary bladder as anticipated. The cystic ovarian disease diagnosed at the time of surgery was an incidental finding and was not diagnosed through any of the diagnostic modality used in the study. As opined by Matton and Nyland (1995), ultrasonographic imaging of the uterus presented a much more specific technique which allowed not only the type of pyometra to be recorded (showing whether it is localized, segmental or uniform tubular in nature) but also integrity of uterine wall and content type.

Male genital system:

In the present study, six male dogs were suspected to have prostatic hyperplasia with clinical signs of constipation, haematuria, mild lethargy, ribbon shaped stools and a smooth mass palpable at the brim of the pelvis on rectal examination as reported by Bhadwal and Mirakur (2000). Of the six dogs tentatively diagnosed, only three were confirmed to have prostatic hyperplasia through other investigations. So it appears that these symptoms are often misleading. Prathaban (2002) and Santa *et al.* (2008) felt that, dyschezia and ribbon shaped stools were more associated with prostatic hyperplasia.

Minimum data base required to evaluate canine prostate includes a complete blood count, biochemistry profile, urinalysis and caudal abdominal radiographs (Rogers *et al.*, 1986). A non significant decrease in haemoglobin and packed cell volume, relative neutrophilia with normal total leucocyte count were observed. Alkaline phosphatase was increased significantly. These findings might be due to concomitant infection.

The prostate gland is located at the neck of the bladder and encircles the urethra. It enlarges progressively with age and extends in to the abdominal cavity after attaining sexual maturity (Evans, 1994). The prostate is often distinguishable on lateral or dorso-ventral survey views. The size, location and contour of the prostate can be determined by radiography of the caudal abdomen (Prathaban, 2002). The technique of comparing the size of the prostate to the pelvic inlet was thought to be more appropriate as it could rule out prostatic hyperplasia in three dogs. In the present study prostate hyperplasia was seen alone without any accompanying lesions like perineal hernia, with primary prostatic haemangiosarcoma as reported by Santa *et al.* (2008).

On ultrasonography, in sagittal section, the gland appeared spherical in outline with smooth margins and on transverse plane, the enlargement was asymmetrical. The formula suggested by Ruel *et al.* (1998) appeared suitable in assessing the prostate hyperplasia.

The three dogs with prostate hyperplasia were treated by performing castration. As the prostate is androgen dependent, castration could alleviate the symptoms in this case. From the above discussion, it appears that, symptoms often coincide with those of urinary system disorders. The haemato-biochemical profile is not at all useful in the diagnosis of prostate hyperplasia. Radiography gives only a basic idea about prostatomegaly, while ultrasonography can be best combined to give a final opinion.

Spleen:

In the present study, only one old male dog had splenic haemangiosarcoma. Similar signs of polydipsia, anemia, cardiac insufficiency, cough, dyspnoea, edema of lungs, abdominal distention, extreme weakness, high temperature, and difficulty in swallowing were also observed by Oksanen (1978). Guelbahar *et al.* (1998) noticed some what different signs like progressive weight loss, indifference to the surroundings, marked skeletal muscle weakness. So, it appears that, there are more variations in the expression of this neoplastic condition.

In haemangiosarcoma of spleen, a significant decrease in haemoglobin, and packed cell volume, were the chief haematological alterations. Guelbahar *et al.* (1998), Vijaykumar (2002) Watson *et al.* (2011) and Singh *et al.* (2012) also made similar observations with exception of leukocytosis. Hosgood *et al.* (1989) observed abnormal forms of erythrocytes and nucleated erythrocytes which were not seen in the present case. Alkaline phosphatase, blood urea nitrogen, serum calcium and serum creatinine were found to be elevated significantly as recorded by Patil *et al.* (2011).

The lateral radiograph of the abdomen showed a large diffuse radio opaque mass with irregular and on ventro dorsal view; the spleen occupied major part of the abdomen. The origin of the tumor mass was not clears through radiographs. Unlike this observation, Guelbahar *et al.* (1998) recorded numerous radio-opaque masses of varying sizes throughout the abdomen in an old dog affected with splenic haemangiosarcoma with abdominal dissemination. Patil *et al.* (2011) diagnosed an emergency case of splenic torsion in a dog, in which, they detected non typical radio - opaque mass just below the stomach, which extended beyond its normal location. The present case appeared to have a chronic wasting disease, rather than an emergency.

Visualization of splenic echotexture even at the pubic region and a typical honey comb appearance made ultrasonographic findings definitely conclusive. Patil *et al.* (2011) also documented similar findings with the only difference of presence of dilated splenic vessels with coarse /lacy appearance in case of splenic torsion. Watson *et al.* (2011) suggested needle core biopsy was complementary to ultrasonography in the diagnosis of splenic neoplasia in dogs. They recommended that, the combined protocol might improve detection of splenic neoplasia besides providing neoplastic sub classification.

