RADIOGRAPHIC EVALUATION OF PYOMETRA AND ITS SURGICAL MANAGEMENT IN DOGS

By
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Thesis submitted in partial fulfilment of the requirement for the degree of

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DECLARATION

I, hereby declare that this thesis entitled **"RADIOGRAPHIC EVALUATION OF PYOMETRA AND ITS SURGICAL MANAGEMENT IN DOGS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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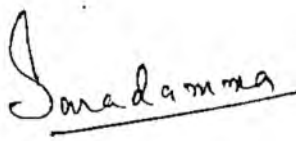
CERTIFICATE

Certified that this thesis entitled **"RADIOGRAPHIC EVALUATION OF PYOMETRA AND ITS SURGICAL MANAGEMENT IN DOGS"** is a record of research work done independently by **K.D. John Martin** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship of associateship to him.



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K.D. JOHN MARTIN

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INTRODUCTION

1. INTRODUCTION

Pyometra in dogs is an acute or chronic polysystemic metoestral disease with a complex etiology and pathogenesis. Incidence of pyometra, as stated in a few reports, was counted to five to 12% in certain selected canine communities; but those did not gave an exact representation of the general dog population. Generally pyometra is considered as a disease of female dogs of middle age or above and those which were not used to breed or not conceived on mating. But nowadays the age of affection was reported to be variable due to the extensive use of steroid hormones for managing mismating and for induction of abortion (Feldman and Nelson, 1996). Usually the expression of pyometra follows an oestrus. There are reports about the breed-wise incidence of this disease (Niskanen and Thrusfield, 1998, Egenvall *et al,* 2001); but it often depended on the geographical distribution of the breed. The etiology and pathogenesis of pyometra still remain obscure even after conducting several researches.

Clinically pyometra is a disease that demand aggressive surgical and medical management. In many occasions failure in early identification and addressing the condition ends up in the death of a most fondled pet or in the termination of the breeding life of a valuable producer of high pedigree. Cases delayed in diagnosis and treatments were found to suffer from serious renal and hepatic impairments.

Traditionally plain abdominal radiography and haematological studies were used for the confirmation of canine pyometra. Only a very few attempts were made for the hysterographic establishment of diagnosis of pyometra (Cobb, 1959, Cobb and Archibald, 1959, Funkquist *et al.,* 1985 and Lagerstedt , ... 1993a). It may be because, the uterine cannulation demands technical skill and special instrumentation owing to the anatomical peculiarities of vagina and cervix of the canine female compared to other species (Johnston *et al.,* 2001).

Similarly, only a few clinicians had shown courage to go off the road in the management of pyometra than following the conventionally established treatment,

ovariohysterectomy, which put an abrupt end to the breeding a valuable female dog. Marsupialization was once used to drain the contents of the uterus. A few others surgically or non-surgically catheterised the uterus to reduce the volume of the contents before its surgical extirpation (Cobb, 1959 and Meyers-Wallen *et al.,* 1986). Success was claimed in regaining the breedability in a few cases by draining the uterus through transcervically placed indwelling catheters by yet another team of researchers (Funkquist *et al.,* 1983 and Lagerstedt *et al.,* 1987). These attempts also demanded skill and specialized instrumentation and also had the risk of penetration and recurrence.

As the prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) became popular, several trials were reported stating the treatment of canine pyometra with that drug. Many compounds like dinoprost and cloprostenol and different dose rates ranging from 20 µg to 1000 µg /kg body weight were attempted with mixed outcome (Nelson *et al.,* 1982, Arnold *et al.,* 1988 and Gilbert *et al.,* 1989). Ability of $PGF_{2\alpha}$ to induce luteolysis, cervical relaxation and myometrial contraction was utilized despite the risk of uterine rupture and other side effects. Anyhow, $PGF_{2\alpha}$ therapy is now recommended as a viable alternative to ovariohysterectomy in young breeding dogs and to reduce the toxic load on the animal's system before exposing it to the surgical stress (Feldman and Nelson, 1996) Antiprogestins were also used alone or in combination with $PGF_{2\alpha}$ to medically manage pyometra.

But reports regarding the combination of beneficial effects of uterine drainage through transcervically placed indwelling catheters and $PGF_{2\alpha}$ therapy could not be traced from the literature reviewed.

Hence the present work was undertaken to identify a radiographic technique for diagnosis of pyometra in dogs; to compare the efficacy of transcervical drainage with and without $PGF_{2\alpha}$ therapy to ovariohysterectomy in salvaging the affected dog and to assess the efficacy of transcervical drainage in regaining the breedability in dogs affected with pyometra.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. PYOMETRA – INCIDENCE

2.1.1. Breed

Jackson (1979) reported a case of pyometra in a Labrador bitch

In a study of pyometra, Nelson *et al.* (1982) reported involvement of 15 different breeds among 17 bitches.

Lagerstedt *et al.* (1987) reported three cases of pyometra involving Pointer, Reisenschnauzer and Leonberger.

Out of 40 bitches selected for treatment of pyometra by Gilbert *et al.* (1989) 21 were of various breeds and seven mixed breeds.

Sen (1998) reported the incidence of pyometra in breeds like Spitz, Lhaza Apso, non-descript, Cocker Spaniel, Dachshund and Dobermann Pinscher in descending order.

Modestly increased risk of pyometra was reported in nine breeds *viz.*, Golden Retriever, Miniature Schnauzer, Irish Terrier, rough Saint Bernard, Leonberger, Airedale Terrier, Cavalier King Charles Spaniel, Rough Collie and Rottweiler. The risk was strongly low with mongrel dogs. (Niskanen and Thrusfield, 1998).

According to Egenvall *et al.* (2001) the occurrence of pyometra differed with age, breed and geographic location. The risk of developing pyometra was reported more in rough Collie, Rottweiler, St. Bernard, Cavalier King Charles Spaniel, Golden Retriever, Bernese Mountain Dog and English Cocker Spaniel. Breeds with low risk were Drevers, German Shepherd Dog, Dachshund and Swedish Hound.

Roy (2002) reported pyometra in 20 bitches of different breeds *viz.*, Spitz (10), German Shepherd Dog (6), Dobermann Pinscher (2), Boxer (4) and Labrador (1)

Smith (2006) observed an increased risk of pyometra in certain breeds viz. Golden. Retriever, Miniature Schnauzer, Irish Terrier, Saint Bernard, Airedale Terrier, Cavalier King Charles spaniel, Rough Collie Rottweiler and Bermise Mountain Dogs. A familial tendency for increased risk of early development of pyometra was observed in Chow Chow and English setter.

2.1.2 Age

Dow (1957) reported that the average age was 8.2 years with a range of three to 15 years for those 100 dogs affected with cystic hyperplasia-pyometra complex. Of these only 12% were under the age of 6 years

Jackson (1979) reported a case of pyometra, in a seven-year-old bitch.

Nelson *et al.* (1982) observed that the age of the 17 bitches affected with pyometra ranged from 8 months to 12 years.

Lagerstedt *et al.* (1987) reported three cases of pyometra in dogs aged eight years, 11 months and one year.

According to Stone *et al.* (1988) the mean age of 27 dogs affected with pyometra was 6.4 ± 3.6 years with a range of 6 months to 12 years. A study of case records of 100 other dogs with pyometra had shown the mean age of affection as 8.7 ± 3 years with a range of 4 months to 16 years.

Gilbert *et al.* (1989) reported that the age of the 40 dogs with pyometra studied varied from 0.75 years to 14 years with a mean of 3.19 years.

The mean age of 103 bitches affected with pyometra was 7.0 year with a range of one to 14 years (Sevelius *et al.*, 1990).

According to Feldman and Nelson (1996), though pyometra was traditionally described as disorder of middle aged dogs, indiscriminate use of oestrogens for mismating had brought down the age to a mean of 2.1 years.

As reported by Sen (1998) the age of bitches affected with pyometra ranged from six to 13 years.

Niskanen and Thrusfield (1998) reported the mean age of the dogs with pyometra as 8.5 years with a range of one to 18 years.

According to Dhaliwal *et al.* (1998) the mean age of 34 bitches with pyometra was 8.4 ± 2.8 year (range one to 14 years).

Dhaliwal *et al.* (1999) observed that the mean age of 13 bitches affected with pyometra was 8.8 years (range one to 14 years).

Occurrence of pyometra in dogs aged less than 10 years was studied in Sweden among an insurance database involving 2,00,000 dogs for two years. An average of 23-24% of bitches of the database might have experienced pyometra by 10 years of age (Egenvall *et al.*, 2001).

As per the report of Roy (2002), 20 bitches with pyometra were aged between six and 10 years.

Smith (2006) reported incidence of pyometra in 15.2% of bitches at an average age of 9.36 ± 0.35 years in a group of colony raised Beagles.

2.1.3. Parity

As reported by Dow (1957) out of 100 dogs with cystic hyperplasia- pyometra complex only 27% of bitches had whelped and only seven percentage were multiparous.

Lagerstedt *et al.* (1987) in a report of three cases of pyometra stated that one was whelped twice and the other two were nulliparous. All theses dogs had the history of mating in the previous oestrus.

Gilbert *et al.* (1989) reported that out of 40 bitches with pyometra, 19 bitches were nulliparous, seven bitches whelped 1-3 litters and the remaining 14 bitches had an unknown breeding history.

Thirteen out of 83 dogs with pyometra had whelped before as per the report of Sevelius *et al.*, (1990).

Sen (1998) reported that eight out of 12 bitches with pyometra studied were multiparous.

Niskanen and Thrusfield (1998) observed that out of 935 dogs affected with pyometra, 925 were nulliparous and 10 were either primiparous or multiparous. The increased risk of getting pyometra for nulliparous bitches to primiparous/multiparous was to the level of 95%.

Dhaliwal *et al.* (1998) reported that among 34 bitches with pyometra, the exception of two bitches that had whelped at least three years before, all were nulliparous.

2.1.4. Occurrence of Last Oestrus

All the 100 cases with cystic hyperplasia-pyometra complex were reported in luteal phase of the oestrus cycle *i.e.,* 5 to 80 days after oestrus with an average of 30 ± 14 days. Among them irregularities of oestrus cycle were reported in 33% and phantom pregnancy in 15%. (Dow, 1957)

As per the report of Jackson (1979) on pyometra in one bitch, it was developed two weeks after the last oestrus.

According to Nelson *et al.* (1982) eleven out of 17 bitches with pyometra had the history of purulent or bloody uterine discharge four to six weeks after standing oestrus, three experienced oestrus approximately one month prior to development of clinical signs and remaining began to exhibit clinical signs 10 weeks after standing oestrus.

Expression of pyometra was reported in three cases at one week, one month and at three months after the expression of oestrus. (Lagerstedt *et al.*, 1987).

According to Gilbert *et al.* (1989) out of 40 bitches with pyometra twenty nine had a history of oestrus within the preceding two months.

Thirty six dogs out of 83 with pyometra had been in heat eight weeks or less prior to onset of symptoms of pyometra. (Sevelius *et al.*, 1990).

Pyometra usually develop during the progesterone dominant dioestrus *i.e.,* about four to eight weeks after standing heat. But as the syndrome progress slowly, by the time the clinical signs become evident, the ovarian cycle of the bitch might have continued into anoestrus. (Feldman and Nelson, 1996)

Sen (1998) reported expression of symptoms of pyometra six to eight weeks after the last oestrus in 12 bitches.

According to Dhaliwal *et al.* (1999) in 10 of 13 bitches with pyometra, the mean interval from onset of pro-oestrus to ovariohysterectomy was 10.4 weeks (range one to

28 weeks). As per the hormonal estimations, 10 of the bitches were in mid or late metoestrus and three were apparently in anoestrus when they were sampled.

According to Smith (2006) the incidence of pyometra was often reported from 4 weeks to 4 months after the last oestrus.

2.2. CLINICAL SIGNS

In a study involving 100 bitches affected with cystic hyperplasia-pyometra complex, Dow (1957) categorized the bitches into four groups on histological basis. Group I bitches which developed cystic glandular hyperplasia without any inflammatory changes, showed scanty to moderate mucoid vulval discharge without any systemic upset. Group II animals with cystic glandular hyperplasia and stromal infiltration of plasma cells discharged variable amount of glairy mucoid fluid. Only few of these animals showed anorexia, malaise and referable abdominal distension. Group III bitches with acute endometritis with cystic hyperplasia, had shown variable degree of vaginal discharge for variable periods, listlessness, anorexia, increased thirst, vomiting, abdominal distension, and abdominal tenseness. Diarrhoea was seen in few animals. Rectal temperature was normal in most of the animals. Uterine contents varied in colour from yellow to green; but it was often reddish brown with blood. Viscosity varied with the haemorrhage. Uterine horns were uniformly distended but often they exhibited a number of annular constrictions producing a series of irregular ampullae. In Group IV animals with chronic endometritis and open cervix only discharge and inappettance were evident. Those with closed cervix were seriously ill with frequent vomiting, increased thirst, and prostration. Skin was dry and inelastic with areas of alopacia on flanks, abdomen and perineal region. Uterine wall was papery thin in these animals. Vulval oedema was a frequent sign in all the groups.

Jackson (1979) reported a case of pyometra with slight purulent vaginal discharge, dullness, listlessness, body temperature 39.4°C, off feed for 5 days and drinking excessively.

Nelson *et al.* (1982) reported vulval discharge, lethargy/depression, inappettance, polyurea, polydipsia, and vomiting in 17 bitches affected with open or closed cervix pyometra. Only one dog had febrile (41°C) responses, and one had mild posterior paresis. Enlarged uterus was palpable in 12 bitches.

Stone *et al.* (1988) in a study of 27 bitches affected with pyometra found that 70% had the history of diarrhoea, vomiting, anorexia and/or lethargy.

In a study involving 40 bitches with pyometra, Gilbert *et al.* (1989) reported that 39 of them had purulent vaginal discharge, lethargy and anorexia in 26, palpable uterine enlargement in 11 and polydipsia and/or polyurea in two.

Sevelius *et al.* (1990) in a study involving 103 bitches with pyometra (83) or endometritis (20) vaginal discharge was observed in 80% cases of pyometra and 50% cases of endometritis. Although polydipsia was considered as a common sign, one third of pyometra cases lacked it. General appearance was normal in 16% of pyometra cases, and the remaining had shown varying degrees of depression. Elevated body temperature was seen only in 16% of pyometra cases.

Memon and Mickelsen (1993) reported a case of closed cervix pyometra with anorexia, weight loss, lethargy, polydipsia but no polyurea, few times vomiting and body temperature raised upto 39.6°C. The dog had shown signs of depression and pain, resistance to abdominal palpation. On abdominal palpation a firm tubular mass was received.

Ayyappan *et al.* (1995) described a case of pyometra in a bitch, which had shown the symptoms like depression, inappettance, emesis, purulent vaginal discharge, subnormal rectal temperature (97.6°F), congested visible mucous membrane, and elevated pulse (168/min). Vaginal mucosa was hyperaemic, swollen and tinged with thick purulent discharge. Abdomen was pear shaped and changed position when palpated. The dog had the history of non-mating and psuedopregnancy.

Feldman and Nelson (1996) narrated the symptoms of pyometra as lethargy, depression, inappettance/anorexia, fever, polyurea, polydipsia, vomiting and diarrhoea.

Sanguineous to mucopurelent vaginal discharge was obvious in bitches with open cervix pyometra. Uterine enlargement on palpation would be evident.

Sen (1998) reported serosanguineous or mucopurulent vulval discharge, occasional or regular vomiting, poor appetite, listlessness, polydipsia and polyurea and elevation of body temperature by 1 to 2 °F followed by normal or subnormal temperature.

According to Dhaliwal *et al.* (1998) in 34 bitches affected with pyometra, 30 bitches (88.2%) had vulval discharge and four had no vulval discharge indicative of closed cervix.

Heiene *et al.* (2001) reported a body temperature of 39.3 ± 0.6°C in 55 dogs affected with pyometra.

Roy (2002) in a report on the treatment of pyometra in 20 bitches, narrated the symptoms as lethargy, depression, inappettance, polyurea, dehydration, occasional vomiting, elevated body temperature in majority of the patients and vaginal discharge of thin consistency with light chocolate brown colour and bad odour. The vulva was generally enlarged.

Out of the 15 bitches affected with pyometra Zaragoza *et al.* (2004) noticed anorexia and lethargy in 13 dogs (86%), weight loss in 7 (46%), fever in 8 (53%) dehydration in 4 (26%) to the tune of 5% and in one to the tune of 7%, vomiting in 5 (33%), diarrhoea in 3 (20%) and polyurea and polydipsia in 13 (86%). Mucous membrane was congested in three, pale in three and normal in the rest. Four dogs had serosanguineous, four had purulent, two had mucopurulent vaginal discharge and five dogs were not showing any vaginal discharge at all.

Smith (2006) summed up the symptoms of pyometra as inappettance, depression, polydipsia, lethargy and abdominal distention with or without vaginal discharge. Vaginal discharge, if present, was purulent, sanguineopurulent, mucoid or frankly haemorrhagic.

2.3. HAEMATOLOGICAL PARAMETERS IN PYOMETRA

Dow (1957) evaluated the haemogram and histopathology of uterus in 100 bitches affected with cystic hyperplasia-pyometra complex and grouped them. According to him the Group I bitches were with cystic glandular hyperplasia with no inflammatory changes and Group II bitches with cystic glandular hyperplasia and plasma cell infiltration of stroma showed normal haemogram a mild, leucocytosis in few cases (12,000 to 15,000 cells/cu mm). But group III bitches with acute inflammatory reaction and cystic hyperplasia showed severe leucocytosis ranged from 19,000 to 1,45,000 with severe neutrophilia of which upto 35% in immature forms. Erythrocyte sedimentation rate (ESR) was between 10 and 55 mm per hour. Plasma urea level was 33 ± 9 mg per 100 ml, with a range of 21 to 119 mg. In bitches of group IV affected with chronic endometritis total leucocyte count ranged from 16,000 to 21,000 cells per cu mm in those with open cervix and from 31,000 to 68,000 cells per cubic millimeter in those with closed cervix. Neutrophils were the predominant cells. ESR ranged from 8 to 40 mm per hour. Anemia was not evident in any of those cases.

According to Schalm *et al.* (2000), normal values of various haematological parameters are as total leucocyte count 6 to $18x10^3$ cells/cmm (average 11 x 10^3), differential count may be as neutrophils 60-77% (av. 70%), band cells 0-3% (av. 0.8%), lymphocytes 12-30% (av.20%), monocytes 3-10% (av. 5.2%) eosinophils 2-10% (av. 4.0%) and basophils rare. Haemoglobin concentration will be between 12 and 18 g/dl (av. 14.9 g/dl) and packed cell volume 37-55 v% (av. 45.54%).

Out of 40 cases of pyometra studied, Renton *et al.* (1971) reported 90% of the animals had leucocytosis. The total leucocyte count was slightly high among 11 closed pyometra cases (mean 36,600 cells/cmm; range 16,000-54000/cmm) than 29 open pyometra cases (mean 32,500/cmm; range 8,000 to 79,000 cells/c mm). Among

the open pyometra cases four had normal leucocyte count, which were reported to have vaginal discharge for several weeks.