In the present study, symptoms were often inconclusive and haemato-biochemical profiles gave supplementary evidence. Ultrasonography appears more confirmative in diagnosing haemangiosarcoma of spleen, when compared to radiography. This was further confirmed by fine needle aspirate cytology.

Abdominal wall defects/herniation:

The perineal swelling is commonly observed in dogs. The perineal swelling can be due to hernia, accumulation of fluid or some tumorous growths. However, perineal hernia was found to be most common cause of such swellings (Sharma *et al.*, 2010). In the present study, an attempt was also made to find out the nature of the contents of various hernias.

A total of five dogs were treated for various types of hernias and haematoma *viz.*, perineal hernia, inguinal hernia and perineal haematoma. Diagnosis of perineal hernia was very easy based on clinical signs itself. Most of the times, urinary bladder, a loop of intestine or a part of omentum may herniate in to the weak pelvic diaphragm. The nature of the contents can also be dealt based on signs like difficulty in urination, if the urinary bladder is involved. Perineal tumours, haematoma etc need to be differentially diagnosed from that of perineal hernia. Constipation, obstipation, tenesmus, dyschezia are attributed to a

combination of rectal dilatation and prostatomegaly (Bellenger, 1980 and Hosgood *et al.*, 1995).

The changes like anaemia and neutrophilic leukocytosis with shift to left were attributed to chronic inappetance and infection respectively. Hypoproteinemia, increased blood urea nitrogen and serum creatinine values indicated the relative multi organ involvement in the disease.

The lateral radiographs of animals with perineal hernia and haematoma showed a radio opaque structure at the perineal region. Retrograde catheterization of the urinary bladder using an infant feeding tube diagnosed the swelling as urinary bladder. Radiography did not provide any clue about haematoma; only aspiration could confirm the nature of swelling. Pneumocystography indicated the normal position of urinary bladder in this case. Singh *et al.* (2012) also opined that, radiography was not so good enough as compared to ultrasonography. In inguinal hernia also, the nature of contents could not be assessed due to absence of gas in the intestines.

An anechoic structure identified at the perineal region was diagnosed as perineal hernia due to herniation of urinary bladder. Ultrasonography appeared more potent in differentiating hernial swellings especially at the perineal region. The intestines were readily recognized by their peristaltic movements. In perineal haematoma, there was a clear anechoic to hypoechoic structure which was initially regarded as a case of perineal hernia. This finding went erroneous, which was confirmed as haematoma on aspiration of the contents. Ultrasonography appears to be a good technique to know the contents of hernial swelling (Singh *et al.*, 2012). It can be concluded that, ultrasonography was found to be better than radiography in cases of perineal swelling and is very useful in differentiating

hernia, lipoma, haematoma etc. In male animals, enlarged prostate gland, distended urinary bladder, and loops of intestines were observed as contents. In females, urinary bladder and lipoma were noted as hernial contents (Bellenger and Canfield, 2003).

It can be concluded that, ultrasonography is more accurate technique in diagnosing most of the disorders of the abdominal organs in dogs like, intussusception, intestinal obstruction, hepatic neoplasia, hepatic cyst, nodular hyperplasia, polypoid cystitis, haemorrhagic cystitis, transitional cell carcinoma of urinary bladder, splenic haemangiosarcoma, hydronephrosis, prostatic hyperplasia etc. Plain radiography is conclusive only limited instances like urolithiasis, hepatomegaly, pyometra, macerated foetus etc. in many instances, they are complimentary to each other. Haemato-biochemical profiles can be used to assess the severity of the disease, besides adding to diagnosis.

CHAPTER VI
SUMMARY

The present study entitled "Clinical studies on Transabdominal ultrasonography in diagnosing various abdominal disorders in dogs" was undertaken to use clinical examination, haemato-biochemical profiles, radiography and ultrasonography to arrive at a comprehensive diagnosis of various abdominal disorders in dogs and the following conclusions were made.

- Among GIT disorders of surgical interest, the symptoms of intestinal obstruction were more or less similar to those of intestinal intussusception. Decreased Hb, TEC, leukocytoss with neutrophilia, elevated BUN and ALP were observed in intussusception and intestine. The lateral plain radiograph of abdomen disclosed gas filled and distended loops of intestines. The magnitude of distention was greater than the height of fifth lumbar vertebra and twice that of width of last rib.
- In horizontal plane, the typical appearance of intussusception known as "bull's eye" or "ring" sign was clearly seen. The ultrasonography in case of intestinal obstruction revealed dilated lumina of intestines in horizontal plane. In the diagnosis of intussusception, ultrasonography is more appropriate.
- Clinical signs were more misleading in disorders of hepatobiliary system, when compared to any other system. Leukocytoss with neutrophilia, elevated SGOT and ALP, and decreased total protein, blood glucose and cholesterol values were observed. In hepatomegaly, the liver was diffusely enlarged with displacement of structures. Hepatic calcification depicted a radio-opaque structure and ascites had ground glass appearance. The radiographic findings were not conclusive in hepatic cyst, tumor, nodular hyperplasia and gall bladder sludge.

- On ultrasonography, the liver appeared enlarged with rounded margins in hepatomegaly. Ascites, hepatic cyst, liver masses and gall bladder sludge were clearly diagnosed using ultrasonography.
- Symptoms were more or less suggestive of the existing disease in disorders of urinary system. In obstructive urolithiasis and cystitis, significantly decreased Hb and PCV, elevated total leucocyte count with neutrophilia and elevated BUN were observed. The radio-opaque cysto-urethral calculi were visible on radiographs, while the radiolucent calculi were not visible. Transitional cell carcinoma, haemorrhagic cystitis and polypoid cystitis were visible only on pneumocystography.
- On ultrasonography, cystoliths were visible as hyperechoic structures with distinct acoustic shadowing, while in radiolucent calculi the acoustic shadowing was not conspicuous. Transitional cell carcinoma, polypoid cystitis, haemorrhagic cystitis, renal cyst and hydronephrosis were identified using ultrasonography.
- In pyometra, stump granuloma and stump pyometra, anaemia with decreased Hb, PCV and TEC, neutrophilic leukocytoss with shift to left and elevated BUN were observed. Uterus was visible as homogenous radio opacity with coiled uterine horns. Macerated foetus showed more radio-opaque and compact foetal bones. Stump fibroid and abscess were seen as radio opaque masses between descending colon and urinary bladder. Diagnosis of pyometra was very easy on ultrasonography due to visualization of thin walled sacculations. Macerated foetus showed hyperechoic fetal bones. The location of stump fibroid or abscess was easier with ultrasonography.
- In prostate hyperplasia, relative neutrophilia with normal total leucocyte count and elevated ALP were observed. On radiography, the enlarged prostate displacing the bladder and colon was observed. The assessment of prostatic volume by comparing

its dimensions with those of pelvic inlet correlated with ultrasonography and clinical examination.

- In splenic haemangiosarcoma, inconsistent clinical signs, a decreased Hb, PCV; elevated ALP, BUN, serum calcium and creatinine were observed. A large diffuse radio opaque mass was visible in the abdomen in the region of spleen. On ultrasonography spleen had a typical honey comb appearance which was further confirmed by cytology.
- The symptoms, location of hernia and presence of ring etc. were well sufficient to diagnose a case of hernia. However, to differentiate the contents, ultrasonography was felt appropriate. Radiography was useful only when the intestines contained gas. In case of perineal swellings, ultrasonography helped significantly in identification of the lesion.
- It can be concluded that, ultrasonography is more accurate technique in diagnosing most of the disorders of the abdominal organs in dogs like, intussusception, intestinal obstruction, hepatic neoplasia, hepatic cyst, nodular hyperplasia, polypoid cystitis, haemorrhagic cystitis, transitional cell carcinoma of urinary bladder, splenic haemangiosarcoma, hydronephrosis, prostatic hyperplasia etc. Plain radiography is conclusive only limited instances like urolithiasis, hepatomegaly, pyometra, macerated foetus etc. in many instances, they are complimentary to each other. Haemato-biochemical profiles can be used to assess the severity of the disease, besides adding to diagnosis.

LITERATURE CITED

Ackerman N 1981 Radiographic evaluation of the uterus: a review. Veterinary Radiology 22(6): 252-257.

Adel A 2012 Diagnosis and management polypoid lesions of the gall bladder in a dog. Intas polivet 13(1): 127-129.

Arambulo R, Wrigley R and Powers B 2004 Sonographic features of histiocytic neoplasms in the canine abdomen. Veterinary Radiology and Ultrasound 45(6): 554-558.

Atray M, Raghunath M, Singh T and Saini N S 2012 Ultrasonographic diagnosis and surgical management of double intestinal intussusception in 3 dogs. The Canadian Veterinary Journal 53(8): 860.

Baithalu R K, Maharana B R, Mishra C, Sarangi L and Samal L 2010 canine pyometra. Veterinary World 3(7): 340-342.

Ball R L, Birchard S J, May L R, Threlfall W R and Young G S 2010 Ovarian remnant syndrome in dogs and cats: 21 cases (2000–2007). Journal of the American Veterinary Medical Association 236(5): 548-553.

Barr F J, Patteson M W, Lucke V M and Gibbs C 1989 Hypercalcemic nephropathy in three dogs: sonographic appearance. Veterinary Radiology 30(4): 169-173.

Barros C M, Moreira M B P, Figueiredo R A, Teixeira A B and Trinca L A 2000 synchronization of ovulation in Beef cows using GnRH, $PGF_2\alpha$ and estradiol Benzoate. Theriogenology 53: 1121 – 1134.