According to Benjamin (1978) the normal haematological parameters in dog like haemoglobin concentration would be 12-18 g/dl (av. 15 g/dl), erythrocyte sedimentation rate (Wintrobe method) 5.25 mm/ one hour and packed cell volume (microhaematocrit method) 37-55% (av. 45%). The total leucocyte count was designated as moderate leucocytosis when it is between 18 and 30 $x10^3$ cells/cmm, 30-50 x 10^3 as marked and 50-100 x 10^3 as extreme. Serum alanine amino- transferase concentration ranged from 4.8 to 24 IU/L; blood urea nitrogen 10-30 mg/dl and creatinine 1-2 mg/dl. According to him in canine pyometra severe leucocytosis to a range of 20,000 to 1,00,000 cells/µl with an average of 50,000/µl was seen. There would be marked neturophilia with shift to left. ESR generally increased in pyometra while PCV usually found within normal levels or some times lower due to a non-regenerative anaemia.

In a report by Jackson (1979) a bitch with pyometra had a leucocyte count of 39.6 x 10^3/cmm.

Nelson *et al.* (1982) reported mean leucocyte count in 17 bitches with pyometra as 21.48 x 10^3 cells /mm^3 (range 9.7 to 43.5 x 10^3 cells/mm^3) with 72.4% neutrophils.

Meyers-Wallen *et al.* (1986) evaluated the haemogram of 10 bitches affected with open pyometra and reported average packed cell volume 36.1% with range of 31 to 43% and average total leucocyte count 28.9 x 10^3/mm^3 with a range of 13.2 to 43.1 x 10^3/mm^3.

In a group of 112 dogs with pyometra 35 dogs (31%) showed normal blood cell picture, 64 dog (57%) non-regenerative normocytic, normochromic anaemia and 13 dogs (12%) non-regenerative microcytic hypochromic anaemia with regard to various erythrocyte indices. Pronounced leucocytosis with neutrophilia and shift to left with monocytosis also was noted with these animals. In pyometra anaemia was found positively correlated with the degree of leucocytosis (above 5.1 x 10^3/mm^3)

neutrophilia, left shift, and monocytosis. This could be due to bone marrow suppression as a result of chronic inflammation and endotoxaemia, loss of erythrocytes in the pus by diapedisis or by shortened life of the circulating erythrocytes associated with iron deficiency. (De Schepper *et al*, 1987a).

De Schepper *et al.* (1987b) reported that total leucocyte count was higher than 40 x 10^9/l in 53 out of 96 bitches with cystic hyperplasia-pyometra complex. The changed values returned either temporarily to normal after PG $F_2\alpha$ treatment or definitely after ovariohysterectomy.

According to Brec *et al.* (1988) the degree of uterine distension was significantly correlated with the number of leucocyte and serum hepatoglobulin concentration. This correlation suggested a relation between the degree of uterine distension, amount of pus, degree of uterine inflammation and general inflammatory and stress reaction.

Arnold *et al.* (1988) estimated the total leucocyte count in 10 bitches affected with pyometra subjected to treatment with PGF2α. Moderate reduction in total leucocyte count was noticed at the end of the treatment, which returned to normal range one month after treatment.

Stone *et al.* (1988) in 27 bitches affected with pyometra estimated the mean leucocyte count as 35,073 ± 20,700 cells/mm^3 (range 10,700 to 94,000 cells/mm^3). All dogs with leucocyte count above 50,000 cells/mm^3 were above 7 years of age. The mean PCV was 38 ± 6% (range 21 to 48%). The mean RBC count was 5.5 ± 0.86 x 10^6 cells/mm^3 (range 4 to 7.3 x 10^6 cells/mm^3) 26 to 35% of dogs were considered anaemic according to PCV and total RBC counts. The mean platelet count was 1,59,070 ± 86,940 cells/mm^3 (range 26,700 to 3,30,000 cells/mm^3).

According to Willard *et al.* (1989) the normal reference values for total leucocyte count was 6.02 to 16.02 x 103/µl, haemoglobin concentration 14.1-20.0 g/dl, packed cell volume 43.3-59.3%. According to them leucogram in dog with pyometra

was variable, although leucocytosis with left shift was most often present. Profound leucocytosis upto 1,00-2,00 x 10^3/mm3 with left shift was seen in animals with closed pyometra, leucopoenia with degenerative left shift was found in animals with severe sepsis due to pyometra.

In a study involving 40 bitches with pyometra, Gilbert *et al.* (1989) reported leucocytosis, neutrophilia and/or a shift to the left in 30.

According to Sevelius *et al.* (1990) among 103 bitches with pyometra or endometritis 49% showed normal leukocyte count (85% in pyometra and 40% in endometritis). Total leucocyte count was above 30,000/µl in 29 cases, all belonging to pyometra group. Among 50 of pyometra group 28% showed normal leucocyte count and differential count, 24% showed elevated leucocyte count with shift to left, 36% developed leucocytosis with normal differential count, and normal leucocyte count with left shift in 12% cases, mild to moderate anaemia (PCV >40%) in 55% cases (60% in pyometra group and 36% in endometritis group). Nineteen percentage of pyometra group was anaemic with PCV less than 30%. The authors opined that most of the classic signs of pyometra like leucocytosis with left shift and anaemia, were not evident in this study.

Memon and Mickelsen (1993) reported a case of closed cervix pyometra and the haemogram on the first day of observation was as follows: total leucocyte count 39.9 x 10^3 cells/mm^3, total RBC count 5.71 x 10^8 cells/mm^3, PCV 40%, haemoglobin 14.1 g/dl, Neutrophils 75%, Band cells 3%, Lymphocytes 8%, Monocytes 13%, Eosinophils 1% and Platelets 1,80,000 cells/mm^3.

A study conducted by Gandotra *et al.* (1994) in 24 bitches affected with pyometra revealed that there was considerable increase in the total leukocyte count (17,000 – 38,000 cells/mm^3) with marked neutrophilia (76.36 ± 1.45%) and lymphocytes (22.15 ± 1.77%), monocytes (2.26 ± 0.40%) and eosinophils (0.57 ± 0.06%) all within normal range. Neutrophilia was more in bitches with closed pyometra (86.25 ± 0.46%). There was slight decrease in haemoglobin concentration (10.95 ± 0.37%).

Jayathangaraj *et al.* (1994) reported mild anaemia with PCV 19% and total leukocytic count 48,000/cmm in a bitch diagnosed as a case of pyometra.

A case of an eight-year-old crossbred bitch, which on exploratory laparotomy, found to have pyometra with uterine rupture was reported. The haemogram of that dog exhibited total erythrocyte count 4.15 million/c mm, total leucocyte count 48,225/c mm, ESR 31mm/hr, PCV 24%, and haemoglobin 5.6 g%. Differential count was as neutrophils 59%, band cells 31%, lymphocytes 8% and eosinophils 2% (Ayyappan *et al.*, 1995).

According to Feldman and Nelson (1996) the total leucocyte count in pyometra was variable. The percentage of bitches with increased white blood cell counts were found more among bitches with closed-cervix pyometra. Neutrophilia with shift to left was a common finding. The TLC had shown an initial increase after ovariohysterectomy and then rapid reduction to normal values.

Increased leucocyte count with neutrophilia was reported in six bitches with glandular cystic hyperplasia–pyometra complex. Phagocytic activity of neutrophils and immunoglobulin concentration were significantly reduced in all dogs. All these parameters were gradually returned to normal after ovariohysterectomy (Mojzisova and Valocky, 2000).

A study conducted in 20 bitches with pyometra by Ki *et al.* (2000) revealed that 65% of the affected bitches had increased leucocyte count, but erythrocyte count and PCV remained with normal limits.

Rekha *et al.* (2000) reported that the total leucocyte count (TLC) and neutrophil count were significantly higher in bitches with pyometra (25 nos.) compared with healthy controls. Ovariohysterectomy caused a significant decrease in TLC and neutrophil count and a significant increase in phagocytic index.

Heiene *et al.* (2001) following a study in 55 dogs with pyometra reported leucocyte counts of $22.6 \pm 13.5 \times 10^3$ litre^{-1}.

Faldyna *et al.* (2001) studied the function of the immune system in 34 bitches affected by pyometra. Based on history and severity of clinical signs they were divided into three groups. The different cell counts in Groups A, B and C respectively were as total leucocytes 14.6 ± 6.5, 18.1 ± 10.0 and 23.3 ± 10.1 x 10^3/cmm; lymphocytes 2.7 ± 1.7, 2.0 ± 1.0 and 2.2 ± 1.1 x 10^3 cells/c mm; neutrophils 10.6 ± 4.3 14.8 ± 8.8 and 19.2 ± 8.6 x 10^3 cells/c mm; monocytes 0.9 ± 1.3, 1.0 ± 0.8 and 1.5 ± 0.8 x 10^3 cells/c mm and eosinophils 0.4 ± 0.4, 0.3 ± 0.2 and 0.4 ± 0.6 x 10^3 cells/c mm. The most marked change noticed was leucocytosis and lymphopenia, which was directly proportional to the severity of the disease.

Zaragoza *et al.* (2004) reported haematological parameters in bitches affected with pyometra as follows: Mean Total RBC Count 5.41 x 10^6 µl (range 3.93 to 6.55 x 10^6 µl); mean PCV 36.94% (range 28.4 to 48%) and mean leucocyte count 28.16 x 10^3/µl (range 89 to 4.97 x 10^3/µl).

2.4. SERUM BIOCHEMICAL PARAMETERS AND EXTRA-GENITAL LESIONS IN PYOMETRA

According to Renton *et al.* (1971) out of 40 bitches, 28 (70%) had normal levels of blood urea when first seen, in which the outcome of treatment with ovariohysterectomy was favourable. Eight dogs with open pyometra and four dogs with closed pyometra had shown high blood urea nitrogen (BUN) values and among that category death rates were more. In 36 cases the blood urea levels rapidly returned to normal after ovariohysterectomy but in four cases BUN continued to rise even after ovariohysterectomy and supportive therapy and died.

Jackson (1979) reported a case of pyometra, which had blood urea concentration of 2.6 n mol/litre and blood sugar 3.1 n mol/litre.

Results on haemoglobin, PCV, serum proteins, blood urea nitrogen, creatinine, cholesterol, bilirubin and some serum enzymes in bitches with clinical pyometra were

compared with the degree of polydipsia, anorexia and dehydration in some patients and their plasma progesterone levels. The findings indicate that pyometra syndrome includes a liver derangement i.e., cholestasis, in addition to changes in bone marrow activity and renal function. Autopsic results also indicate the presence of an endotoxic influence upon lung function (Borresen, 1980)*.

Nelson *et al.* (1982) reported moderately high alanine aminotransferase activity (540 units/L) and alkaline phosphatase activity (550 units/L) in one bitch and hypergamma globulinemia in seven out of 17 bitches affected with pyometra.

Borresen (1984) stated that bitches with pyometra showed moderate electrolyte disturbances and a mild to severe renal dysfunction.

Meyers-Wallen *et al.* (1986) evaluated the serum biochemistry of 10 bitches affected with open pyometra and reported average plasma solids 8.5 g/dl with a range of 7.8 to 10.0 g/dl, average BUN 12.3 mg/dl with a range of 7 to 22 mg/dl and average serum creatinine 0.89 mg/dl with a range of 0.4 to 1.0 mg/dl.

Colombo *et al.* (1986) reported that, leukocyte count, γ-glutamyl transferase(γ-GT), blood urea, creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (ALP) and alkaline phosphosphatase (AP) values were greatly increased in conditions like pyometra with acute endometritis and pyometra with chronic endometritis and closed cervix. But these values were found normal or slightly raised in cases of initial endometrial hyperplasia and pyometra with chronic endometritis and open cervix.

De Cock *et al.* (1987) reported renal failure in 24 out of 131 bitches with pyometra.

De Schepper *et al.* (1987a) postulated the possibility of bone marrow depression as a result of chronic inflammation and endotoxaemia in pyometra.

In 96 bitches with cystic hyperplasia-pyometra complex there was very significant increase of aspartate aminotransferase (AST), decrease of alanine

aminotransferase (ALT) and increased AST/ALT ratio. The changes were more pronounced in 62 clinically ill bitches with typically endometritis post-oestrum. The changed values returned either temporarily to normal after PG $F_2\alpha$ treatment or definitely after ovariohysterectomy (De Schepper *et al.*, 1987b).

According to Brec *et al.* (1988) in pyometra renal failure was more frequently observed in bitches with a greatly enlarged uterus, than with normal or slightly enlarged uterus.

Stone *et al.* (1988) evaluated the serum biochemical status and histopathological changes in 27 bitches affected with pyometra to assess their renal function. Serum decreased albumin levels and elevated globulin levels were correlated with the leucocytosis and inflammatory condition of uterus. The mean serum potassium value was 4.2 ± 0.6 mEq/L that was within normal limits. The mean serum calcium, glucose values were within normal range. The mean ALP values were 178.7 ± 163.5 IU/L and 36% of the dogs were considered to have increased ALP levels. But an exact correlation could not be made between increased ALP value and pyometra. The mean creatinine value was 1.1 ± 0.9 mg/dl (range 0.4 to 4.2 mg/dl) and the mean Serum Urea Nitrogen (SUN) was 20.4 ± 20.5 mg/dl (range 6 to 61 mg/dl). The mean 24 hour protein excretion did not indicate protein urea. A reduction upto 30% in glomerular filteration rate (GFR) was noticed in 75% of bitches with pyometra indicating some factor associated with pyometra that decreases renal perfusion, which was a functional abnormality and not correlated with structural damage. The mean urine specific gravity was decreased which can be attributed to the inability to concentrate urine. By light microscopy of renal biopsy samples, 20 dogs were having some degree of tubulointerstitial nephritis; 11 dogs had glomerular lesions, two had severe glomerulitis and tubulointerstitial nephritis. Using electron microscopy numerous lesions were noticed in glomeruli of all dogs. They concluded that renal dysfunction without associated morphologic abnormalities developed frequently in dogs with pyometra.

According to Willard *et al.* (1989) in dogs, the normal range of alanine aminotransferase, blood urea nitrogen, serum creatinine and serum potassium values were 0 to 90 IU/L, 7 to 32 mg/dl, 0.5 to 1.4 mg/dl and 3.9 to 5.5 mmol/L respectively.

Considering the values of certain urine and serum constituents as the criteria for renal function, 75 bitches with pyometra were categorized into four groups. Group 1 constituted of 21 bitches, with no indications renal disease (normal urinary levels of γ-glutamyl transferase and protein). They presented a median value of serum creatinin 85 µmol/lit (range 67-129 µmol/lit) and urea 5.0 mmol/lit (2.7 to 12.0 mmol/lit). Group 2 constituted of 17 bitches with signs of glomerular damage (normal urinary γ-GT and increased protein) had median serum creatinine as 85 µmol/lit (66 to 273 µmol/lit) and urea 4.5 mmol/lit (1.7 to 23.3 mmol/lit). Group 3a with 21 bitches which had signs of glomerular and tubular lesions with no signs of renal failure increased urinary γ-GT and protein with normal values of urea and creatinine) presented a median serum creatinine 104 µmol/lit (56 to 144 µmol/lit) and urea 3.8 mmol/lit (2.0 to 7.6 mmol/lit). Animals in Group 3b represented by 16 bitches with glomerular and tubular lesions with signs of renal failure (increased urinary γ-GT and protein with increased serum levels of urea and creatinine) had a median serum creatinine 210 µmol/lit (104 to 70 µmol/lit) and urea 17.3 mmol/lit (6.5 to 93.0 mmol/lit). The authors concluded that, in bitches with pyometra, the usual sequence of events as to renal function can be described as: (1) pyometra → proteinurea → γ-GT -uria → uraemia or (2) pyometra → no renal disease → glomerular dysfunction → proximal tubular disease → renal failure (De Schepper *et al.*, 1989).

According to Sevelius *et al.* (1990) among 103 bitches with pyometra or endometritis total ALP activity raised above 5 µKat/L in 43% in pyometra and 15% in endometritis groups. It was above 10 µKat/L in 14% of pyometra group. The BUN and blood sugar was elevated in two cases from each group and serum ALT levels elevated in seven. Out of four liver biopsy specimen taken, all showed fatty liver degeneration. Mild proteinurea was noticed in 12% cases. The authors opined that

most of the classic signs of pyometra like serum ALT elevation and renal dysfunction were not evident in this study.

Jayathangaraj *et al.* (1994) presented a case report of a six-year-old female Dachshund, which exhibited uniform non-inflammatory limb oedema, exercise intolerance and dry cough and left atrial enlargement as per the electrocardiogram. Biochemical evaluation revealed BUN 60 mg%, creatinine 3.2 mg% and total protein 8 gm%. The condition was diagnosed as congestive heart failure Grade II with mild bronchitis and nephritis and treated accordingly. Subsequently to apparent clinical improvement, the dog exhibited inappettance, moderate abdominal distension and mild vaginal discharge and was diagnosed as pyometra and underwent ovariohysterectomy. The author opined that pyometra is a polysystemic disease with a wide variety of clinical and pathological manifestations in both genital and extra genital organs.

A case of 8-year-old crossbred bitch, which on exploratory laparotomy, found to have pyometra with uterine rupture was reported. On biochemical analysis of serum, total protein was 8.4 gm/100 ml, albumin 3.40 g/100 ml, globulin 5 g/100 ml, blood urea nitrogen 67 mg/100 ml, and creatinine 2 mg/100 ml. ECG recordings were suggestive of myocarditis (Ayyappan *et al.*, 1995).

Mild to moderate increase in serum alanine aminotransferase and alkaline phosphatase was reported in pyometra as a result of hepatocellular damage caused by septicemia and/or diminished hepatic circulation and cellular hypoxia in dehydrated bitch. Interference with resorption of sodium and chloride and subsequent inability for resorption of water or injury caused by tubular deposition of circulating immune complexes were attributed to polyurea and resultant polydipsia in pyometra (Feldman and Nelson, 1996).

A study conducted in 20 bitches with pyometra by Ki *et al.* (2000) revealed that alanine aminotransferate (ALT) and alkaline phosphatase (AP) activities were increased in affected bitches. Blood urea nitrogen (BUN) and creatinine concentrations were increased in 10 (50%) and three (15%) bitches respectively. Bitches that had increased ALT and AP activities, BUN, creatinine and potassium concentration died after

ovariohysterectomy. It was concluded that the recovery of bitches with pyometra after ovariohysterectomy can be predicted using haematological and biochemical profile.

The urinary enzyme markers of renal damage, alkaline phosphatase, γ-glutamyl transferase and N-acetyl-β-glucosaminidase were studied in 55 dogs with pyometra. The elevated enzyme levels indicated severe morphological lesions in renal tubular cells and that decreased after ovariohysterectomy. Serum urea concentration was 5.1 ± 3.9 n mol litre^{-1}, and serum creatinine was 97.5 ± 35.8 μ mol litre^{-1} in those dogs. It indicated that pyometra could induce acute reversible lesions in renal tissue. (Heiene *et al.*, 2001).

Faldyna *et al.* (2001) studied the function of the immune system in 34 bitches affected by pyometra. The most marked change noticed was leucocytosis and lymphopenia, which was directly proportional to the severity of the disease. Average percentage of phagocytosing neutrophils and monocytes were low and their absolute counts were high. Inhibition of lymphocyte proliferation, functional inhibition of lymphocytes, suppressed activity of lymphocytes, higher levels of immunoglobulins, lysozymes and circulating immune complexes were evident. Glomerular or tubular deposition of the circulating immune complexes might be attributed to the renal function disturbances, polyurea and low urine specific gravity.It was concluded that pyometra is associated with an inflammatory response but also with a marked suppression of immune system activity.