Bellenger C R 1980 Perineal hernia in dogs. Australian veterinary journal 56(9): 434-438.

Besso J G, Wrigley R H, Gliatto J M and Webster C R L 2000 Ultrasonographic appearance and clinical findings in 14 dogs with gallbladder mucocele. Veterinary Radiology and Ultrasound 41(3): 261-271.

Bhadwal M S and Mirakhur K K 2000 Evaluation of canine prostate by transabdominal ultrasonography. Indian Journal of Veterinary Surgery 21(1): 12-16.

Bokhari S G, Hou J, Iqbal M, Wu Y and Wang Y 2012 influence of renal ultrasonographic findings on GFR during chronic unilateral ureteral obstruction in dogs. The Journal of Animal & Plant Sciences 22(3): 576-583.

Boza S, Lucas X, Zarelli M, Soler M, Belda E and Agut A 2010 Late abscess formation caused by silk suture following hysterectomy in a female dog. Reproduction in domestic animals 45(5): 934-936.

Bradea A, Codreanu M and Vlagioiu C 2013 Ultrasonographic aspects in ureterohydronephrosis in dogs. Scientific Works. Series C. Veterinary Medicine 59(1): 46-48.

Braun U 2009 Ultrasonography of the liver in cattle. Veterinary Clinics of North America: Food Animal Practice 25(3): 591-609.

Bromel C, Barthez P Y, Leveille R and Scrivani P V 1998 Prevalence of gallbladder sludge in dogs as assessed by ultrasonography. Veterinary Radiology and Ultrasound 39(3): 206-21.

Bru N, Garcia-Real I, Martinez E M, Rollan E, Mayenco A and Llorens P 1998 Ultrasonographic appearance of ovarian tumors in 10 dogs. Veterinary Radiology and Ultrasound 39(3): 226-233.

Campbell G 2004 Omentalization of a nonresectable uterine stump abscess in a dog. Journal of the American Veterinary Medical Association 224(11): 1799-1803.

Carlisle C H 1995 Ultrasonographic examination of the canine liver based on recognition of hepatic and portal veins. Veterinary Radiology and Ultrasound 36(3): 234-239.

Chaudhary P S, Varshney J P and Deshmukh V V 2008 Application of ultrasonography, radiography and clinico-biochemical profile in the diagnosis of hepatic diseases and their clinical management. Intas Polivet 9(2): 168-176.

Choi J, Kim A, Keh S, Oh J, Kim H and Yoon J 2014 Comparison between ultrasonographic and clinical findings in 43 dogs with gallbladder mucoceles. Veterinary Radiology and Ultrasound 55(2): 202-207.

Christensen N I, Brain P H, Langova V and Flory A B 2013 Vaginal discharge in a spayed dog with multiple distinct malignancies. Australian veterinary journal 91(7): 287-291.

Cyrus J, Vaseem S S and Basavanagowda M T 2010 Surgical removal of mango kernel causing intestinal obstruction in a dog. Intas Polivet 11(2).

Diana A, Penninck D G and Keating J H 2009 Ultrasonographic appearance of canine gastric polyps. Veterinary Radiology and Ultrasound 50(2): 201-204.

Elhiblu M A, Dua K, Mohindroo J, Mahajan S K, Sood N K and Dhaliwal P S 2015 Clinico-hemato-biochemical profile of dogs with liver cirrhosis. Veterinary World 8(4): 487-491.

England G C 1996 Renal and hepatic ultrasonography in the neonatal dog. Veterinary Radiology and Ultrasound 37(5): 374-382.

Evans K L, Smeak D D and Biller D S 1994 Gastrointestinal linear foreign bodies in 32 dogs: a retrospective evaluation and feline comparison. Journal of the American animal hospital association 30: 445-450.

Feeney D A, Johnston G R, Klausner J S, Perman V, Leininger J R and Tomlinson M J 1987 Canine prostatic disease: comparison of ultrasonographic appearance with morphologic and microbiologic findings: 30 cases (1981-1985). Journal of the American Veterinary Medical Association 190(8): 1027-1034.

Feldman E C and Nelson R W 1989 Diagnosis and treatment alternatives for pyometra in dogs and cats. Current Veterinary Therapy Small Animal Practice 10: 1305-1310.

Felts J F, Fox P R and Burk R L 1984 Thread and sewing needles as gastrointestinal foreign bodies in the cat: a review of 64 cases. Journal of the American Veterinary Medical Association 184(1): 56-59.

Gaber E, El-Khamary A and Abdelwahed R 2014 Tube Cystostomy VS Bladder Marsupialization: Clinical and Ultrasonographic Evaluation in Dogs. Alexandria Journal of Veterinary Sciences 42(1): 16-27.