According to Zaragoza *et al.* (2004) canine pyometra often characterized by glomerulonephritis by immune complex deposition in glomeruli. Proteinurea ranging from moderate to severe might be present secondary to renal failure. There were low molecular weight proteins like immunoglobulins were present in five dogs (26.6%) in the urine of bitches affected with pyometra, suggesting tubular injury. The bitches had mean BUN 38.64 mg/dl (17-80 mg/dl) and mean serum creatinine 1.3 mg/dl (0.9 – 2.3 mg/dl).

2.5. FORMOL GEL TEST

Christensen and Cole (1960) described the formol gel for tentative diagnois of pyometra. Into one milliliter serum a few drops of 40% formaldehyde was added and mixed thoroughly and left in room temperature. During the first one hour it was examined at every 10 minutes and then at hourly interval. A reaction was considered positive when serum formed a solid gel, which could not be broken by vigorous shaking. Honey like consistency considered doubtful whereas no coagulation indicated a negative reaction.

Ayyappan *et al.* (1992) conducted formol gel test in 12 bitches. Six dogs that gave positive results were later confirmed as cases of pyometra by radiography and laparotomy. Positive reaction was attributed to increase in globulin fractions in serum. Six other dogs gave negative or doubtful results.

2.6. PLASMA OESTRADIOL AND PROGESTERONE CONCENTRATIONS IN PYOMETRA

Hadley (1975) estimated the unconjugated oestrogen and progesterone concentrations in the blood 13 bitches with pyometra and reported that the concentrations of these hormones were within normal limits.

Chaffaux and Thibier (1978) estimated the peripheral plasma progesterone concentration in 35 bitches. All the bitches examined after 60 days post-oestrus had a low progesterone concentration (about 1 ng/ml). Among the 27 bitches observed before that time 22 had a high mean level (about 8 ng/ml) and five of them had low levels. Authors opined that (1) there was no evidence of an essentially high or prolonged progesterone secretion in pyometra. (2) luteolysis occurring normally about 60 days post-ovulation was not postponed by the disease and (3) in some animals, early luteolysis seems to occur. It was concluded that progesterone has no indispensable role in pyometra.

Austad *et al.* (1979) estimated peripheral plasma progesterone levels in the bitches with spontaneously developing pyometra and found that these values did not differ significantly from those in normally cycling or pregnant bitches. Macroscopic ovarian morphology also gave no indication of an increased corpus luteal activity and ovarian follicular cyst was noticed in four out of 31 cases.

Nelson *et al.* (1982) estimated plasma progesterone level in 17 bitches affected with open or closed pyometra. The mean value was 3.38 ng/ml with a wide range of 0.08 to 10.2 ng/ml and median 2.4 ng/ml. Plasma progesterone concentration 0.5 ng/ml or greater was indicative of luteal activity.

According to Meyers–Wallen *et al.* (1986) the mean progesterone levels in 10 bitches with open pyometra was 3.91 ng/ml. with a range of 0.6 to 23.2 ng/ml.

According to Chastian and Ganjam (1986) oestradiol in anoestrus or spayed bitches would be below 15 pg/ml and progesterone level in them would be less than 1 ng/ml.

Arnold *et al.* (1988) estimated the plasma progesterone concentrations in 10 bitches with pyometra, before and after treatment with prostaglandin F2α and the values ranged from 0.04 to 9.58 ng/ml and 0.40 to 4.22 ng/ml respectively.

According to Willard *et al.* (1989) oestradiol assays were not particularly found useful for evaluating dogs and cats because normal serum concentration in these species were at on below detectable level for assays. Therefore normal or abnormal conditions could not always be differentiated. Progesteron levels >2-5 mg/dl suggested luteal function and luteal function usually lasted for 65 days after oestrus, highest (>50 ng/dl) at mid luteal phase and lowest (<2 ng/dl) in non-luteal phase.

Vandeplassche *et al.* (1991) reported high levels of blood progesterone in 64 out of 81 cases of pyometra.

Renton *et al.* (1993) estimated plasma progesterone level in eight bitches affected with pyometra before treatment with prostoglandin $F_2\alpha$. Three of the bitches

had low concentration of plasma progesterone before treatment. All bitches had a basal progesterone concentration after treatment.

According to Feldman and Nelson (1996) the progesterone and oestrogen concentration in pyometra was dependant upon the stage of oestrus cycle. The plasma progesterone concentration in anoestrus was lesser than 0.5 ng/ml; below 1 ng/ml in proestrus; above 2 ng/ml in oestrus, which continued to increase above 40 ng/ml in the first few weeks of dioestrus and returned to normal concentration below 1 ng/ml towards the end of dioestrus.

According to De Cock *et al.* (1997), blood progesterone levels were high in bitches with cystic hyperplasia endometris – pyometra complex than in normal bitches with same stage of oestrus cycle. The mean blood progesterone concentration in bitches with Cystic Hypertrophic Endometritis-Pyometra (CHE-P) was found elevated in early secretory stage but not much variation in late secretory stage than normal bitches. There was a relatively high variation in oestradiol concentration among the groups investigated. But oestradiol values were found comparatively higher in bitches with CEH-P.

Out of 13 bitches affected with pyometra, the plasma 17β oestradiol assay gave concentrations less than 5 pg/ml except in one, in which it was 7.3 pg/ml. The mean plasma progesterone concentration was 14.0 ± 10.9 ng/ml with a range < 0.5 to 33 ng/ml. This indicated that 10 bitches were in mid or late metoestrus and three were in anoestrus (Dhaliwal *et al.*, 1999).

Based on the studies conducted and literature reviewed, De Bosschere *et al.* (2001) adopted the following scheme to determine the different stages of reproductive cycle in the bitch.

Progesterone < 0.5 ng/mL and estradiol - 17β <25 pg/mL – Anoestrus

Progesterone < 1.0 ng/mL and estradiol - 17β >25 pg/mL – Proestrus

Progesterone > 1.0 ng/mL and estradiol - 17β >25 pg/mL – Oestrus

Progesterone > 0.5 ng/mL and estradiol - 17β <25 pg/mL – Metoestrus

It was opined that the all dogs with pyometra were either in metoestrus or in anoestrus.

Ververidis *et al.* (2004) studied the serum concentrations of estradiol 17β and progesterone in normal bitches and in bitches with spontaneous Cystic Endometrial Hyperplasia-Pyometra (CHE-P), in first half of dioestrus and second half of diertrous and in early anoestrus. The bitch with spontaneous CEH-P had significantly high concentrations of estradiol 17β in dioestrus-first half (9.3 $pgml^{-1}$ (range 5.4 to 23), in dioestrus-second half (9.7 $pgml^{-1}$ (range 3.7 to 14.2) and early anoestrus (7.0 $pgml^{-1}$ range 5.2 – 10) compared to the values of similar stages in normal bitches (2.7 $pgml^{-1}$ (2.1 – 3.1), 4.6 $pgml^{-1}$ (2.0 – 5.6) and 2.6 $pgml^{-1}$ (2.0 – 4.8) respectively). But the progesterone level did not show any significant difference between bitch with CEH-P and normal bitches, in any of the three stages. The progesterone values in dioestrus-first half were15.6 $ngml^{-1}$ (11.8-32) v/s. 16.6 $ngml^{-1}$ (10.7 – 23.2); in dioestrus-second half 8.5 $ngml^{-1}$ (3.3 – 24) v/s. 7.4 $ngml^{-1}$ (3.4 – 23.0) and in anoestrus 0.51 $ngml^{-1}$ (0.36 – 1.05) v/s. 0.78 $ngml^{-1}$ (0.17 – 1.5) in respective conditions.

2.7. UTERINE CANNULATION

Cobb (1959) described a method of uterine cannulation for hysterography and uterine drainage. A seven inch long metal urethral catheter, on which the cuff cut from Magill's endotracheal tube fitted was used. A metal tomcat catheter was shaped to fit inside the bitch catheter attached with a syringe was inserted into the previous one to inject the contrast material. According to him the 45° angle of the tip of the bitch catheter corresponded very closely to the upward tilt of the cervical canal and the cuff engaged in the anterior vagina prevented the back flow of contrast materials. The bitches were prepared with enema and general anaesthesia. The catheter was then passed into anterior vagina. The cervix was fixed between thumb and index finger in such a way that ventral abdominal wall was in contact with the palm of the hand. The tip of the catheter was then gently manipulated through the external *os*. Author claimed

success in outlining the uterus, in normal cycles and pathologies and also for draining the uterus where the uterus was filled with fluid. The passage of the catheter along the cervical canal was found easy at oestrus and postpartum period.

Farstad (1984) attempted intrauterine artificial insemination in dog using special uterine catheter and claimed success in 55 bitches and failure to cannulate uterus in 12. The failure to cannulate uterus was because of extremely narrow cervical canal or because of inadequate external fixation of cervix due to large abdomen.

Lagerstedt and Obel (1987) attempted uterine cannulation in 65 normal as well as diseased bitches. Out of the 148 attempts 140 (95%) were claimed to be successful. All cannulations were performed under general anaesthesia. Using a device consisting of an outer 'guide', a metal tube with a wire loop at end to clasp the cervix and inner bulb ended cannula. Ten different sizes of the device were fabricated for bitches of different size and detailed measurements were discussed. For cannulation of the cervix, three methods were tried: Method I under fluoroscopy by injecting 60% Urographin intravaginally to locate the cervical *os*. In Method II, viscous contrast material (Perjodal) was used and in Method III transabdominal manipulation, instead of fluoroscopy was used. Cervical cannulation was confirmed by infusion of contrast material. The failures in catheterization were attributed to hypertrophic cervix in five cases, narrowing of cranial vagina, bent vagina and vaginal constriction in one case each. In one dog cannulation was performed by cervical palpation via prepubic laparotomy without any complication. The authors opined that the anatomical arrangement of the genital organs in the bitch renders an instrumental approach to the uterine cavity more different than in other species. Lack of fluoroscopic equipment and need for general anaesthesia limit the success of the method described.

Fougner (1989) described a method of intrauterine deposition of semen employed in fox breeding. A plastic speculum and a slender metal catheter, slightly angled at the tip, passed inside was used. After introducing the speculum with the metal catheter, with one hand cervix was fixed transabdominally. With the other hand, the cervix was fixed from behind with pressure on guiding tube. The external *os* of the

papilla shaped cervix was then located by sliding the angled tip of the catheter over the cervix from cranial part of cervix backwards and at the same time holding the cervix so that the opening presented ventrally. Once the opening was located, the catheter was introduced through the cervical canal with slight rotation and semen deposited one centimeter inside the uterus.

Watts and Wright (1995) performed transcervical cannulations of uterus in bitches with the aid of post-uterine endoscopy. Success of cannulation was influenced by experience of the operator, stage of reproductive cycle, size of bitch and size of the cannula. Uterine cannulation was successful in 110 times in 144 attempts. Success rate was 52% in the initial 25 attempts and was 79% in the last 24 attempts. Cannulation was generally easier in proestrus and oestrus. During dioestrus and anoestrus, the paracervix was narrow and the passage through it was difficult. Cervix and paracervix appeared sensitive as movement in this area was often resented during these periods, which indicated sedation in most of the case. Uterine cannulation had the risk of developing endometritis, uterine and vaginal tear and vaginitis.

Linde-Forsberg (2001) described transcervical cannulation of uterus in bitch using Scandinavian (Norwegian) transcervical catheter for intrauterine insemination The Scandinavian artificial insemination (AI) catheter consisted of 1-2 mm wide steel catheter with 0.75 mm to 1 mm diameter tip and available in three lengths of 20, 30 and 40 cm. It was used with 10 mm diameter outer protecting nylon sheath. The catheterisation could be performed with the bitch in standing position and without sedation. The AI catheter was introduced through the vulval lips, as far as to immediately cranial to pelvic brim. Then the cranial end of the catheter was lowered closer to the abdominal wall to make it more accessible to palpation. The catheter was then carefully introduced further under continued palpatory control upto paracervical area. The dorsal median post-cervical folds were palpated as 1 to 2 cm long firm structure. Cervix could be palpated next to it as round to ovoid hard freely movable structure of 0.5 to 1.5 cm length. Once the cervix had been identified, corpus uteri and uterine horns could be palpated in front of it. The tip of the catheter was lowered and then closed the tip of the thumb against that of the

index finger above the catheter. Then the cranial end of the catheter lifted in such a way that the cervix and uterine horns were pulled upward between fingers. The cervix was fixed between the thumb and index finger and by applying slightly downward traction at the *corpus uteri* it was tilted so that the angle of cervical canal became more horizontal. The tip of the catheter was carefully withdrawn while pushing it repeatedly against the surface of the cervix in search of opening of the cervical canal. The sensation when opening of the cervix had been found was described as touching cartilages *i.e.* "crispy". Once the opening was located, the catheter was fixed and the cervix was worked against the catheter. Then slight pressure was applied while rotating the catheter to ease it through. Once it was placed in the uterus, tip of the catheter could be easily palpated. Author opined that the technique required some practice, especially in nulliparous dogs. Risk of perforations was reported if introduced blindly or with force. Intrauterine insemination with the help of rigid fiberoptic endoscope and urinary catheter, laparoscopy and surgery were also discussed.

According to Johnston *et al.,* (2001) the dorsal median fold along with the constriction of the ventral and lateral walls of anterior vagina made the uterine cannulation difficult. Additionally the cervical canal was nearly perpendicular to long axis of vagina and uterine body, further impending easy cannulation. The ease of cannulation also depended on the size of the dog, experience of the veterinarian and the type of equipment used.

2.8. RADIOGRAPHIC DIAGNOSIS OF PYOMETRA

Dow (1957) reported that radiograph or radiograph with pneumoperitoneum was useful in diagnosing cystic hyperplasia - pyometra complex in bitches. But in those with ampulla formation it was often impossible to distinguish between pyometra and mid-pregnancy on a purely radiographical basis. He also claimed success in uterine cannulation and outlining normal and diseased uterus.

Cobb (1959) performed hysterography in 80 bitches in various stages of oestrus cycle, by cannulating the uterus and infusing of contrast material, Skiodan, an aquous organic compound containing 40% iodine at the rate of one cubic centimeter per 10 lb body weight.

Cobb and Archibald (1959) reported hysterography in three bitches affected with cystic hyperplastic endometritis. They introduced a metal urethral catheter through cervix using one hand with simultaneous abdominal palpation with the other hand with animal under anaesthesia and injected 20-40% aqueous radiopaque solution (Skiodan sodium). In a 9½-year-old female German Shepherd Dog with vulval discharge, infusion six cubic centimeter solutions outlined the uterus as longitudinal streaks of varying diameters and by a stellate outline at cross sections. In a 3½-year-old Dachshund bitch, later diagnosed as a case of cystic hyperplastic endometritis, an infusion of 25 cc of contrast material outlined a grossly distended uterus with corrugations due to the cystic hyperplastic endometrium. Hysterogram in five-year-old Chihuahua cross, on infusion of eight cubic centimeter of the contrast agent showed uterus with normal length but distended three times with corrugations due to the cystic hyperplastic endometrium.

Renton *et al.* (1971) opined that radiography as the most important ancillary aid to diagnosis of pyometra. Out of 11 dogs with closed pyometra seven had gross distension of uterus (+++) and four had marked distension (++). Among 29 dogs with open pyometra eight had gross distension (+++), ten had marked (++) distension and 11 had moderate distension (+).

Distended uterus with lobulations in a plain radiograph of abdomen was reported by Jackson (1979) in a case of pyometra.

Holt *et al.* (1984) performed vagino-urethrography in 123 bitches using Folley's catheter. Cranial vagina was clearly visible in 74 of 100 bitches. The dorsal median fold of paracervix and vaginal cervix was demonstrated. In the remaining 26 cases, the cranial vagina appeared as a fine 'tail'. But their technique failed to demonstrate patency of cervix in a bitch with open pyometritis.

Allen and France (1985) described a method of radiographically investigating the vagina and uterus in bitches. A modified cuffed endotracheal tube and a 6 French gauge dog urethral catheter was used to infuse 25% w/v sodium diatriazoate solution to fill the vagina. According to them the cranial end of vagina is spoon shaped with the *os* of the uterine cervix opening dorsally into the concavity of the 'spoon'. Cervix was found patent during proestrus, oestrus and variable period after parturition, when they got the contrast material passed into the uterus.

Funkquist *et al.* (1985) attempted hysterography in 28 bitches and claimed success in 26, in various stages of oestrus cycle and with or without pathological changes. They used a special guiding device consisting of a metal tube with a metal wire loop at the end, a bulb ended cannula, which fit into the lumen of guiding device and Teflon catheter with silicon rubber cuff just behind its tip. The wire loop clasp and raise the protruding part of cervix and into its *os* the bulb-ended cannula was passed. Amipaque or Urographin 60% was used as the contrast agent. Exposure was made in right and left lateral and ventro-dorsal positions. In 13 bitches diagnosed as cystic endometrial hyperplasia-pyometra, the uterus initially appeared enlarged and smooth walled and size of the uterus corresponding to that seen in survey radiograph. In one, rough inner surface with numerous filling defects and another one, deep membrane like contraction furrows alternated with sac like dilatations were observed. Twelve hours or more after drainage, these uteri appeared 'corrugated' with multiple contraction furrows and reduced diameter.

In a retrospective study of lateral abdominal radiograph of 131 bitches with proven pyometra, Brec *et al.* (1988) found out that in 31 cases (24%) the uterine silhouette could not be seen in survey radiograph. In 100 (76%) cases uterus was clearly visible. The diameter of uterine shadow was measured and compared to the length of second lumbar vertebrae and this ratio ranged from 0.4 to 3.5. Smallest uterine diameter measured in plain radiograph was 12 mm

Lagerstedt (1993a) reported the results of hysterographic studies in 82 bitches with clinical signs related to genital system. Hysterography was performed under

general anaesthesia with the assistance of fluoroscopy. Colpography was first performed using a cuffed endotracheal tube to visualize vagina and *portio vaginalis*. A "guiding device" consisting of a metal tube with a metal wire loop at the anterior end to clasp and align the cervical and the catheter was used. A bulb ended metal catheter was inserted through the guiding device and was manipulated into the uterine lumen through the cervical canal. Contrast material (Urographin 60%) was infused approximately at the rate of ½ ml per kg body weight and radiographs were made. The radiographic appearance was correlated with macroscopic appearance of a few extirpated uterus via ovariohysterectomy and suggestions were made for the hysterographic diagnosis of uterine pathologies. 'Cork Screw' appearance was found related to myometrial contractions subsequent to $PGF_2\alpha$ administration in dilated uterus. 'Tight spiral' like appearance was explained as multiple cysts with regular arrangement on endometrium or contractions of myometrium. Distinct 'filling defects' seen in hysterograms might be due to cystic endometrial hyperplasia. Small dilatations making 'string of pearl' appearance is considered to be an appearance in postpartum period. Persistence of 'cotton-reel-like' formations was seen during later stages of puerperium. Apparently normal uterus with 'distal local dilatation' was suggestive of myometrial cyst. The author concluded hysterography as a diagnostic tool to exclude uterine pathologies without affecting future fertility.

Lagerstedt (1993b) described the technique and results of hysterography in various stages of oestrus cycle including postpartum period in four bitches. A bulb ended metal catheter was inserted into uterine cavity with the help of a guide instrument with a wire loop at the end. All attempts were made under general anaesthesia except for those in postpartum period. The cannulation was performed with the aid of fluoroscopy with the bitch controlled in right lateral recumbency. Colpography was performed before hysterography to visualize vagina and *portio vaginalis*. Urographin 60% was used as contrast material and the volume required to fill the uterus adequately was approximately 0.5 ml per kg body weight. Out of the 93 attempts, auther claimed success in 83 and the hysterographic appearance of uterus in

various stages of oestrus cycle was described. A complication reported was only slight dilatation of uterine lumen due to 12-13 times of repeated hysterography.

Feldman and Nelson (1996) stated that on a plain radiograph of abdomen in bitches affected with pyometra a fluid-dense tubular structure that was larger in diameter than small intestinal loops could be typically seen in the ventral and caudal abdomen, displacing intestinal loops dorsally and cranially. This has to be differentiated from early pregnancy.

2.9. ULTRASONOGRAPHY IN PYOMETRA

England and Allen (1989) reported that on ultrasound scanning, a characteristic tubular anechoic appearance was seen in pyometra, which was distinct from cystic endometrial hyperplasia for which the uterus was homogenously hypoechoic.

According to Burk and Ackerman (1996) distended uterus in pyometra can be identified in ultrasonography as enlarged tubular structure, thin walled and filled with an echogenic fluid.

Fayer-Hosken *et al.* (1991) described the ultrasonographic appearance of enlarged uterus with hypoechoic shadows, three circular echogenic masses within the horns (1 x 3 cm) and round anechoic structure within the ventral wall of right horn near bifurcation. Uterus harvested surgically revealed gross and microscopic lesions of pyometra with early embryonic resorption and periuterine cyst. Ultrasonography was thus suggested as a powerful tool for early detection of uterine abnormalities and early successful therapy.

Experiences of the diagnostic value of ultrasonography of pyometra in the bitch were reported. Results were compared with clinical diagnosis and pathophysiological findings after laparotomy and surgical removal of uteri. Very close correlation was found between the postoperative macroscopic and ultrasound scan measurements was reported. Authors summarized that ultrasonography is an accurate procedure for the

qualitative and quantitative examination and diagnosis of canine pyometra (Zoldag *et al.*, 1992).

Nyland and Mattoon (1995) opined that ultrasonography was more accurate than survey radiography in diagnosing pyometra. Ultrasonographic findings included symmetrical or occasionally segmental or focal enlargement of uterus and uterine horns with homogenous and anechoic or hypoechoic contents. Uterine wall was variable in appearance, from very smooth and thin to thick and irregular. Wall usually appeared more echogenic than the contents. In response to PG $F_2\alpha$ therapy uterine wall became thick and contents diminished.

Feldman and Nelson (1996) opined that ultrasonography allowed diagnosis of pyometra and assessment of uterine distension, wall thickness, and nature of contents before and after medical treatments. Uterus took on the appearance of an anechoic convoluted tortuous tubule with pyometra on a longitudinal plane and as anechoic circular structures when viewed on transverse plane.

2.10. UTERINE DRAINAGE IN PYOMETRA

Cobb (1959) successfully drained the uterus before surgery in 11 bitches, where the uterus was filled with fluid. A seven inch bitch urinary catheter passed into the uterus per vaginally after fixing the cervix transabdominally with thumb and index finger.

Frankquist *et al.* (1983) attempted uterine drainage, in 12 bitches with pyometra, by introducing 2.2 mm 'radio opaque plastic catheter in the posterior part of the uterus under general anaesthesia. For placing the catheter transcervically a guiding device consisting of a 25 cm long metal tube with 5.5 mm outer diameter and 4.5 mm inner diameter fixed with an oval metal wire loop at one end was used. The metal wire loop was used to clasp and lift the vaginal part of cervix, the '*portio*', so that the external orifice of the cervix wwould be made straight. A 35 cm long bulb ended cannula with inner diameter of 1.6 mm was passed through the lumen of the guiding device and

manipulated through the cervix. The said procedure was conducted either by trans abdominal manipulation of *portio* (3 out of 5 cases successful) or with the help of fluoroscopy (all attempted 7 were successful). Once the tip of cannula was placed intrauterine two flexible metal guides used for arterial catheterization were introduced into the uterus. After removing the cannula and replacing the guiding device with simple metal tube (inner diameter 5.0 mm), two radiopaque 2.2 mm plastic tubes were introduced into the uterus by threading over the flexible metal guides. After removal of the flexible guides, the tubes were cut short and fixed 1-2 cm cranial to the dorsal edge of entrance of vagina. Catheters were left in place for 5-15 days (mean 9.7 days). The regression of size of uterus was assessed by hysterography using 5-10 ml of Urographin 60% or Amipaque. All the 12 bitches had shown regression of size of uterus and discharged healthy. But three bitches later were subjected to ovariohysterectomy within six months due to persistent discharge; six of the remaining nine were mated in the next oestrus and five conceived and had viable litters. Technical complications were aroused in two animals, in one both catheters were introduced into one horn by mistake and drainage from that horn alone was effected. In the second animal the catheters perforated the uterine wall between 6^{th} and 8^{th} day of drainage. In few cases the catheter was found expelled spontaneously or bitten away by the dog itself before the end of the treatment period. They concluded that the length of drainage period and outcome were not related; a mechanical stimulation of uterine wall with the catheter or osmotic stimulation with the contrast material promoted resolution of uterus and the drainage had less favourable prognosis in old animals than in young animals.

Meyers-Wallen *et al.* (1986) during study on the effect of prostaglandin $F_{2\alpha}$ on canine pyometra, placed a catheter through the cervix into the uterus after performing laparotomy and incising the uterus. The uterus was flushed with nitrofurazone in sterile normal saline solution and deposited one gram of ampicillin into each horn through the catheter. The catheter was removed before abdominal closure.

Lagerstedt *et al.* (1987) reported uterine drainage through transcervical catheter for treatment of pyometra in three cases. Under general anaesthesia, a bulb ended cannula was introduced into the uterus through cervix, with the help of a guiding device

with metal wire loop at the end to fix the cervix, under fluoroscopic assistance. A flexible metal guide was inserted through the cannula. The catheter and the guiding device were then removed. A radiopaque plastic catheter was threaded over the guide. At the next step a thin metal tube with slightly larger inner diameter was threaded over the plastic catheter. Then the plastic catheter was removed and another flexible metal guide with same dimensions as the first one was inserted. The thin metal tube was then replaced by a thicker metal tube, which could accommodate two plastic catheters to be passed simultaneously. Two radiopaque plastic catheters were threaded over the flexible metal guides. After removal of metal guides, the plastic tubes were positioned in either horn till the tip laid 5-10 cm cranial to bifurcation, with the help of fluoroscopy and injected the contrast material (Urographin 60%). The catheters were fixed to the dorsal wall of vaginal vestibule using 3.0 stainless steel sutures. The catheters were placed for 9, 10 and 13 days respectively in three dogs. Uterus was found regressed after treatment period, all the dogs came into oestrus and one dog bred and whelped six puppies, two of which were found dead. Authors suggested uterine drainage as a valuable alternative in cases refractory to prostaglandin therapy and the effect of combination of drainage and prostaglandin treatment has to be studied.

Feldman and Nelson (1996) opined that, even though report of drainage of the uterine contents in pyometra through transcervically placed catheters were there, that approach was not practical, need complex instrumentation, skill and luck and might be life threatening. Hence that treatment could not be recommended.

Sen (1998) described a non-surgical and non-hormonal treatment for canine open cervix pyometra. The treatment comprised of intrauterine infusion of 10% enrofloxacin at the rate of 1 ml per 10 kg body weight using sterile infant feeding tube of 5 to 7G size followed by daily deep vaginal douches with 100 to 200 ml, of lukewarm 2.5% povidone iodine solution for six day consecutively. The bitches were also administered with a polyherbal drug (named Gynomeena) at the rate of 2 to 4 teaspoon full twice daily for 14 days along with anti-emetics, systemic antibiotics, steroids and Ringer's solution with 5% dextrose. The palpable size of the uterus was reduced in 3 or 4 days and total absence of vaginal discharge in 14 days. Recurrence

was not reported in any of the 12 bitches treated and three out of them conceived on mating.

2.11. PROSTAGLANDIN THERAPY IN PYOMETRA

2.11.1. Dose

Jackson (1979) reported an unsuccessful treatment of a case of pyometra in seven-year-old Labrador bitch, with single injection of dinoprost at the rate of 0.23 mg/kg body weight.

Sokolowski (1980) administered Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) tromethamin at a dose ranging from 100 to 1000 mcg/kg in 16 bitches diagnosed to have endometritis, metritis and pyometritis. Author suggested $PGF_2\alpha$ - tromethamin at the level of 250 mcg/kg body weight as optimal dose to minimize side effects and to obtain clinical cure with minimal number of treatments.

Nelson *et al.* (1982) treated 17 bitches with pyometra using dinoprost at dose rates of 0.10 mg/kg (5 cases), 0.25 mg/kg (8 cases) and 0.50 mg/kg (4 cases) subcutaneously, once daily until the discharge from vulva stopped or until five injections.

Meyers-Wallen *et al.* (1986) administered dinoprost tromethamine in 10 bitches with pyometra at the rate of 0.25 or 0.50 mg/kg body weight subcutaneous, once daily for three days.

Lagerstedt *et al.* (1987) reported three cases of pyometra treated with $PGF_2\alpha$ at the rate of 0.25 mg/kg body weight once daily subcutaneously for seven days.

Arnold *et al.* (1988) treated 10 bitches with pyometra with $PGF_{2\alpha}$ at a dose rate of 20 µg/kg body weight three times a day on 4-8 consecutive days.

Gilbert *et al.* (1989) reported treatment of 40 bitches having pyometra with dinoprost, a $PGF_{2\alpha}$ THAM salt, at a dose rate varied from 26.8 to 258 µg/kg body weight for a period of two to 26 days along with antibacterial drugs.

Hubler (1991) treated 12 bitches with pyometra with $PGF_{2\alpha}$ at the rate of 20 µg/kg bodyweight three times daily for eight days.

Memon and Mickelsen (1993) reported successful treatment of bitch suffering from closed cervix pyometra with $PGF_{2\alpha}$ with a dosage started from 0.025 mg/kg body weight on first day and increasing to 0.25 mg/kg body weight on seventh day and continued so upto 14^{th} day.

Azim *et al.* (1995) used cloprostenol, synthetic $PGF_{2\alpha}$ analogue, at a dose rate of 10 µg/kg subcutaneously twice daily in ten bitches with induced pyometra.

Feldman and Nelson (1996) recommended the protocol for use of natural $PGF_{2\alpha}$ as: day 1: 0.1 mg/kg subcutaneously once; day 2: 0.2 mg/kg SC once; day 3 through 7: 0.25 mg/kg once daily, which reduced the side effects. They recommended ovariohysterectomy if the condition of the bitch gets worse.

Sridevi *et al.* (2000) described the use of low dose $PGF_{2\alpha}$, in seven bitches affected with pyometra. $PGF_{2\alpha}$ as administered at the dose rate of 30 µg/kg body weight twice daily for eight days.

Roy (2002) described the medical management of open cervix pyometra in ten bitches with administration of dinoprost at a dose rate of 0.1 to 0.25 mg/kg body weight subcutaneously for five days.

Gobello *et al.* (2003) reported the effect a synthetic prostaglandin, cloprostenol at the dose rate of 1 µg/kg s.c. on day 3 and 8, in bitches with pyometra.

Smith (2006) suggested a starting dose of $PGF_{2\alpha}$ as low as 50 µg/kg and gradually increasing to 250 µg/kg over the treatment period to reduce the side effects.

2.11.2. Results of Treatment

Sokolowski (1980) claimed that seven of seven pyometritis cases, successfully recovered with remission of clinical signs with $PGF_{2\alpha}$ therapy . In two of three re-treatments with doses less than 100 mcg/kg was required. All the nine dogs had a subsequent oestrus period, five were bred and two whelped normal litters.

Nelson *et al.* (1982) treated 17 bitches with pyometra using dinoprost at different dose rates. Eleven bitches required five or fewer injection and recovered with stoppage of vulval discharge, reduction in size of uterus, disappearance of anorexia, depression and polydipsia and return of leucocyte counts and plasma progesterone levels to normal. Nine bitches had shown a reduction in plasma progesterone levels (below 0.5 mg/ml) after treatment and in three it remained greater than 1 ng/ml even after second series of treatment with $PGF_{2\alpha}$. The recovery was unrelated to the dose of $PGF_{2\alpha}$. One bitch with close pyometra and two with open pyometra required second series of treatment to get the recovery and another one with closed cervix failed to respond, even to a third series of treatment.

According to Meyers-Wallen *et al.* (1986) all the ten bitches treated with $PGF_{2\alpha}$ were clinically improved by 8^{th} or 9^{th} day and the leucocyte counts significantly decreased. Out of these ten bitches four bitches (40%) reproduced in next one year after treatment. Four bitches (40%) had recurrence of pyometra in one year after treatment. Out of the nine bitches observed for more than one year seven (77%) had the recurrence of pyometra. Since long-term recurrence rate is high, prostaglandin therapy may be useful only in temporarily decreasing clinical signs thus by reducing the risk for ovariohysterectomy.

Nelson and Feldman (1986) opined that though ovariohysterectomy is the treatment of choice in pyometra of bitches, $PGF_{2\alpha}$ appeared to offer the owner a

reasonable alternative in the management of pyometra. The goal of the $PGF_2\alpha$ therapy is to salvage the reproductive tract in the young breeding bitches in the hopes of obtaining future litters. According to them the results were very much promising especially for bitches with open cervix pyometra.

Lagerstedt *et al.* (1987) reported three cases of pyometra, which were found refractory to $PGF_2\alpha$ therapy.

According to Arnold *et al.* (1988) seven out of ten bitches treated with $PGF_2\alpha$ responded to the treatment and remaining three underwent ovariohysterectomy. Moderate reduction in total leucocyte count was noticed at the end of the treatment, which returned to normal range one month after treatment. Plasma progesterone level ranged from 0.04 to 9.58 ng/ml before and 0.40 to 4.22 ng/ml after treatment.

Gilbert *et al.* (1989) claimed cure in 33 bitches out of 40 affected with pyometra using $PGF_2\alpha$. Among the cured, follow-up in regard to future breeding revealed failure to conceive one abortion, five case of anaestrus, six bitches either not mated or spayed before next oestrus, relapse of pyometra in two cases normal whelping at least one in nine cases. The authors suggested that (1) failure to get clinical remission within six day of treatment indicate poor progress and recovery of breeding potential, (2) mating should be encouraged in the first oestrus after treatment and should be accompanied by antibacterial therapy, (3) success should be regarded as temporary and (4) ovariohysterectomy remains the treatment of choice for bitches that are not destinated for breeding.

As per the reports of Hubler (1991) out of the 12 bitches treated for pyometra using $PGF_{2\alpha}$, pyometra was resolved in nine bitches and all came into heat 2-5 months after treatment; seven of them were mated and six bitches gave birth to healthy litters. Recurrence of pyometra was not reported in any of these nine bitches in 10 months following the treatment. In three of the bitches, uterus was found still enlarged on 8^{th} day and ovariohysterectomy was performed.

Memon and Mickelsen (1993) reported cervical dilatation and uterine discharge by second day of $PGF_{2\alpha}$ treatment in a bitch with closed cervix pyometra. Decrease in size of uterus noticed by day five of $PGF_{2\alpha}$ treatment. The bitch was discharged seven days after the course of therapy and was bred at subsequent heat and delivered eight pups. The haemogram of the bitch before and after treatment was as follows. The total leucocyte count was 39.9 x 10^3 cells/mm^3 and 39.6 x 10^3 cells/mm^3 before and sixth day of $PGF_{2\alpha}$ treatment respectively. Total erythrocyte count was 5.71 x 10^8 cells/$mm^3$and 4.88 x 10^6 cells/mm^3; packed cell volume 40% and 34%; haemoglobin 14.1 g/dl and11.7 g/dl; neutrophils 75% and 80%, band cells 3% and 3%; lymphocytes 8% and 10%; monocytes 13% and 7% eosinophils 1% and nil and platelet count 1,80,000 cells/mm^3 and 2,63,000 cells/mm^3 before and sixth day of $PGF_{2\alpha}$ treatment respectively.

According to Azim *et al.* (1995), among ten bitches with induced pyometra and treated with $PGF_{2\alpha}$ analogue, one died on second day and all others except three responded well with stoppage of vaginal discharge and return of leucocyte counts after 15 days. On autopsy at 16th day, in those responded to $PGF_{2\alpha}$ treatment the size of uterus was reduced to normal while in those do not respond to treatment the uterus was distended. *Corpora lutea* was absent in cases except that died on second day. Cervix was open in all cases except in those not responded to $PGF_{2\alpha}$ treatment where cervix was partially or completely closed. The authors opined that ovariohysterectomy is advisable in bitches that are not intended for breeding and prostaglandin therapy as an alternative for surgery in bitches kept for breeding.

Feldman and Nelson (1996) reported 93% recovery among 111 bitches with open- cervix pyometra and 34% recovery among 41 bitches with closed-cervix pyometra treated using $PGF_{2\alpha}$. Out of the recovered in the former group 87% had whelped, 57% had litters more than once and five redeveloped pyometra. In the latter group all the recovered bitches whelped viable litters.

Sridevi *et al.* (2000) described the results of low dose $PGF_{2\alpha}$, in seven bitches affected with pyometra. By fifth day of treatment, rectal temperature returned to

normal and appetite was improved. By eighth day all bitches had scanty or no vaginal discharge. On review after two weeks of therapy, there was total cessation of vaginal discharge, with little or no palpable evidence of uterine enlargement. It was confirmed with radiography and ultrasonography.

Roy (2002) reported that eight were completely cured subsequent to administration dinoprost in ten bitches with open cervix pyometra. Recurrence was not reported in cured dog and four of them conceived when mated subsequently.

Gobello *et al.* (2003) reported improvement in clinical signs, blood parameters and uterine diameter to normal, throughout the treatment with a synthetic prostaglandin (PG), cloprostenol in bitches affected with pyometra. Redevelopment of pyometra occurred in 20% of the bitches in next oestrus cycle. Authors concluded that the number of PG administration had an effect on serum progesterone change throughout the treatment and uterotonic effect of PG contributed more in for the recovery.

2.11.3. Side effects and Complications

Jackson (1979) reported a case of pyometra, which subsequent to treatment with dinoprost developed a rupture of uterus and escape of pus into peritoneal cavity. It was opined that prostaglandin therapy in pyometra might lead to complications if the cervix is not fully dilated, if the uterine wall is friable or if the bitch is debilitated.

According to Coulson (1979) the clinical signs associated with dinoprost toxicity when it exceeds the median lethal dosage (LD_{50}) of 5.13 mg/kg included excess salivation, vomiting, diarrhoea, hyperpnoea and ataxia. Some bitches developed engorgement of viscera and haemorrhagic foci in adrenal gland noted at post mortem examination.

Side effects like salivation, retching, vomiting, defecation and urination were noticed in bitches received 500-1000 mcg/kg body weight (Sokolowski, 1980).

According to Nelson *et al.* (1982) one out of 17 bitches treated with $PGF_{2\alpha}$, one bitch with closed pyometra succumbed to uterine rupture with the first $PGF_{2\alpha}$ injection itself. Another one bitch with closed pyometra exhibited posterior paralysis 24 hour after first injection, which was later found not related to $PGF_2\alpha$ injection. All the bitches received $PGF_{2\alpha}$ had shown side effects like restlessness, pacing, hypersalivation, panting, vomiting, defecation which diminished 20 minutes after injection. Frequency and severity of these reactions were not dose related and reactions were minimum or absent in many bitches by 4^{th} or 5^{th} injections. Authors did not recommend the use of $PGF_{2\alpha}$ in bitches with closed pyometra and recommend antibiotics along with it. They suggested the possibility of refractoriness of uterus to the myotonic effects of repetitive or increasing doses of $PGF_{2\alpha}$ and suggested the possibility of recurrence of pyometra.