Gadelha C R F, Vicente W R R, Ribeiro A P C, Apparício M F, Covizzi G J and Machado L D S 2009 Age-related ultrasonography, cytology, and microbiologic exam of canine prostate. Arquivo Brasileiro de Medicina Veterinária e Zootecnia 61(6): 1261-1267.

Gandotra V K, Singla V K, Kochhar H P S, Chauhan F S and Dwivedi P N 1994 Hematological and bacteriological studies in canine pyometra. Indian veterinary journal 71(8): 816-818.

Ghadiri A, Avizeh R, Baniadam A and Ranjbar A 2013 Comparison of Transabdominal and Transrectal Ultrasonography of the Prostate Gland in Dogs. Iranian Journal of Veterinary Surgery 8(2): 43-48.

Graham J P, Newell S M, Roberts G D and Lester N V 2000 Ultrasonographic features of canine gastrointestinal pythiosis. Veterinary Radiology and Ultrasound 41(3): 273-277.

Graham J P, Lord P F and Harrison J M 1998 Quantitative estimation of intestinal dilation as a predictor of obstruction in the dog. Journal of small animal practice 39(11): 521-524.

Guelbahar M Y, Guevenc T and Besalti O 1998 Splenic haemangiosarcoma with abdominal dissemination in a dog. Turkish Journal of Veterinary and Animal Sciences 22: 459-464.

Gupta A K, Dhami A J, Patil D B, Kumar D and Darr M 2013 Clinical and ultrasonographic evaluation of bitches affected with pyometra. Indian Journal of Field Veterinarians 8(3): 1-4.

Gupta P, Sharma A, Gupta A K, Kushwaha R B and Dwivedi D K 2012 Gastric foreign body and its surgical management in a dog. Intas Polivet 13(1): 104-105.

Hagman R, Lagerstedt A S, Hedhammar Å and Egenvall A 2011 A breed-matched case-control study of potential risk-factors for canine pyometra. Theriogenology 75(7): 1251-1257.

Hagman R 2004 New aspects of canine pyometra. Studies on Epidemiology and Pathogenesis. Doctor's dissertation 182: 55.

Halati F, Molazem M, Asadi S and Masoudifard M 2012 Unilateral Orthotopic Ureterocele in a Dog. Iranian Journal of Veterinary Surgery 7(1): 97-102.

Hanazono K, Fukumoto S, Endo Y, Ueno H, Kadosawa T and Uchide T 2014 Ultrasonographic findings related to prognosis in canine transitional cell carcinoma. Veterinary Radiology and Ultrasound 55(1): 79-84.

Hanson J A and Tidwell A S 1996 Ultrasonographic appearance of urethral transitional cell carcinoma in ten dogs. Veterinary Radiology and Ultrasound 37(4): 293-299.

Heng H G, Lowry J E, Boston S, Gabel C, Ehrhart N and Stocker Gulden S M 2006 Smooth muscle neoplasia of the urinary bladder wall in three dogs. Veterinary Radiology and Ultrasound 47(1): 83-86.

Hosgood G, Hedlund C S, Pechman R D and Dean P W 1995 Perineal herniorrhaphy: perioperative data from 100 dogs. Journal of the American Animal Hospital Association 31(4): 331-342.

Hosgood G, Bone D L, William III, D V and Reed W M 1989 Splenectomy in the dog by ligation of the splenic and short gastric arteries. Veterinary Surgery 18(2): 110-113.

Hotz B, Hauser B and Arnold P 1996 Ultrasonographic findings in canine gastric neoplasia in 13 patients. Veterinary Radiology and Ultrasound 37(1): 51-56.

Jain N C 1986 the dog: normal hematology with comments on response to disease. Veterinary hematology, 4th edition. Lea & Febiger, Philadelphia 103-125 (pp).

Jawre S, Shahi A, Chandrapuria V P and Tiwari D K 2008 Diagnosis of ileo-caecal intussusception and its surgical management in bull mastiff bitch. Intas polivet 9(2): 153-155.

Kim J M, Kang S S, Kim G and Choi S H 2012 Double intussusception in a Shih-Tzu puppy: the triple-circle sign. Pakistan Veterinary Journal 32: 292-294.

Kitchell B E, Fan T M, Kordick D, Breitschwerdt E B, Wollenberg G and Lichtensteiger C A 2000 Peliosis hepatis in a dog infected with Bartonella henselae. Journal of the American Veterinary Medical Association 216(4): 519-523.

Konde L J, Wrigley R H, Park R D and Lebel J L 1984 Ultrasonographic anatomy of the normal canine kidney. Veterinary Radiology 25(4): 173-178.

Krol L and O'Brien R 2012 Ultrasonographic assessment of abdominal lymph nodes in puppies. Veterinary Radiology and Ultrasound 53(4): 455-458.