Approximately 15 minutes after the injection of $PGF_{2\alpha}$, salivation, panting, restlessness, emesis and defecation were exhibited by all the 10 bitches studied, which lasted for less than 30 minutes, according to Meyers-Wallen *et al.* (1986)

Arnold *et al.* (1988) reported that treatment of 10 bitches with pyometra with $PGF_{2\alpha}$ at a dose rate of 20 μg/kg body weight did not produce any overt side effects.

Side effects like hypersalivation, vomiting and diarrhoea were observed after five to 20 minutes following injection of $PGF_{2\alpha}$ in a bitch with pyometra. (Memon and Mickelsen, 1993)

Azim *et al.* (1995) reported the side effects $PGF_{2\alpha}$ treatment in 10 bitches with pyometra like vomiting within two to three minutes after administration of $PGF_{2\alpha}$, defecation and urination within 5-10 minutes, restlessness and severe salivation.

Restlessness, pacing, panting, hypersalivation, abdominal pain or cramps, tachycardia, fever, vomiting and defecation were the side effects observed within five to 60 min after injection $PGF_{2\alpha}$ and lasted for 20 to 30 min (Feldman and Nelson, 1996).

Sridevi *et al.* (2000) reported that, adverse side effects of high dose $PGF_{2\alpha}$ therapy, like vomiting salivation, restlessness and panting were not observed when $PGF_{2\alpha}$ therapy at the dose rate of 30 µg/kg body weight was given to seven bitches affected with pyometra.

Roy (2002) observed side effects like vomiting salivation, panting and restlessness subsequent to administration of dinoprost.

Kirihara *et al.* (2005) reported side effects like vomiting, salivation, tachypnea, diarrhoea and drop in body temperature on administration of various dose rates of etiproston tromethamin and cloprosterol for three hours after administration.

According to Gobello *et al.* (2003) a synthetic PG, cloprostenol, administered in bitches with pyometra at the dose rate of 1 µg/kg had not produced any side effects and they opined that it might be because of use of a low dose of the potent prostaglandin.

Smith (2006) listed the side effects of $PGF_{2\alpha}$ therapy as panting nausea, vomiting, diarrhoea and salivation seen 15 to 45 min after injection and decreasing in severity with each subsequent doses.

2.12. OVARIOHYSTERECTOMY IN PYOMETRA

Feldman and Nelson (1996) preferred ovariohysterectomy as a viable treatment in bitches with pyometra unless the owner strongly desires to maintain her reproductive potential or the bitch is six years of age or younger.

Hedlund (2002) described the procedure for ovariohysterectomy in pyometra. The abdomen was exposed through a ventral midline incision beginning 2 to 3 cm caudal to xiphopid and continued upto pubis, under general anaesthesia. The abdomen was explored and the distended uterus was located. Uterus was exteriorized carefully without applying pressure or excessive traction, as the fluid filled uterus was often friable.

Uterus was then isolated from the rest of the abdomen with sterile pads or towels. The ovarian pedicles, anterior to the ovary on both sides and vagina just behind the cervix were ligated with absorbable monofilment suture material and ressected. The vaginal stump was thoroughly lavaged. The abdominal incision was closed in the routine pattern. According to the author, prognosis of the surgery is good if abdominal contamination was avoided, shock and sepsis were controlled and renal damage reversed with fluid therapy. Mortality rate after surgical treatment of pyometra was approximately 5 – 8 %.

2.13. PATHOGENESIS OF PYOMETRA

According to Chastian and Ganjam (1986) oestrogen promote the growth of endometrium, increase progesterone receptors while serum progesterone is rising. Progesteron promotes maturation of uterine glands, stimulating them to tortuous and secretory and eventually cystic. Intraluminal secretions accumulate which along with immunosuppression by progesterone promote bacterial growth.

Nomura *et al.* (1990) induced Cystic Endometrial Hyperplasia (CEH) in eight bitches in left horn by scratching the endometrium with Kirschner's wire after performing laparotomy, in the luteal phase. Seven out of eight bitches (87.5%) developed CEH and no difference in incidence of CEH was noticed in pregnant and non-pregnant groups. Histological examination showed CEH with dilatation of basal glands resembling "Swiss cheese endometrium".

Dhaliwal *et al.*, (1999) hypothised that since peripheral plasma progesterone concentrations were the same as the same time after onset of proestrus, pyometra might had been expressed because of an increased concentration of progesterone receptors in uterine wall.

Histopathological examination of uterus conducted using a computerized image analyzing system, in 26 clinically healthy bitches and 42 bitches with clinical suspicion of pyometra had shown thickening or atrophy of the endometrium and varying degrees

of cystic change in glands in most of the bitches in both groups. In most of the diseased bitches, variable degree of inflammation was found. But some bitches with clinical signs of pyometra had no inflammatory changes in uterus and these bitches were misdiagnosed as suffering from pyometra. Based on the results of the study the authors opined that cystic endometrial hyperplasia – pyometra complex had to be divided into two entities: a cystic endometrial hyperplasia-mucometra complex and endometritis-pyometra complex. Both the entities bear similarities with each other except for inflammatory reaction in endometritis - pyometra complex and latter probably did not follow the former (De Bosschere *et al.*, 2001).

Noakes *et al.* (2001) reviewed the roles of endogenous and exogenous steroid hormones, steroid receptors, spontaneously occurring and experimentally induced genital tract infections and the role of endometrial trauma in the cause and pathogens of cystic endometrial hyperplasia/pyometra in bitches. It was postulated that intrauterine bacteria, which ascended from the vagina during proestrus and oestrus induced the disease during metoestrus by acting on the progesterone-primed endometrium directly via toxin production and indirectly by release of inflammatory mediators. The lesion could be produced by endometrial trauma in sterile uterus without systemic effects associated with the disease. There was no association with premature or increased progesterone concentration at the time that the disease is normal diagnosed in mid to late meteostrus. However such aberrant endocrine changes could not be excluded from the involvement in the pathogenesis of the disease, as there were no data from bitches preceding the onset of clinical signs. Endogenous steroid hormones modified expression of the oestrogen and progesterone receptors, but there was no clear evidence that the changes in receptors were involved in the pathogenesis of the disease. Exogenous hormones could modify receptor expression of this hormone.

De Bosschere *et al.* (2003) induced pyometra in five bitches, by intraluminal innoculation of a ligated uterine horn in metoestrus with *Escherichia coli* suspension and the other horn serving as an uninnoculated control. Histologically the inoculated horns resembled with those with naturally occurring pyometra. Immunohistochemically the expression of sex hormone receptors in the inoculated

horns resembled that with natural cases of pyometra. But such receptors were virtually not expressed in uninnoculated horn, in contras to such expression in metoestrus. Bacteria associated ovario-uterine interactions may have been responsible for these changes.

2.14. CANINE POSTUTERINE TRACT – AN ANATOMICAL CONCEPT

The canine uterus consisted of a neck or cervix, a body and two horns. Uterine size varied with breed, age, and size of the animal, parity and stage of oestrus cycle. The thick, firm tissue between the uterus and vagina, referred as the cervix, had an average length of 1.5 to 2 cm and it protruded 0.5 to 1.0 cm into the vagina. Canine cervix maintained an abdominal position above the urinary bladder and frequently palpated transabdominally in proestrus and oestrus. The cranial vagina is limited by the fornix, which extended ventral and cranial to cervix. A dorsal median fold of tissue extended caudally from the vaginal portion of cervix. The caudal portion of the fold and constriction of the lateral and ventral walls of anterior vagina gave the appearance of a cervix *i.e.*, pseudocervix. The cervical canal was nearly perpendicular to the long axis of the vagina and uterine body. The vagina, the musculomembraneous tube extending from cervix to vestibule was often described as bottle shaped due to the narrow anterior end and the dilated mid portion (Johnston *et al.*, 2001).

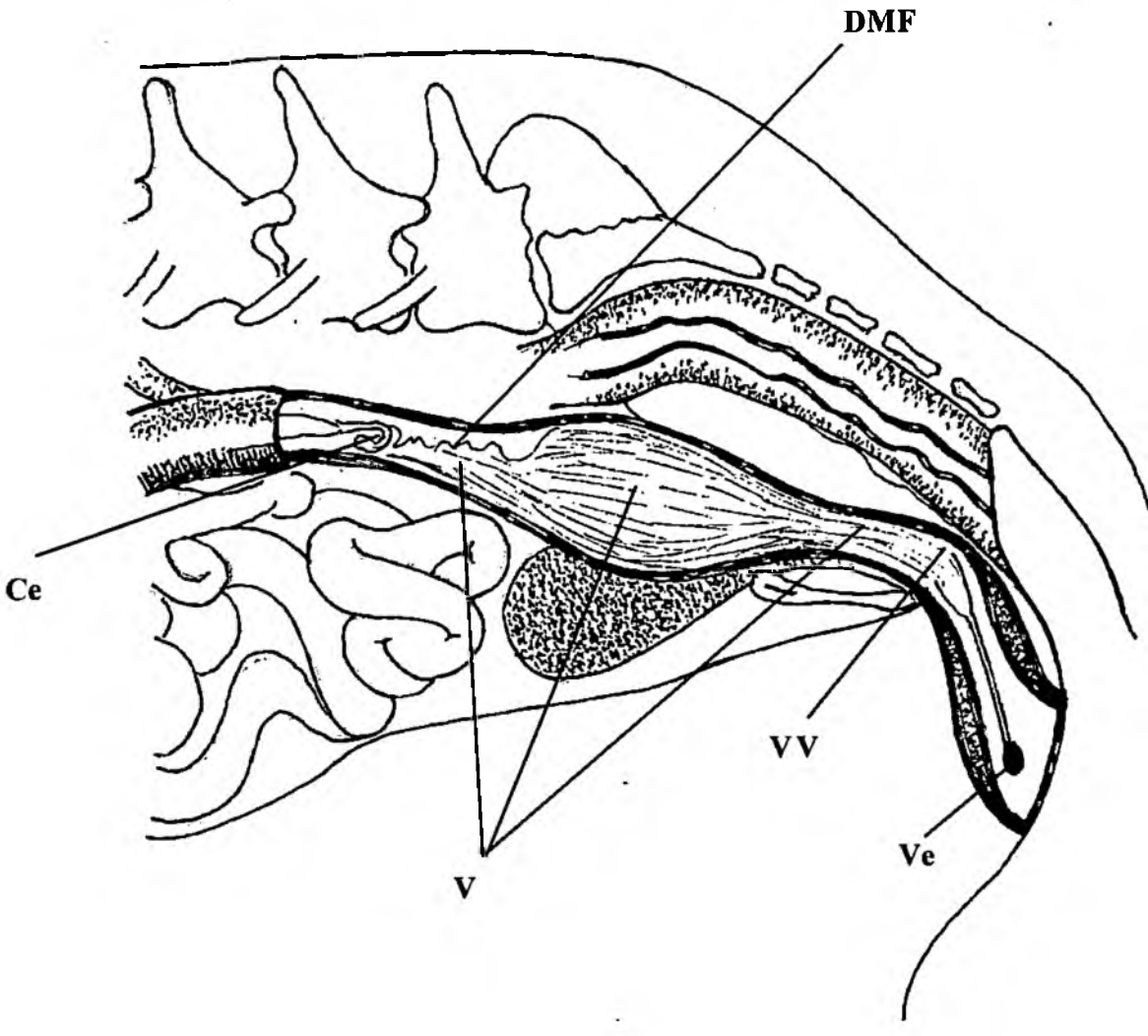

Plate 1. Diagram showing the anatomy of postuterine tract in female dogs Ve, vestibule, VV, vestibulo-vaginal junction, V, vagina, DMF, dorsal median fold, Ce, cervix

MATERIALS AND METHODS

3. MATERIALS AND METHODS

Eighteen female dogs of various age and breeds presented to the College Veterinary Hospitals, Mannuthy and Kokkalai with the history and clinical signs suggestive of pyometra were selected for the study. These dogs were randomly divided into three groups *viz.*, Group I, II and III, consisting of six each.

The animals in Group I were serially numbered *viz.*,I_1, I_2, I_3, I_4, I_5 and I_6; Group II *viz.*, II_1, II_2, II_3, II_4, II_5 and II_6, and Group III *viz.*, III_1, III_2, III_3, III_4, III_5 and III_6.

All the dogs belonging to the three groups were subjected to physiological, haematological, biochemical and clinical examination and detailed radiographic evaluation to confirm the diagnosis.

Surgical management of pyometra was carried out as hereunder:

Group I : Transcervical drainage

Group II : Transcervical drainage coupled with administration of prostaglandin $F_{2\alpha}$

Group III : Ovariohysterectomy

The following observations were made in all dogs of the three groups.

3.1. MAIN ITEMS OF OBSERVATION

3.1.1. Anamnesis

Detailed history including patient data (*viz.*, breed, age and body weight), parity, previous breeding, details regarding immediate past oestrus and mating, food intake,

presence of polydipsia and vomiting presence and nature of vaginal discharge and treatment given, if any were collected.

3.1.2. Clinical Observations

Detailed clinical observations including general distension and shape of abdomen, nature of vaginal discharge if present, nature of vulval lips and nature and consistency of abdomen on palpation etc. were recorded before and after the surgical management at 24 hr, seventh, 14th, 21st and 28th days.

3.1.3. Physiological Parameters

Respiratory rate, pulse rate, rectal temperature and colour of visible mucous membrane were recorded before and at 24 hr and at seventh, 14th, 21st and 28th days after the surgical management.

3.1.4. Haematological Parameters

Blood samples were collected from cephalic or saphenous vein with anticoagulants (EDTA), before and at 24 hr and on seventh, 14th, 21st and 28th days after the surgical management, for the estimation of total leucocyte count (TLC), differential leucocyte count (DLC) and haemoglobin concentration (Hb) (Schalm *et al.*, 2000); volume of packed red cells (VPRC) by microhaematocrit method (Benjamin, 1978) and erythrocyte sedimentation rate (ESR) (Wintrobe, 1961).

3.1.5. Serum Biochemical Parameters

From blood samples collected without anticoagulants, before and after the surgical management at 24 hr and on seventh, 14th, 21st and 28th days, serum was separated for estimation of blood urea nitrogen (BUN), creatinine, alanine aminotransferase (ALT) and potassium using interferential filter photometric analyser[1].

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[1] Clima Plus Semi-auto analyzer, RAL Tecnica para el Laboratorio, S.A., Barcelona, Spain

3.1.6. Hormonal Assay

Plasma oestradiol was assayed by Enzyme Linked Immunosorbant Assay (ELISA)[2] and progesterone was assayed by Fluorimetric analysis[3] in all the cases before and after the surgical management at 24 hr and on seventh, 14th, 21st and 28th days.

3.1.7. Formol Gel test

Formol-gel test was conducted in all cases before and after the surgical management at 24 hr, seventh, 14th, 21st and 28th days. To one milliliter of serum a few drops of 40% formaldehyde was added contents were mixed thoroughly, left at room temperature and observed at 10 min interval during the first hour and thereafter at hourly interval for 12 hours. A reaction was considered positive when the serum formed a solid gel, which could not be broken by vigorous shaking. If the reaction is honey like consistency, it was considered doubtful and no coagulation indicated negative reaction (Christensen and Cole, 1960).

2.0.7. Radiographic Evaluation

3.1.8.1. Survey Radiography

All the dogs were subjected to survey radiography of the abdomen, keeping them on right lateral recumbency, to assess uterine distension before the treatment.

3.1.8.2. Hysterography

Hysterography in all the cases was attempted preoperatively, depending on the feasibility of transcervical cannulation.

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[2] Oestradiol estimation kit by IBL, Germany

[3] Fluorimetric Analyser by Vidas, France

3.1.8.2.1. Anaesthesia and Control

The dogs were premedicated with atropine sulphate[4] given at a dose rate of 0.045 mg/kg body weight subcutaneously. At 15 min interval xylazine hydrochloride[5] at the rate of 1.0 mg/kg body weight and ketamine hydrochloride[6] at the rate of 10 mg/kg body weight were administered intramuscularly. The dogs were positioned on right lateral recumbency.

3.1.8.2.2. Transcervical Cannulation

The transcervical cannulation was carried out employing any of the following techniques *viz.*, Technique I, II and III.

3.1.8.2.2.1 Technique I

The instrument used consisted of guiding device of a 30 cm long metal tube with outer diameter 5 mm and inner diameter 3 mm, the cranial end of which was fitted with a loop of metal wire. A small handle was fixed at the other end of this guiding device, which also acted as an indicator for the direction of wire loop. The set of instruments also included 38 cm long bulb-ended cannula with an outer diameter of 3 mm and inner lumen with 1mm diameter, the main part of which fit into the lumen of the tube of the guiding device. The cranial end of the cannula was tapered to two millimeter diameter and ended in a bulb of 2.5 mm diameter (Plate 2A). The cranial end when introduced through the guiding device would pass above the cranial end of wire loop (Plate 2B). Instruments with three sizes were constructed with the wire loops having diameters of 12 mm, 8 mm and 6 mm respectively to suit different sizes of dogs.

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[4] Inj. Avatropine, Avecia Laboratories, Mumbai, 10 ml vial

[5] Inj. Xylaxin, Indian Immunologicals Ltd., A.P., 10 ml vial

[6] Inj. Ketmin 50, Themis Medicare Ltd., Mumbai 10 ml vial

The guiding device with the cannula was inserted into the vestibule oriented dorsocranial and when it reached the caudal part of the vaginal roof the instrument was straightened and advanced anteriorly, parallel to the vertebral column, with the concavity of wire loop facing the ventral vaginal wall. The instrument was advanced till the wire loop reached the vaginal fornix. The guide was introduced sufficiently anterior to allow the wire loop to clasp and fix the vaginal part of the cervix. The handle of the instrument was fixed by an assistant, whereby the operator could use the left hand for palpation through the abdominal wall and right hand for manipulation of the cannula (Plate 3). The uterine corpus was grasped by the thumb and the index finger and the uterine body was drawn cranially and simultaneously bending it over the cranial end of the loop (Plate 4), and thus alignment was achieved between the direction of the cervical canal and that of the cannula. When this alignment was achieved, the cannula was advanced with small rotary and a feeling movement to locate the *os* of the cervix and then the cannula was advanced further to pass through the cervix to the uterus (Plate 5) (Funkquist *et al.*, 1983 and Lagerstedt and Obel, 1987).

3.1.8.2.2.2. Technique II

A stainless steel cannula with 38 cm length and 3 mm outer diameter tapered at the tip to 2 mm sized blunt end with a hole at the tip, and an inner diameter of one millimeter (Scandinavian AI Catheter) (Plate 2C) was used. The cannula was introduced through the vestibule in a cranio-dorsal direction, through the dorsal commissure of the vulva. When it reached the vestibulo-vulval junction, the direction was changed and advanced parallel to the vertebral column. When the tip of the cannula was introduced as far as to immediately cranial to the pelvic brim, it was palpated. The cranial end of the cannula was then lowered closer to the abdominal wall and made it more palpable. The cannula was carefully introduced further, under continued palpatory control, through the narrow paracervical region upto the vaginal fornix. Just above to its tip the cervix could be palpated as a round to ovoid freely movable structure. In front of the cervix, the uterine body and horns could be palpated. The tip of the cannula was moved towards the abdominal wall and the thumb was closed against the index finger just above it. The tip of the cervix was moved dorsally so that, the

cervix and uterine horns were pulled dorsally between the fingers. By applying a slightly downward traction of *corpus uteri*, the cervical canal was made horizontal. The tip of the cannula was then withdrawn slightly while pushing it repeatedly against the surface of the cervix in search of the opening of cervical canal (Plate 6 and 7). Once the opening was located, the cannula was fixed and the cervix was worked against it with slight pressure and cannula rotated to ease it through (Plate 8) (Linde-Forsberg, 2001).

3.1.8.2.2.3. Technique III

A human, graduated rigid ordinary proctoscope of 28 cm length and outer diameter of two centimeters, which tapered to 1.7cm at the cranial end, was used as a vaginal speculum. A light source, a high luminescent Light Emitting Diode (LED) was fixed inside the lumen of the proctoscope towards its anterior end and was connected to a power source outside. Along with a six French sized infant feeding tube with a rigid stainless steel stillette was used to attempt catheterization of cervix (Plate 2D).

The proctoscope was lubricated well and introduced into the vagina as mentioned in the previous techniques. It was advanced gently with a careful pressure till it reached just behind the paracervical area. The proctoscope was then kept fixed at that position by an assistant. The polythene cannula along with the stillette was introduced through the proctoscope and viewing through it, the catheter was advanced through the paracervix (Plate 9). With simultaneous transcervical fixing and manipulation, the cervix was attempted to thread over the cannula (Plate 10). When the cannula could be palpated beyond the cervix, the stillette was gradually withdrawn fixing the polythene cannula inside the uterine body using thumb and index finger transabdominally (Plate 11). The proctoscope also was then withdrawn.

3.1.8.2.3. Contrast Material

Aqueous solution of diatriazoate meglumine 60%[7] was used as the contrast material (Plate 12). It was infused through the transcervical cannula into the uterus approximately at the rate of 0.5 ml/kg body weight (Lagerstedt and Obel, 1987).

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[7] Inj. Trazograph 60%, J.B. Chemicals and Pharmaceuticals Ltd. Ankaleswar, 20 ml ampoulle

3.1.8.2.4. Hysterographic Procedure

A syringe, filled with calculated quantity of contrast material, was attached to the cannula through an adapter at its posterior end and the contrast material was infused gently. Lateral abdominal radiographs were made immediately by controlling the dog on right lateral recumbency, following the standard procedure.

The radiographic changes observed in survey radiographs and hysterographs were studied and recorded.

Radiographic evaluation was repeated after the surgical management in successful cases of Group I and II with plain lateral abdominal radiographs on seventh and 28th day postoperatively.

3.1.9. Ultrasonographic Investigation

In some of the cases, the uterine distension was assessed by real-time B-mode sector ultrasonography using 5.5 and 7.5 MHz transabdominal probe and the findings were recorded.

3.2 SURGICAL MANAGEMENT

3.2.1 Group I

Drainage of the uterine contents was carried out through transcervically placed polythene catheter, depending on the feasibility of transcervical cannulation.

In dogs in which transcervical cannulation was successful with Techniques I and II, a 26 gauge stainless steel wire was inserted into uterine body through the lumen of the cannula (Plate 13). The cannula and the guiding device (in Technique I) were then gently withdrawn and were replaced by a steel tube of 8 mm outer diameter. Over the steel wire, an 8 French sized polythene catheter was sleeved (Plate14). When the tip of polythene catheter had reached the uterine body, it was fixed with the thumb and index finger transabdominally and the steel wire was withdrawn. The catheter was fixed

at the dorsal wall of vagina at the vestibulo-vaginal junction using silk sutures (Plate 15).

In dogs in which the Technique III was successful the polythene cannula already introduced into the uterine body was retained in position as the catheter for drainage. It was cut short and fixed at the dorsal wall of the vestibulo-vaginal junction using silk suture.

The catheters were retained in position at least for seven days and the dogs were maintained under antibiotic therapy (ampicillin-cloxacillin[8] at the rate of 20 mg/kg body weight or ceftriaxone[9] at the rate of 30 mg/kg body weight) parenterally and intravenous fluids (dextrose normal saline at the rate of 20 ml/kg body weight) for five days.

Those dogs did not show any clinical improvement was subjected to ovariohysterectomy. Among the recovered animals breeding history was followed up for 12 months in available cases.

3.2.2 Group II

Transcervical drainage was tried as in Group I. In addition the dogs were subjected to a low dose prostaglandin regimen with administration of dinoprost tromethanin[10] (Plate 16) at the rate of 30 µg/kg body weight twice daily intramuscularly for five days.

Postoperative care and management was carried out as in Group I.

Those dogs did not show any clinical improvement were subjected to ovariohysterectomy. Among the recovered animals breeding history was followed up for 12 months in available cases.

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[8] Inj. Intamox 0.5 g, Intas Pharmaceuticals, Mumbai
[9] Inj. Intacef 0.5 g, Intas Pharmaceuticals, Mumbai
[10] Inj. Lutalyse, Pharmacia, Pfizer Animal Health, Mumbai

3.2.3 Group III

Ovariohysterectomy was performed in the dogs of this group under general anaesthesia following standard surgical procedures (Hedlund, 2002).

3.2.3.1 Anaesthesia and control

The dogs were premedicated with atropine sulphate given at a dose rate of 0.045 mg/kg body weight subcutaneously. At 15 min interval xylazine hydrochloride[3] at the rate of 1.0 mg/kg body weight and ketamine hydrochloride at the rate of 10 mg/kg body weight were administered intramuscularly. The dogs were controlled on dorsal recumbency.

3.2.3.2 Procedure

The ventral abdomen was surgically prepared. A linear incision starting two to three centimeter behind xiphopid, extending to variable distance between umbilicus and pubis, cutting through the skin and *linea alba* was put and the abdominal cavity was accessed. Urinary bladder, if distended was evacuated by squeezing with gentle pressure between the palms. The distended uterine horns and the body including the cervix was exteriorized with gentle traction and packed off from the rest of the viscera using sterile towels (Plate 17). The ovarian pedicles were clamped and ligated with transfixation and the ovaries were separated from their anterior attachment. Posteriorly clamps and ligatures with transfixation were applied on anterior vagina and was incised and separated just behind the cervix. The uterus including the ovaries and the cervix were extirpated by tearing the mesometrial attachments. The vaginal stump was inverted with Parker-Kerr suture and secured with omentalization. Wound on the *linea alba* and subcutis were closed with simple continuous sutures using chromic catgut 2/0. The skin wound was closed with a series of simple interrupted sutures using monofilament nylon.

3.2.3.3 Postoperative care

All the animals were kept under antibiotic therapy (ampicillin-cloxacillin at the rate of 20 mg/kg body weight or ceftriaxone at the rate of 30 mg/kg body weight) parentarally for five days. Intravenous fluid (dextrose normal saline at the rate of 20

ml/kg body weight) was administered daily till the dog started taking food by its own. Sutures were removed on seventh postoperative day.

Complications if any, during and after the surgery for four weeks were also recorded.

The data obtained were statistically analysed.

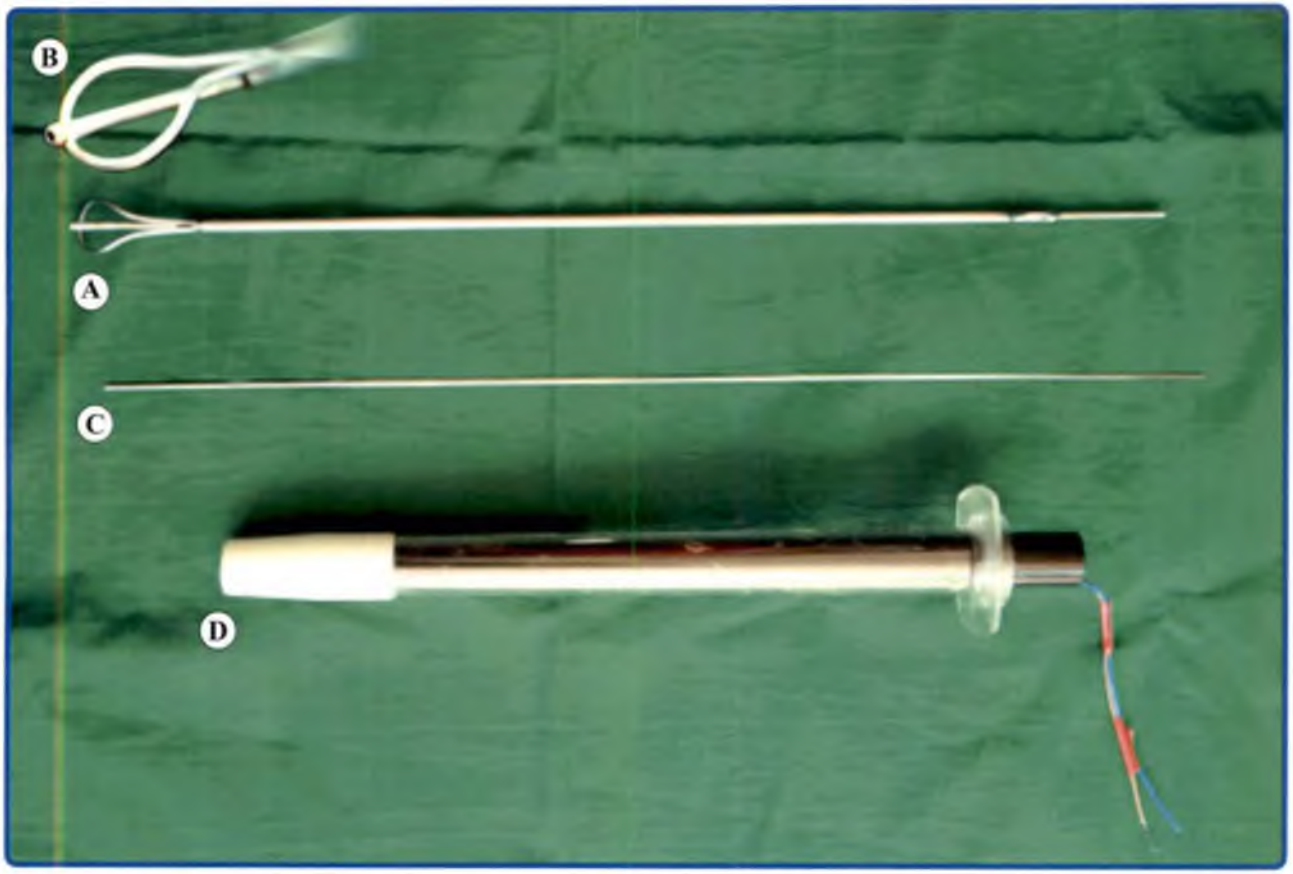


Plate 2. Instruments used for transcervical cannulation.
A & B - Technique I C - Technique II D – Technique III

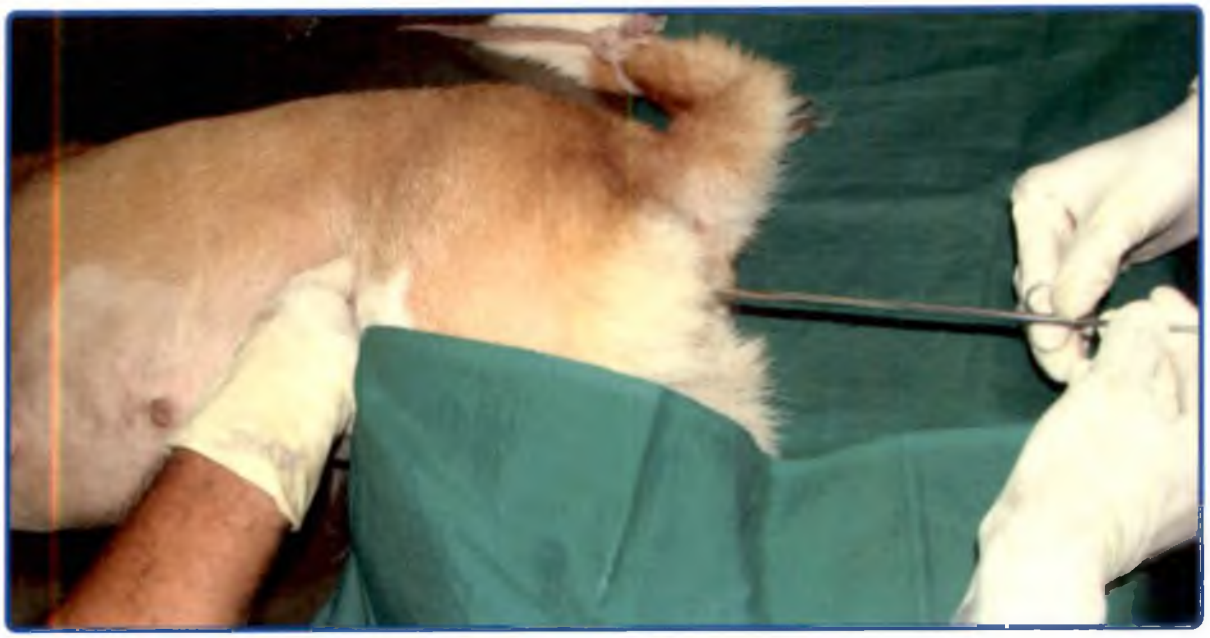


Plate 3. Transcervical cannulation by Technique I

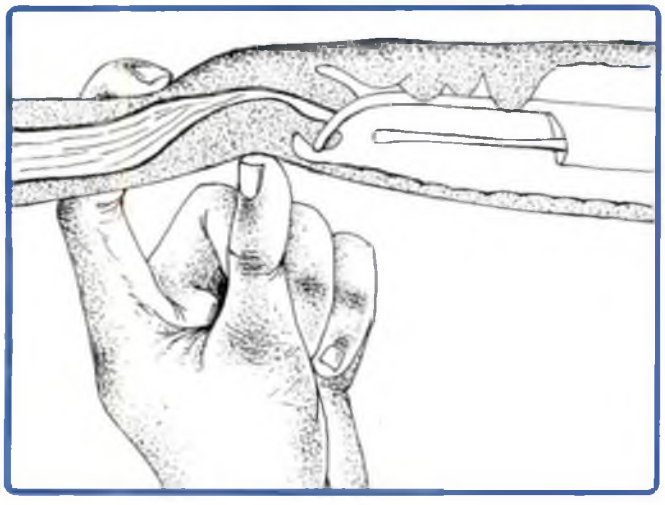


Plate 4. Schematic drawing of transcervical cannulation by Technique I

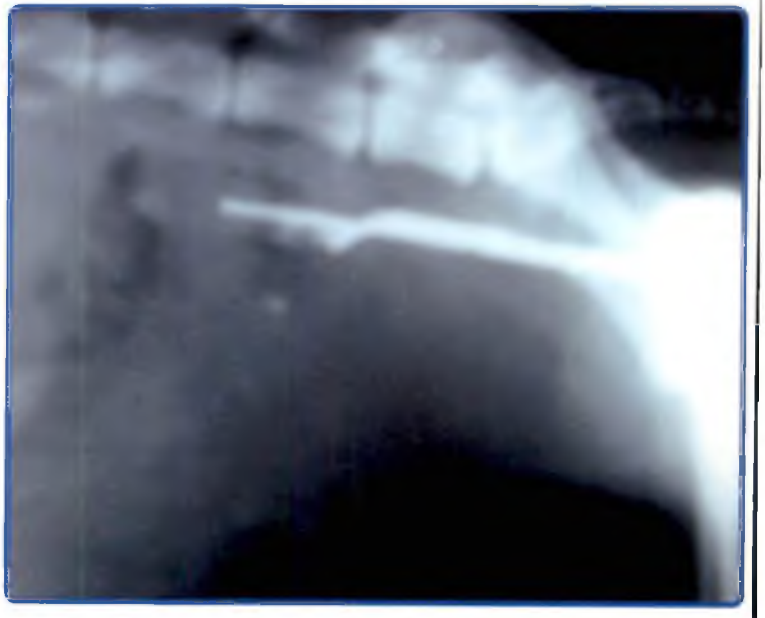


Plate 5. Skiagram showing the transcervical positioning of cannula by Technique I (Dog No. I_4)

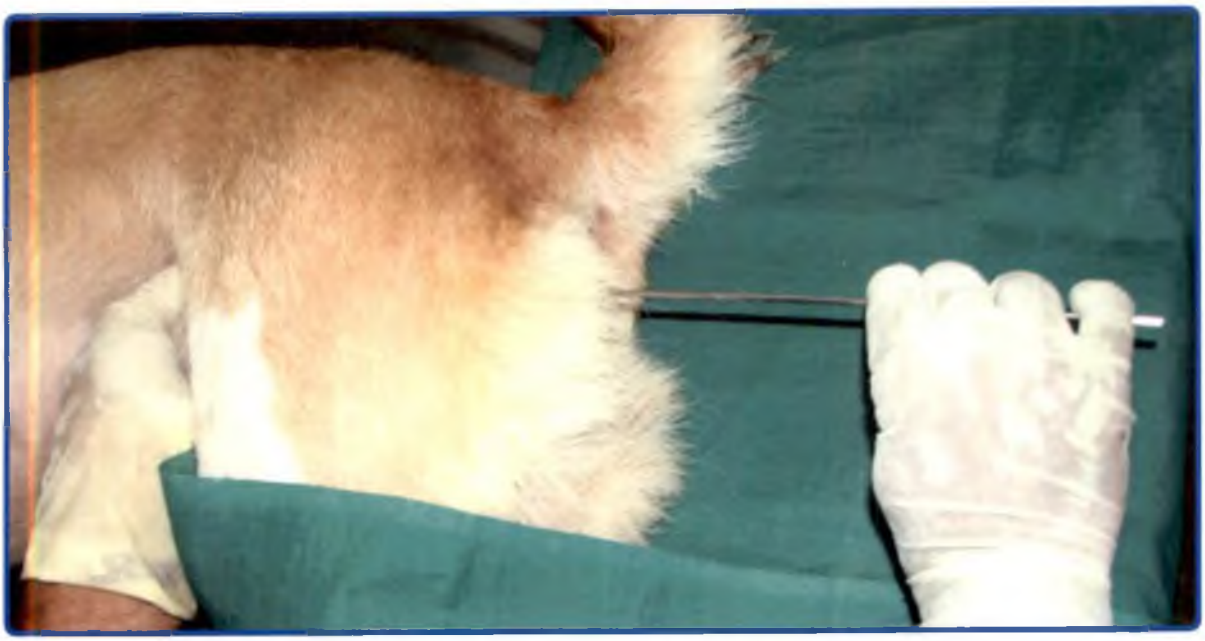
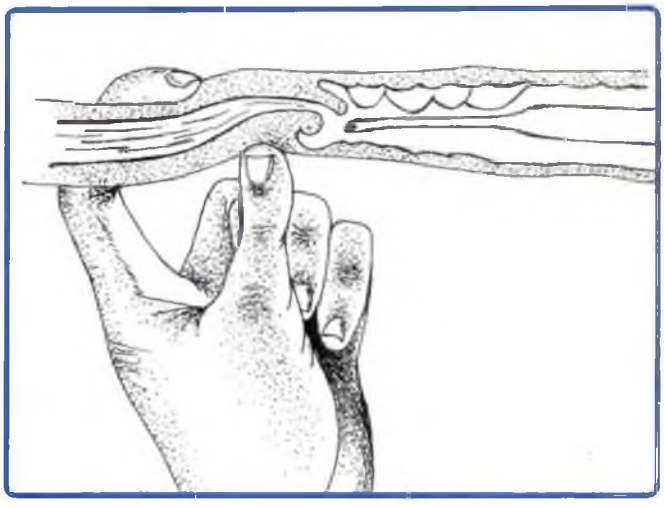