Kumar M, Mondal D B, Saravanan M and Sharma K 2013 Therapeutic Management of Hepatobiliary Dysfunction in Canines. Intas Polivet 14(1): 117-120.

Kumar R V S, Veena P, Sankar P, Dhanalakshmi N and Kokila S 2010 Surgical removal of bottle cap from the stomach of a pup. Intas Polivet 11(2): 307-308.

Kumar S, Ranganath L, Nagaraja B N, Shivakumar E and Gowda A B 2015 Successful surgical management of ileo-ceaco-colic intussusception in an adult Labrador retriever dog. Indian Journal of Canine Practice 7(1).

Kumar K S and Srikala D 2014 Ascites with right heart failure in a dog: diagnosis and management. Journal of Advanced Veterinary and Animal Research 1(3): 140-144.

Lamb C R and Gregory S P 1998 Ultrasonographic findings in 14 dogs with ectopic ureter. Veterinary Radiology and Ultrasound 39(3): 218-223.

Langston C, Gisselman K, Palma D and McCue J 2008 Diagnosis of urolithiasis. Compendium. 447-454.

Larson M M and Biller D S 2009 Ultrasound of the gastrointestinal tract. Veterinary Clinics of North America: Small Animal Practice 39(4): 747-759.

Lee D H, Lim J H, Ko Y T and Yoon Y 1990 sonographic detection of pneumoperitoneum in patients with acute abdomen. American Journal of Roentgenology 154: 107-109.

Lee H, Yeon S, Lee H, Chang D, Eom K, Yoon J and Lee Y 2005 Ultrasonographic diagnosis-pylorogastric intussusception in a dog. Veterinary Radiology and Ultrasound 46(4): 317-318.

Leib M S, Larson M M, Panciera D L, Troy G C, Monroe W E, Rossmeisl J H and Herring E S 2010 Diagnostic utility of abdominal ultrasonography in dogs with chronic vomiting. Journal of Veterinary Internal Medicine 24(4): 803-808.

Mahesh V, Ranganath L, Ravikumar S and Manjunath D R 2014 solitary cystic calculus in a female dog. Indian Journal of Canine Practice 6(2): 147.

Malancus R N, Tofan C and Solcan G 2010 The use of ultrasonography in the diagnosis of gastrointestinal disease in dogs. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Veterinary Medicine 67(2): 143-149.

Mantis P, Brockman D, Whatmough C, Gregory S P, Lamb C R, Mahoney P and Jakovljevic S 2006 Sensitivity, specificity and accuracy of diagnostic imaging methods for the diagnosis of ectopic ureters in the dog. Journal-Hellenic Veterinary Medical Society 57(4): 289.

Marin C C, Molina L, Vizuete G, Sanchez J M, Zafra R and Bautista M J 2014 Uterine and ovarian remnants in an incorrectly spayed bitch: a case report. Veterinarni Medicina 59(2): 102-106.

Marin G, Crivineanu M and Codreanu M D 2011 Study regarding the relevance of the ultrasound examination in uterine diseases associated with polyuria-polydipsia syndrome in bitch. Scientific Works-University of Agronomical Sciences and Veterinary Medicine, Bucharest Series C, Veterinary Medicine 57(2): 23-30.

Matthews A R, Penninck D G and Webster C R 2008 Postoperative ultrasonographic appearance of uncomplicated enterotomy or enterectomy sites in dogs. Veterinary Radiology and Ultrasound 49(5): 477-483.

Matton J C and Nyland T G 1995 Ultrasonography of the genital system. Veterinary diagnostic ultrasound Saunders W.B. Company 141-164 (pp).

Meshram B and Kamble M 2010 Successful Retrieval of Plastic Ball from the Intestine of a Labrador dog. Intas Polivet 11(2): 328-329.

Mesquita L R, Rahal S C, Matsubara L M, Mamprim M J, Foschini C R, Faria L G and Kano W T 2015 Bilateral hydronephrosis and hydroureter after ovariohysterectomy using nylon cable tie: a case report. Veterinarni Medicina 60(1): 52-56.

Mircean M, Giurgiu G, Scurtu I, Popovici C and Kiss T 2008 Observations regarding the comparative value of ultrasonography and laboratory diagnosis of hepatobiliary diseases in dogs. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Veterinary Medicine 65(2).

Molazem M, Vajhi A, Masoudifard M A J I D and Soroori S 2010 Three-dimensional color Doppler ultrasonography of the kidney vasculature in normal dogs. International Journal of Veterinary Research 4(2): 101-105.

Myers N C and Penninck D G 1994 Ultrasonographic diagnosis of gastrointestinal smooth muscle tumors in the dog. Veterinary Radiology and Ultrasound 35(5): 391-397.

Nyland T G, Wallack S T and Wisner E R 2002 Needle-tract implantation following US-guided fine-needle aspiration biopsy of transitional cell carcinoma of the bladder, urethra, and prostate. Veterinary Radiology and Ultrasound 43(1): 50-53.