Plate 6. Transcervical cannulation by Technique II

Plate 7. Schematic drawing of transcervical cannulation by Technique II



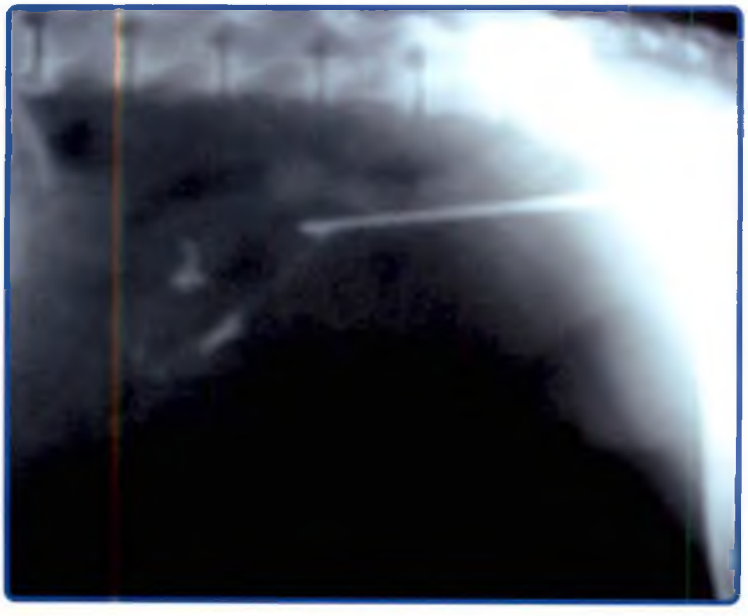


Plate 8. Skiagram showing transcervical positioning of cannula by Technique II (Dog. No. II_6)

Plate 9. Transcervical cannulation by Technique III

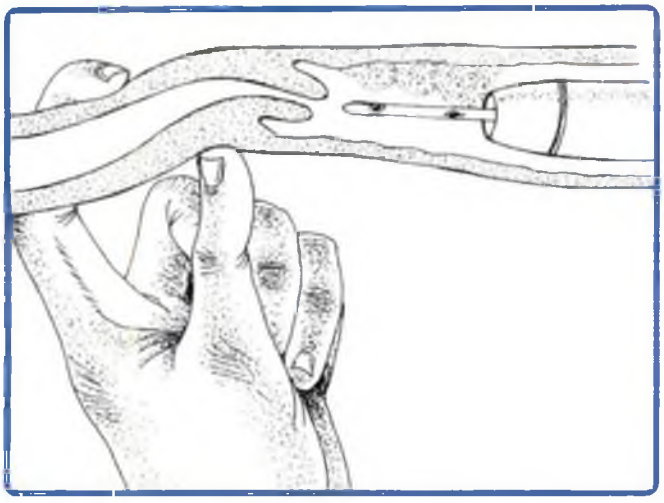


Plate 10. Schematic drawing of transcervical cannulation by Technique III

Plate 11. Skiagram showing placement of speculum in Technique III

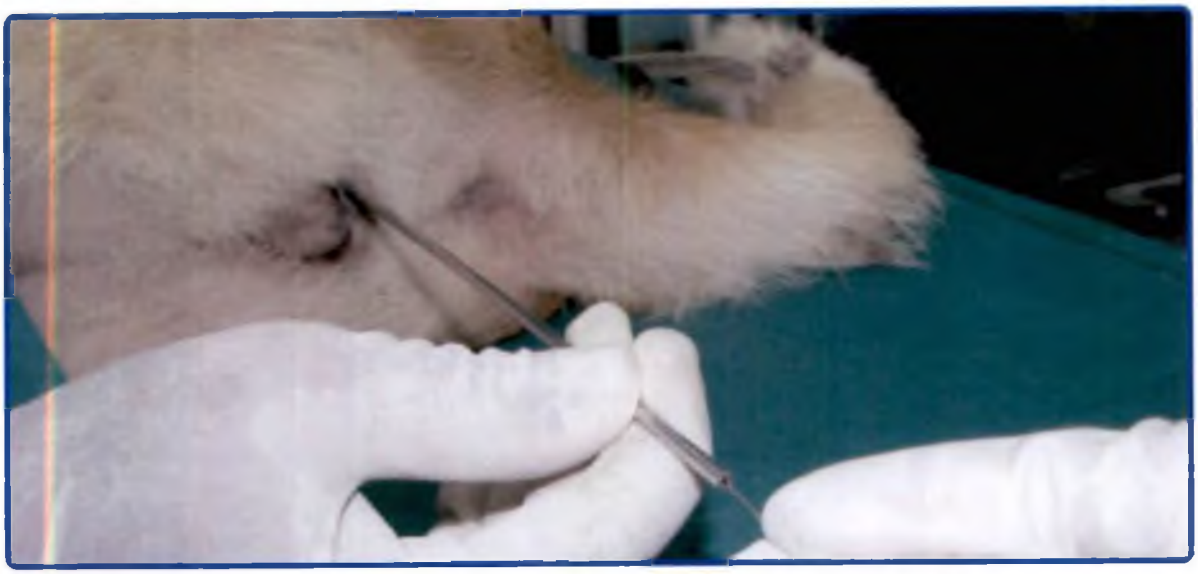


Plate 12. Transcervical catheterisation – Passing 26 G steel wire through the cannula

Plate 13. Transcervical catheterisation – Threading polythene catheter over steel wire

Plate 14. Transcervical catheterisation – Catheter fixed at vestibulo-vaginal junction by silk sutures

Plate 15. Contrast medium – Trazograph 60 %, diatriazoate meglumine

Plate 16. Lutalyse – Dinoprost tromethamine

Plate 17. Ovariohysterectomy – Uterus exteriorised during the surgery

RESULTS

4. RESULTS

4.1. GROUP I

4.1.1. Anamnesis (Table 1)

4.1.1.1. Breed

Dogs of this group belonged to German Shepherd Dog (2), Spitz (2), Dachshund (1) and Labrador retriever (1).

4.1.1.2. Age

Average age of the dogs was 11.0 ± 3.5 years with a range of six to 15 years.

4.1.1.3. Body weight

Body weight of the dogs ranged from nine to 28 kg.

4.1.1.4. Parity

Among these dogs three (I_1, I_3 and I_5) had whelped once, before the age of two years and never mated thereafter. Remaining three dogs (I_2, I_4 and I_6) were nulliparous and never mated in any of the oestrus.

4.1.1.5. Occurrence of last oestrus and mating

The dogs of this group had shown oestrus signs, approximately, on an average 60 days back and except in one dog (I_2), which had not shown oestrus recently. Any of the dogs of this group was not mated in last oestrus.

4.1.1.6. Food Intake

Food intake was reduced in four dogs (I_2, I_4, I_5 and I_6) and absent in two (I_1 and I_3) at the time of admission. Food intake gradually improved in I_4 and I_6, which

recorded clinical improvement with the treatment. In others appreciable increase in food intake was not observed.

4.1.1.7. Polydipsia and Vomiting

Polydipsia and vomiting were reported in all the dogs of this group, except in I_4 and I_5 in which only polydipsia was noted.

4.1.1.8. Vulval Discharge

Purulent vulval discharge was reported in three dogs (I_2, I_4 and I_6); sanguineopurulent discharge in two (I_1 and I_5) and vulval discharge was not noticed in one dog (I_3).

4.1.2. Clinical Observations (Table 2)

4.1.2.1. Abdominal Distension

Abdomen was highly distended and pear shaped in two dogs (I_1, and I_6) on the preoperative day. In other two dogs (I_2 and I_3) it was markedly distended and in the remaining two (I_4 and I_5) moderately. Abdominal distension was increased in I_2 by 14th day and in I_5 by seventh day and they underwent ovariohysterectomy subsequently. Dog No. I_4 had shown inappreciable abdominal distension by 14th day onwards. But in Dog No. I_6 it reduced to inappreciable level by 21st day. Both theses dogs improved clinically.

4.1.2.2. Vulval Discharge

Vulval discharge was copious and purulent in three dogs (I_2, I_4 and I_6). It was scanty and purulent in one (I_3) and moderate and sanguino-purulent in two (I_1 and I_5). Moderate vaginal discharge remained in I_2 and I_4 upto 14th and seventh days respectively. In I_4 and I_6, which recovered, vaginal discharge became scanty by 14th day and was totally absent by 28th day.

4.1.2.3. Appearance of Vulval Lips

The vulval lips, except in one dog (I_3), were oedematous in all cases. In recovered cases it became normal by 14th or 21st day postoperatively.

4.1.2.4. Polydipsia and Vomiting

Polydipsia and vomiting were present in four dogs (I_1, I_2, I_3 and I_6) and polydipsia alone in two (I_4 and I_5) on the initial stages. These symptoms were not shown by the two recovered dogs (I_4 and I_6) after seventh day of observation.

3.0.2. Physiological Parameters (Table 3)

4.1.3.1 Respiratory Rate

The mean respiratory rate (per min) was 34.5 ± 1.75 before treatment and 33.6 ± 3.29, 34.25 ± 2.06, 34.0 ± 2.0, 34.0 ± 0 and 32.0 ± 0 at 24 hr and on seventh, 14th, 21st and 28th days after treatment respectively. The variations in the respiratory rate were within the normal range.

4.1.3.2. Pulse Rate

The average pulse rate (per min) recorded was 104 ± 11.03 pre-operatively 98.8 ± 10.16, 101.5 ± 4.43, 98 ± 0, 102 ± 0 and 100 ± 2.83 respectively on 24 hr and on seventh, 14th, 21st and 28th day post operatively. All the values of the pulse rate were within normal range.

4.1.3.3. Rectal Temperature

The average rectal temperature (°C) recorded was 39.23 ± 0.86 before treatment and 38.92 ± 0.95, 39.1 ± 0.6, 38.67 ± 0.12, 38.6 ± 0 and 38.9 ± 0.14 respectively at 24 hr and on seventh, 14th, 21st and 28th days after treatment. The average values were within normal range. Dog No. I_3, which died on third day after uterine catheterization, had shown hypothermia on both the days of observation. All the other animals had shown mild to moderate hyperthermia, before and upto seventh day after treatment.

4.1.3.4. Colour of Visible Mucous Membrane (Table 4)

The colour of visible mucous membrane was pale roseate in all animals throughout the period of observation except in case number I_3 and I_5 which was pale throughout the available period of observation.

4.1.3. Haematological Parameters (Table 3)

4.1.4.1. Total Leucocyte Count

The average total leucocyte count (TLC) ($x10^3$ cells/c mm) was 49.25 ± 24.52 preoperatively and 58.0 ± 20.3, 34.7 ± 9.02, 23.97 ± 12.67, 12.3 ± 0 and 9.35 ± 1.2 respectively at 24 hr and on seventh, 14th, 21st and 28th days of post operative observation. Marked leucocytosis, noticed upto seven days of admission, was reduced to moderate leucocytosis by 14th day and to normal ranges by 21st day post operatively. Dog Nos. I_1 and I_3 showed extreme leucocytosis in the initial stages. But Dog No. I_6 had, though elevated initially, TLC remainedwithin normal range throughout the period of observation.

4.1.4.2. Differential Leucocyte Count

The differential leucocyte count (DLC) had shown a typical neutrophelia with a regenerative shift to left and a relative lymphopenia in all the six animals initially. The mean DLC (%) was as neutrophils 50 ± 9, band cells 34 ± 8, lymphocytes 15 ± 6, monocytes 1 ± 0 and eosinophils 2 ± 1 on the preoperative day. On 28th postoperative day, it was as neutrophils 51 ± 8, band cells 8 ± 5, lymphocytes 38 ± 4, monocytes 2 ± 0, eosinophils 3 ± 0 and basophils 1±0. Generally neutrophilia was marked to extreme till 14th postoperative day, which reduced gradually thereafter.

4.1.4.3. Haemoglobin Concentration

The mean haemoglobin concentration (gm/dl) recorded was 9.45 ± 1.98, preoperatively and 8.68 ± 1.08, 9.63 ± 2.27, 9.87 ± 2.42, 11.8 ± 0 and 11.9 ± 0.42

postoperatively at 24 hrs and on seventh, 14th, 21st and 28th days respectively. Haemoglobin concentration was lower than normal range in all the animals preoperatively as well as postoperatively. The fall in haemoglobin concentration was more at 24 hr observation postoperatively. But had shown gradual increase from 21st postoperative day onwards. Very low haemoglobin values were recorded in Dog No. I_3.

4.1.4.4. Volume of Packed Red Cells

Volume of packed red cells (VPRC) (v%) was lower than the normal range in all animals except in one (I_6) at the time of admission and throughout the observation period. But a gradual increase to normal levels was noticed from 21st postoperative day onwards. The mean VPRC was 29.5 ± 6.63, 25.89 ± 2.28, 30.0 ± 7.66, 31.33 ± 8.08, 36.0 ± 0 and 39.0 ± 1.41 respectively on preoperative day, at 24 hr, on seventh, 14th, 21st and 28th day of postoperative days.

4.1.4.5. Erythrocyte Sedimentation Rate

The average erythrocyte sedimentation rate (ESR) (mm/one hr) was 70.83 ± 67.57 preoperatively. Postoperatively at 24 hr and on seventh, 14th, 21st and 28th days the ESR was 86.8 ± 65.87, 44.25 ± 47.63, 46.67 ± 64.47, 12.0 ± 0 and 9.0 ± 4.24 respectively. Generally in this group the mean ESR values were elevated initially till 14th postoperative day and then came back to normal limits on subsequent observations. The ESR had shown wide variation ranging from 8 to 160 preoperatively and was very much higher than the normal range in case numbers I_1, I_2, I_3 and I_5. In others it remained within normal range.

4.1.5. Serum Biochemical Parameters (Table 3)

4.1.5.1. Blood Urea Nitrogen

The mean blood urea nitrogen (BUN) (mg/dl) was 73.67 ± 94.03 pre operatively and 84.6 ± 104.01, 37.75 ± 12.76, 31.33 ± 5.03, 25.0 ± 0 and 17.0 ± 1.41 at 24 hr and

on seventh, 14th, 21st and 28th days post operatively. The BUN values had shown a marginal increase in all the dogs on the first day and gradually returned to normal range by 21st postoperative day. BUN was extremely raised in dog no. I_3, which died on third postoperative day.

4.1.5.2. Serum Creatinine

Serum creatinine was within normal range in all the dogs except the Dog No. I_3 (8.4 mg/dl on the first day). The mean serum creatinine concentration (mg/dl) in this group was 2.45 ± 2.92 preoperatively and 2.78 ± 3.28, 1.28 ± 0.34, 1.2 ± 0.44, 1.8 ± 0 and 1.3 ± 0.71 postoperatively in respective observations made at 24 hr and on seventh, 14th, 21st and 28th days. The elevated values observed on the day of admission were gradually reduced to normal by seventh day, except in I_3, which died on the third day.

4.1.5.3. Alanine aminotransferase

The mean value of alanine aminotransferase (ALT) (IU/L) obtained in this group was 64.17 ± 74.97 preoperatively and 71.0 ± 81.66, 37.0 ± 1.15, 34.67 ± 7.02, 34.0 ± 0 and 29.0 ± 1.41 postoperatively at 24 hr and on seventh, 14th, 21st and 28th days respectively. All the animals had shown homogenous values slightly higher than the normal range, except Dog No. I_3, which had an extremely high value of 217 IU/L and that affected the averages.

4.1.5.4. Serum Potassium

The mean serum potassium level (m mol/L) was 4.53 ± 0.9 pre operatively and 4.26 ± 0.57, 4.5 ± 0.68, 4.3 ± 0.46, 4.3 ± 0 and 3.85 ± 0.49 respectively at 24 hrs and on seventh, 14th, 21st and 28th days post operatively. The mean values before and after treatment remained within the normal range. The individual values were elevated in I_3 and I_6. The former died on third day and in the latter the values gradually became normal.

4.1.6. Hormonal Assay (Table 3)

4.1.6.1. Oestradiol

The mean serum oestradiol level (pg/ml) was 95.05 ± 65.77 pre operatively and 81.0 ± 26.26, 53.33 ± 27.81, 39.62 ± 28.26, 23.5 ± 0 and 18.9± 4.38 respectively at 24 hrs, and on seventh, 14th, 21st and 28th days post operatively. The mean oestradiol concentration had shown gradual reduction towards the last observation.

4.1.6.2. Progesterone

The progesterone level (ng/ml) on an average was 2.81 ± 1.69 preoperatively in this group. Post operatively the progesterone levels were 3.72 ± 1.6, 2.83 ± 1.77, 1.9 ± 1.13, 0.9 ± 0 and 0.63 ± 0.25 at 24 hr and on seventh, 14th, 21st and 28th day respectively. After an initial elevation at 24 hr observation, the serum progesterone had shown a gradual decline towards the end of observation period.

4.1.7. Formol Gel Test (Table 5)

The Formol gel test was positive in 10 min in three dogs (I_1, I_3 and I_5), positive in 30 min in one (I_2), positive in 40 min in one (I_4) on the day of admission and the test was negative upto 12 hours in one dog (I_6) in all the observations. It became negative in Dog No. I_4 from seventh day onwards.

4.1.8. Radiographic Evaluation

4.1.8.1. Survey Radiography

On the survey radiographs taken in all the cases preoperatively, the uterus appeared as distended tubular structures of uniform radiopacity occupying majority of the space in the abdominal cavity.

4.1.8.2.Hysterography (Table 17)

Hysterography was performed in two dogs (I_4 and I_6), where the transcervical cannulation was successful. Inside the uterus the contrast material was not always found easily dispersed because of the thick and tenacious uterine contents, as found later after ovariohysterectomy

4.1.8.2.1. Anaesthesia and control

The anaesthetic protocol selected was satisfactory for the transcervical cannulation and all the dogs had an uneventful recovery. The dogs were controlled on right lateral recumbency, which was found convenient for manipulations in transcervical cannulation.

4.1.8.2.2. Transcervical Cannulation Technique (Table 17)

Among the dogs of this group transcervical cannulation was successful in two dogs *viz.*, Dog No. I_4 and I_6 using Technique I and III respectively.

The difficulties encountered in Technique I were the lack of reachability of wire loop on the guiding device upto the *portio vaginalis* of cervix, through the anatomically narrow anterior vagina, further narrowed by the presence of dorsal median paracervical folds. Alignment of the cervical canal and the cannula, both with the wire loop as well as with palpation were difficult. So also the location of the *os* of cervix by feeling movement of the cannula as the size of the cervix was too small to locate and hold especially in dogs with thick abdominal wall.

The difficulty felt in Technique II was to locate the *os* of the cervix and to push the cannula through it. Transabdominal fixing of the small cervix was not practical in all the cases, especially in those with thick abdominal wall.