Nyland T G and Mattoon J S 1995 Veterinary diagnostic ultrasound. WB Saunders 357 (pp).

Nyland T G and Park R D 1983 Hepatic ultrasonography in the dog. Veterinary Radiology 24(2): 74-84.

Nyland T G, Matton J S, Herrgese E J and Wisner E R 2002 Physical principles, instrumentation and safety of diagnostic ultrasound. Published by WB Saunders 2 (pp).

Okkens A C, Biewenga W J, Rothuizen J and Voorhout G 1981 Urological complications following ovariohysterectomy in dogs. Tijdschrift voor diergeneeskunde 106(23): 1189-1198.

Oksanen A 1978 Haemangiosarcoma in dogs. Journal of comparative pathology 88(4): 585-595.

Parrah J D, Moulvi B A, Gazi M A, Makhdoomi D M, Athar H, Dar S and Mir A Q 2013 Gastric ulceration in dog: A review. Veterinary World 6(7): 449-454.

Paskalev M, Lazarov L and Atanasov A 2012 A case of solitary renal cyst in a dog. Bulgarian Journal of Veterinary Medicine 15(1): 62-67.

Patil D B, Dar M U D and Tiwari D K 2011 Splenic Torsion in a Dog and its Emergency management. Intas Polivet 12(2): 395-398.

Patsikas M N, Jakovljevic S, Moustardas N, Papazoglou L G, Kazakos G M and Dessiris A K 2003 Ultrasonographic signs of intestinal intussusception associated with acute enteritis or gastroenteritis in 19 young dogs. Journal of the American Animal Hospital Association 39(1): 57-66.

Penninck D, Smyers B, Webster C R, Rand W and Moore A S 2003 Diagnostic value of ultrasonography in differentiating enteritis from intestinal neoplasia in dogs. Veterinary Radiology and Ultrasound 44(5): 570-575.

Petite A, Busoni V, Heinen M P, Billen F and Snaps F 2006 Radiographic and ultrasonographic findings of emphysematous cystitis in four non-diabetic female dogs. Veterinary Radiology and Ultrasound 47(1): 90-93.

Pillai U N, Ambily V R, Kanaran P P, Elias P and Jayakumar K M 2009 Ultrasonographic Diagnosis of Intussusception in a Pup. Intas polivet 10(1): 91-91.

Prathaban S 2002 Diagnosis and management of canine benign prostate hyperplasia. Intas Polivet 3(2): 219-222.

Prause L C and Twedt D C 2000 Hepatic nodular hyperplasia. Kirks current veterinary therapy 13: 675-676.

Pretzer S D 2008 Clinical presentation of canine pyometra and mucometra: a review. Theriogenology 70(3): 359-363.

Rallis T S, Papazoglou L G, Adamama-Moraitou K K Prassinos N N 2000 Acute enteritis or gastroenteritis in young dogs as a predisposing factor for intestinal intussusception: a retrospective study. Journal of Veterinary Medicine association 47(8): 507-511.

Raposo T M, Varallo G R, Huppes R R, Brum A M D De Nardi A B 2013 Dog with hydronephrosis due to abdominal trauma. Pakistan Veterinary Journal 526-528.

Rogers K S, Wantschek L and Lees G E 1986 Diagnostic evaluation of the canine prostate. The Compendium on continuing education for the practicing veterinarian 8: 11.

Rousset N, Abbondati E, Posch B, Owen L J and Herrtage M 2011 Unilateral hydronephrosis and hydroureter secondary to ureteric atresia, and uterus unicornis in a young terrier. Journal of Small Animal Practice 52(8): 441-444.

Ruel Y, Barthez P Y, Mailles A and Begon D 1998 Ultrasonographic evaluation of the prostate in healthy intact dogs. Veterinary Radiology and Ultrasound 39(3): 212-216.

Salib F A, Farghali H A and Abdou N E M 2013 Hepatic Pseudo-Fasciola infection in German Shepherd Dogs. Journal of Advanced Veterinary Research 3(2): 83-85.

Salvekar S P, Chauhan A R, Upadhye S V, Dhakate M S and Rode A M 2010 Ultrasonography-an important tool for diagnosis of liver disorders in dogs. Intas Polivet 11(2): 372-377.

Santa D, Dandrieux, J, Psalla D, Gorgas D, Lang J, Geissbuehler U and Howard J 2008 Primary prostatic haemangiosarcoma causing severe haematuria in a dog. Journal of Small Animal Practice 49(5): 249-251.

Saravanan M, Sharma K, Kumar M, Vijaykumar H and Mondal D B 2012 Analysis of serum ascites albumin gradient test in ascitic dogs. Veterinary World 5(5): 285-287.

Schwarz L A , Penninck D G and Leveille-Webster C 1998 Hepatic abscesses in 13 dogs: a review of the ultrasonographic findings, clinical data and therapeutic options. Veterinary Radiology and Ultrasound 39(4): 357-365.

Schwerk W B and Schmitz-Moormann P 1981 ultrasonically guided fine-needle biopsies in neoplastic liver disease: Cytohistologic diagnoses and echo pattern of lesions. Cancer 48(6): 1469-1477.

Secrest S, Britt L and Cook C 2011 Imaging diagnosis-bilateral orthotopic ureteroceles in a dog. Veterinary Radiology and Ultrasound 52(4): 448-450.

Sevelius E and Anderson M 1994 Serum protein electrophoresis as a prognostic marker of chronic liver disease in dogs. The Veterinary record 137(26): 663-667.

Sharma A, Kushwaha R B and Gupta A 2010 Perineal hernia in a dog involving multiple abdomino-pelvic organs. Intas Polivet 11(2): 341-343.

Sharma A, Thompson M S, Scrivani P V, Dykes N L, Yeager A E, Freer S R and Erb H N 2011 comparison of radiography and ultrasonography for diagnosing small-intestinal mechanical obstruction in vomiting dogs. Veterinary Radiology and Ultrasound 52(3): 248-255.

Singh P, Kumar P, Agnihotri D, Chandolia R K, Behl S M and Kumar K 2012 perineal swelling in dogs -ultrasonographic/radiological diagnosis and management. Intas Polivet 13(1): 117-119.

Singh U B and Sulochana 1997 A practical manual of histopathological and histochemical techniques. Kothari publications, Bombay, 12-101(pp).

Smith F O 2006 Canine pyometra. Theriogenology 66(3): 610-612.

Solter P F, Hoffmann W E, Chambers M D, Schaeffer D J and Kuhlenschmidt M S 1994 Hepatic total 3 alpha-hydroxy bile acids concentration and enzyme activities in prednisone-treated dogs. American journal of veterinary research 55(8): 1086-1092.

Sravanthi P, Sekhar E C, Raghavender K B P, Kumar D P and Kumar V G 2014 haemato-biochemical and imaging studies for diagnosis of urolithiasis in dogs. International journal of agricultural Sciences and veterinary medicine 2(3): 61-65.

Strombeck D R, Miller L M and Harrold D 1988 Effects of corticosteroid treatment on survival time in dogs with chronic hepatitis: 151 cases (1977-1985). Journal of the American Veterinary Medical Association 193(9): 1109-1113.

Swann H and Hughes D 2000 Diagnosis and management of peritonitis. Veterinary Clinics of North America: Small Animal Practice 30(3): 603-615.

Tantary H A, Soodan, J S, Chirag S, Ansari M M, Kumar S and Imtiyaz T 2014 Diagnostic studies in dogs with hepatic disorders. International Journal of Veterinary Science 3(4): 210-215.

Tantary H A, Soodan J S and Chirag S 2013 diagnosis and therapeutic studies in ascites in dogs. Veterinary Research 6(5-6): 111-114.

Taylor A J, Lara-Garcia A and Benigni L 2014 Ultrasonographic characteristics of canine renal lymphoma. Veterinary Radiology and Ultrasound 55(4): 441-446.

Tiwari P, Varshney J and Hoque M 2005 Significance of biliary sludge in dogs with hepatobiliary diseases. Indian veterinary journal 82(5): 533-534.

Tomar S S, Mehta H and Nema S P 2011 Ultrasonographical and haematobiochemical evaluation of cholecystitis in dogs. Indian Journal of Field Veterinarians 6(3).

Upadhye S V, Dhakate M S and Kamble M 2010 Surgical management of intussusception in a dog. Intas Polivet 11(2): 317-318.

Valocky I G O R and Mojzisova J 2006 Glandular cystic hyperplasia of endometrium/pyometra complex. Medycyna Weterynaryjna 62(4): 363-365.

Varshney J P, Deshmukh V V and Chaudhary P S 2010 Acute prostatitis in German shepherds-a report of two cases. Intas Polivet 11(1): 90-93.

Varshney J P and Hoque M 2002 Clinico-pathological and ultrasonographic observations in canine hepatopathies. Indian journal of animal sciences 72(6): 423-427.

Vijayakumar G 2002 Therapeutic Management of Ascites in dogs. Intas polivet 3(11): 179-184.

Vijayanand V and Nagarajan B 2007 Ultrasonographic diagnosis of cirrhosis in a dog. North-East Veterinarian 7(2).

Watson A T, Penninck D, Knoll J S, Keating J H and Sutherland-smith J A M E S 2011 safety and correlation of test results of combined ultrasound-guided fine-needle aspiration and needle core biopsy of the canine spleen. Veterinary Radiology and Ultrasound 52(3): 317-322.