In Technique III, the narrow anterior vagina did not permit the proctoscope upto the *portio vaginalis* of cervix. Hence catheter was tried to pass through the cervix by manipulation alone, without actually visualizing it, even though an illuminated device of sufficient diameter was used. Transabdominal location of the small cervix was difficult in dogs with large abdomen

4.1.8.2.3.Radiographic Observation

Dog No. I_1: The plain lateral abdominal radiograph, before treatment had shown a moderate distension of the uterus. In contrast radiography uterine cannulation was failed and the contrast material was visible as a tortuous thread at the pelvic brim, filling the anterior vagina with the major quantity of the contrast material accumulated in the mid vagina.

Dog No. I_2: Plain lateral abdominal radiograph on first day of admission was showing grossly enlarged uterus with sacculations and air in the rectum. Contrast radiography was not taken as the cannulation was failed. On seventh day, the silhouette of the distended uterus was still visible.

Dog. No. I_3: Plain lateral abdominal radiograph on the day of admission was showing grossly distended uterus occupying most of the abdominal cavity giving a uniform ground grayish black appearance. The second radiograph on the same day had shown accumulation of contrast material in the mid vagina inside the pelvic canal showing incorrect position of cannula.

Dog No. I_4: Survey radiograph with the cannula in position showed moderate distension of uterus. Contrast radiograph clearly showed diffusion of the contrast material into both the uterine horns as radiopaque strips with serrated borders coiled each other. Plain radiograph taken on seventh day of observation showed distended uterine horns but reduced in size and in that taken on 28^{th} day the image of the uterus was inappreciable (Plate 5, 18 and 19).

Dog No. I_5: Plain radiograph showed gross distension of uterus with clear sacculations, folded backward at the anterior end. Hysterography was not successful; a thin stream of contrast material in the anterior vagina was visible. Conducted ovariohysterectomy on the 10^{th} day.

Dog No. I_6: Silhouette of the distended uterus was visible with sacculations and was folded backward, occupying major part of abdominal cavity. In the contrast radiography, some quantity of the contrast material had entered into the uterus, making its posterior part visible as an ovoid structure with even borders. The vagina was also lined by the contrast material that escaped outside. Distended uterus as imaged on seventh day and on 28^{th} day the image of the uterus was inappreciable on plain radiograph.

4.1.9. Sonological Observations

Ultrasonography was conducted in three dogs (I_2, I_4 and I_6) preoperatively and on seventh and 28^{th} postoperative days.

Dog No. I_2: The uterine horns were visible preoperatively as distended hypoechoic circles in the transverse scans with very thin walls. Any change in size or echo texture was obtained on seventh day postoperatively.

Dog No. I_4: Preoperatively the uterine horns were visible as distended, anechoic round structures with thin walls. On the seventh day the uterine distension was reduced, walls thickened and irregularly shaped. By 28^{th} day the size was regressed to small and was only slightly appreciable (Plate 20 and 21).

Dog No. I_6: Preoperatively the uterus was distended, hypoechoic with sacculations. On 28^{th} day observation the size of the uterus was regressed very much and walls appeared thick.

4.1.10. Surgical Management

Passage and retention of transcervical catheter was performed in two cases (I_4 and I_6) (Table 17), where the transcervical cannulation was successful. In the former case there was moderate drainage of pus was noticed for two days and it was scanty thereafter. But on seventh day of observation, the catheter was found displaced from the uterus and was protruding between the vulval lips. In the latter case catheter was mutilated and removed by the dog on the fifth day and till then there was drainage through the tube.

4.1.11. Outcome of the Treatment (Table 6)

4.1.11.1. During the period of observation

Dog No. I_1, as the transcervical cannulation using Technique II and hence the intrauterine catheterization was failed, was subjected to ovariohysterectomy on the third day of admission and recovered subsequently.

In Dog No. I_2, the attempts for transcervical cannulation using Technique I and placement of intrauterine catheter were not fruitful. Clinically the condition of the dog was found declining by 14^{th} day and ovariohysterectomy was performed on 16^{th} day and the dog recovered eventually.

Dog No. I_3 died on the third day of admission, in which transcervical cannulation by Technique II and passage of intrauterine catheter was failed.

Dog No. I_4 transcervical cannulation via Technique I for hysterography and intrauterine catheterization was successful. The catheter was found misplaced on the seventh day. But subsequently the dog improved clinically and was discharged.

Dog No. I_5, in which the transcervical cannulation with Technique III failed, was subjected to ovariohysterectomy on the 10th day of admission and recovered subsequently.

In Dog No. I_6, the passage of transcervical cannulation was effected by Technique III and the intrauterine catheter placed. It was mutilated and removed by the dog on fifth day. Subsequently the dog clinically improved and was discharged as cured.

4.1.11.2 Long Term observation

Information was not followed up after 28 days in dog I_1, I_2 and I_5 which were subjected to ovariohysterectomy. Dog No. I_4 had shown a healthy oestrus four months after the treatment, but was not mated. But the same dog was presented, eight months later, with recurrence of symptoms of pyometra and ovariohysterectomy was performed. About Dog No. I_6 that clinically recovered after treatment, further information was not available as the owners shifted from the given address.

Table 1. Observations on breed, age, body wiehgt and history of dogs with pyometra selected for the study

Group	Animal No.	Breed	Age (Years)	Body Weight(kg)	Parity	Last estrus seen before	Mated in last oestrus or not	Food Intake	Vomiting	Polydipsia	Vulval discharge	
											Presence	Nature
Group I	I_1	Spitz	9	12	1	one month	N	Absent	Y	Y	Y	SP
	I_2	Dachshund	15	13	0	Not noticed	N	Reduced	Y	Y	Y	P
	I_3	Spitz	14	9	1	3 months	N	Absent	Y	Y	N	NA
	I_4	German Shephered Dog	6	27	0	2 months	N	Reduced	N	Y	Y	P
	I_5	German Shephered Dog	13	24	1	1.5 months	N	Reduced	N	Y	Y	SP
	I_6	Labrador	9	28	0	2 months	N	Reduced	Y	Y	Y	P
		Group Mean	11.0 ± 3.5			60 days						
Group II	II_1	Lhaza Apso	8	7	0	Not noticed	N	Absent	Y	Y	Y	P
	II_2	German Shepherd Dog	9	26	0	Not noticed	N	Reduced	N	Y	Scanty	P
	II_3	Spitz	14	6	1	2 months	N	Absent	Y	Y	N	NA
	II_4	Dalmatian	12	30	0	1.5 months	N	Reduced	Y	N	Y	P
	II_5	Spitz	12	11	0	6 months	N	Reduced	Y	Y	Scanty	SP
	II_6	Labrador Retriever	4	37	1	3 weeks	Y	Reduced	N	Y	Scanty	P
		Group Mean	9.8 ± 3.6			76.5 days						
Group III	III_1	Labrador cross	12	29	1	6 months	N	Redued	N	Y	Y	SP
	III_2	Spitz	7	8	1	1.5 months	N	Reduced	Y	Y	Y	SP
	III_3	Cocker Spaniel	5	12	0	Not noticed	N	Absent	Y	N	Y	SP
	III_4	Dachshund	10	12	0	3 weeks	N	Absent	N	Y	N	NA
	III_5	Spitz	11	11	0	one month	N	Absent	N	Y	Y	SP
	III_6	Spitz cross	4	14	0	3 weeks	Y	Absent	Y	Y	Y	P
		Group Mean	8.2 ± 3.3			59.4 days						
Mean		Mean of all dogs	9.7± 3.5			63.4 days						

Y - Yes N - No P - Purulent SP - Sanguineopurulent NA - Not Applicable

Table 2. Clinical observations of the dogs of Group I before and after treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day	Remarks
Abdominal Distension							
I_1	++++	++++	Ovariohysterectomy on 3rd day				++++ Highly distended and pear shaped +++ Marked distension ++ Moderate distension + Slight distension - No distension NA Observation not available
I_2	+++	+++	++	+++	Ovariohysterectomy		
I_3	+++	+++	Patient died on 3rd day				
I_4	++	++	+	-	NA	-	
I_5	++	++	+++	Ovariohysterectomy			
I_6	++++	NA	++	++	-	-	
Vulval Discharge							
I_1	++	++	Ovariohysterectomy on 3rd day				+++ Copious discharge ++ Moderate discharge + Scanty discharge - No discharge NA – Observation not available
I_2	+++	+++	++	++	Ovariohysterectomy		
I_3	+	+	Patient died on 3rd day				
I_4	+++	+++	++	+	NA	-	
I_5	++	++	+	Ovariohysterectomy			
I_6	+++	NA	+	+	-	-	
Appearance of the Vulval Lips							
I_1	E	E	Ovariohysterectomy on 3rd day				E – Oedematous N – Normal NA – Observation not available
I_2	E	E	E	N	Ovariohysterectomy		
I_3	N	N	Patient died on 3rd day				
I_4	E	E	E	E	NA	N	
I_5	E	E	N	Ovariohysterectomy			
I_6	E	NA	E	N	N	N	
Polydipsia and Vomiting							
I_1	P & V	P & V	Ovariohysterectomy on 3rd day				P – Polydipsia V – Vomiting P & V- Polydipsia and vomiting NA – Observation not available
I_2	P & V	P & V	P	-	Ovariohysterectomy		
I_3	P & V	P & V	Patient died on 3rd day				
I_4	P	P	-	-	NA	-	
I_5	P	P	P	Ovariohysterectomy			
I_6	P & V	NA	-	-	-	-	

Table 3. Physiological, haematological, biochemical and hormonal parameters in dogs of Group I, before and after the treatment

Parameters	Before	24 hr	7th day	14th day	21st day	28th day
Physiological Parameters						
Rate of respiration (per min)	34.5 ± 1.75	33.6 ± 3.29	34.25 ±2.06	34.0 ± 2.0	34.0 ± 0	32 ± 0
Pulse Rate (per min)	104 ±11.03	98.8 ± 10.16	101.5 ± 4.43	98.0 ± 0	102 ± 0	100 ± 2.83
Rectal Temperature (^{0}C)	239.23 ± 0.86	38.92 ± 0.95	39.1 ± 0.6	38.67 ± 0.12	38.6 ± 0	38.9 ± 0.14
Haematological Parameters						
Total Leucocyte Count (x 10^3 /cmm)	49.25 ± 24.52	58.0 ± 20.3	34.71 ± 9.02	23.97 ± 12.67	12.3 ± 0	9.35 ± 1.2
Differential Leucocyte Count (%)						
Neutrophils	49 ± 9	51 ± 12	52 ± 5	55 ± 7	52 ± 0	51 ± 8
Band Cells	34 ± 8	31 ± 8	25 ± 9	20 ± 11	7 ± 0	8 ± 5
Lymphocytes	15 ± 6	16 ± 5	20 ± 5	22 ± 10	32 ± 0	38 ± 4
Monocytes	1 ± 0	1 ± 1	1 ± 1	0 ± 0	2 ± 0	2 ± 0
Eosinophils	1 ± 1	1 ± 1	2 ± 0	3 ± 1	6 ± 0	3 ± 0
Basophils	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	1 ± 0
Haemoglobin concentration (g/dl)	9.45 ± 1.98	8.68 ± 1.08	9.63 ± 2.27	9.87 ± 2.42	11.8 ± 0	11.9 ± 0.42
Volume of Packed Red Cells (v%)	29.5 ± 6.63	25.9 ± 2.28	30.0 ± 7.66	31.33 ± 8.08	36.0 ± 0	39.0 ± 1.41
Erythrocyte edimentation Rate (mm/ one hr)	70.83 ± 67.57	86.8 ± 65.87	44.25 ± 47.63	46.67 ± 64.47	12.0 ± 0	9.0 ± 4.24
Biochemical Parameters						
Blood Urea Nitrogen (mg/dl)	73.67 ± 94.03	84.6 ± 104.01	37.75 ± 12.76	31.33 ± 5.03	25.0 ± 0	17.0 ± 1.41
Creatinine (g/dl)	2.45 ± 2.92	2.78 ± 3.28	1.28 ± 0.34	1.2 ± 0.44	1.8 ± 0	1.3 ± 0.71
Alanine aminotransferase (IU/L)	64.17 ± 74.97	71.0 ± 81.66	37.0 ± 1.15	34.67 ± 7.02	34.0 ± 0	29.0 ± 1.41
Potassium (m mol/L)	4.53 ± 0.9	4.26 ± 0.57	4.5 ± 0.68	4.3 ± 0.46	4.3 ± 0	3.85 ± 0.49
Hormonal Assay						
Oestradiol (pg/ml)	95.05 ± 65.77	81.0 ± 26.26	53.33 ± 27.81	39.62 ± 8.26	23.5 ± 0	18.9 ± 4.38
Progesteron (ng/ml)	2.81 ± 1.69	3.72 ± 1.6	2.83 ± 1.77	1.9 ± 1.13	0.9 ± 0	0.63 ± 0.25

Table 4. Physiological parameters – Colour of mucous membrane in Group I before and after the treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
I_1	PR	PR	Ovariohysterectomy on 3rd day			
I_2	PR	PR	PR	PR	Ovariohysterectomy	
I_3	Pale	Pale	Patient died on 3rd day			
I_4	PR	PR	Pale	PR	NA	PR
I_5	Pale	Pale	Pale	Ovariohysterectomy		
I_6	PR	NA	Pale	Pale	PR	PR

PR - Pale Roseate NA - Not available

Table 5. Observation in Formol gel test in Group I before and after the treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
I_1	10 min	10m min	Ovariohysterectomy on 3rd day			
I_2	30 min	30 min	30 min	20 min	Ovariohysterectomy	
I_3	10 min	10 min	Patient died on 3rd day			
I_4	40 min	40 min	Negative	Negative	NA	Negative
I_5	10 min	10 min	NA	Ovariohysterectomy		
I_6	Negative	NA	Negative	Negative	Negative	Negative

Table 6. Outcome of the treatment in Group I

Animal No.	Transcervical drainage and its outcome	Next oestrus seen	Mated or not	Whelped or not	Pyometra - Recurrence
I_1	Failed, ovariohysterectomy on 3rd day and recovered	NA	NA	NA	NA
I_2	Failed, ovariohysterectomy on 16th day and recovered	NA	NA	NA	NA
I_3	Failed. Patient died on 3rd day	NA	NA	NA	NA
I_4	Successful, catheter displaced on 7th day and recovered	After 4 months	No	NA	after 8 months
I_5	Failed, ovariohysterectomy on 10th day and recovered	NA	NA	NA	NA
I_6	Successful, catheter removed by the dog on 5th day and recovered	Not available. Owner shifted			

4.2. GROUP II

4.2.1. Anamnesis (Table 1)

4.2.1.1 Breed

Dogs of this group belonged to Dalmatian (1), German Shepherd Dog (1), Lhaza Apso (1) and Labrador retriever (1) and Spitz (2).

4.2.1.2 Age

Average age of dogs of this group was 9.8 ± 3.6 years with a range of 4 to 14 years.

4.2.1.3. Body Weight

Body weight of the dogs ranged from six to 37kg.

4.2.1.4.Parity

Among these dogs two (II_3 and II_6) had whelped once, before the age of two years. The former was never mated thereafter and the latter mated twice but not conceived. Remaining four dogs (II_1, II_2, II_4 and II_5) were nulliparous and never mated in any of the oestrus.

4.2.1.5.Occurrence of last oestrus and mating

The dogs this group had shown oestrus signs, approximately on an average, 76.5 days back and except in two (II_1 and II_2), which had not shown oestrus signs recently. Any of the dogs of this group were not mated in last oestrus, except II_6 .

4.2.1.6. Food Intake

Food intake was reduced in four dogs (II_2, II_4, II_5 and II_6) and absent in two (II_1 and II_3). Food intake gradually improved in II_2, II_4 and II_6, which recorded clinical

improvement with treatment. In others appreciable increase in food intake was not recorded till the end of observations.

4.2.1.7. Polydipsia and Vomiting

Polydipsia and vomiting were reported in three dogs (II_1, II_3 and II_5) and only polydipsia in the remaining three (II_2, II_4 and II_6).

4.2.1.8. *Vulval discharge*

Purulent vulval discharge was reported in four dogs (II_1, II_2, II_4 and II_6); sanguineopurulent discharge in one (II_5) and vulval discharge was not reported in one dog (II_3).

4.2.2. Clinical Observation **(Table 7)**

4.2.2.1. Abdominal distension

Abdomen was highly distended and pear shaped in animal number II_3, on the preoperative day. In animals II_1, II_4 and II_5 it was markedly distended and distension was not reduced much in both these dogs and were subjected to ovariohysterectomy after 14 days. While animal II_4 had marked distension, which was much reduced after 14th day. Slight abdominal distension was recorded in II_2 and II_6 that reduced subsequent to the treatment.

4.2.2.2. Vulval Discharge

Vaginal discharge was moderate and purulent in two dogs (II_1 and II_4). It was scanty and purulent in other two (II_2 and II_6); scanty and sanguinopurulent in one (II_5) and was inappreciable in one (II_3). Moderate vaginal discharge remained in II_1 on 14th day. In Dog No. II_2 and II_6 that were catheterized successfully, vaginal discharge became scanty by 14th day and totally absent by 28th day. In Dog No. II_4 that recovered

with $PGF_{2\alpha}$ treatment alone the vaginal discharge was absent by 14^{th} day. In II_3 discharge was increased to moderate level by 14 days and it died on 16^{th} day.

4.2.2.3.Appearance of vulval lips

The vulval lips, except in II_3 and II_6, were oedematous in all cases on the preoperative day, which became normal by 14^{th} day postoperatively in the recovered dogs.

4.2.2.4. Polydipsia and Vomiting

Polydipsia and vomiting were present in three dogs (II_1, II_2 and II_5) and polydipsia alone in three (II_2, II_4 and II_6) on the initial stages. These symptoms disappeared by seventh day in Dog No. II_6 and by 14^{th} day in II_2 and II_4.

4.2.3. Physiological Parameters (Table 8)

4.2.3.1. Respiratory Rate

The mean respiratory rate (per min) was 33.33 ± 3.72 before treatment and 32.67 ± 1.63, 32.0 ± 3.1, 32.75 ± 0.96, 31.33 ± 1.15 and 31.33 ± 2.31 at 24 hr and on seventh, 14th, 21^{st} and 28^{th} days after treatment respectively. The variations in the respiratory rate were within the normal range.

3.1.2.1. Pulse Rate

The average pulse rate (per min) recorded was 97.33 ± 7.45 pre-operatively 95.17 ± 5.53, 92.0 ± 3.1, 89.75 ±4.35, 91.33 ± 1.15 and 92.0 ± 4.0 respectively on 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} day post operatively. All the values of the pulse rate were within normal range.

4.2.3.3. Rectal Temperature

The average rectal temperature (°C) recorded was 39.3 ± 0.5 before treatment and 39.23 ± 0.39, 38.9 ± 0.35, 38.5 ± 0.48, 39.0 ± 0.35 and 38.8 ± 0.53 respectively at 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} days after treatment. The average values were

within normal range. Dog No. II_3, which died on 16th day after uterine catheterization, had shown hypothermia on 14th day observation. All the other animals had shown mild to moderate hyperthermia, before and upto seventh day after treatment.

4.2.3.4. Colour of Visible Mucous Membrane (Table 9)

The colour of visible mucous membrane was pale roseate in II_3, II_4 and II_6, pale in II_1 and II_5 and congested in II_2.

4.2.4. Haematological Parameters (Table 8)

4.2.4.1. Total Leucocyte Count

The average total leucocyte count (TLC) ($x10^3$ cells/c mm) was 42.37 ± 21.04 preoperatively and 43.75 ± 21.82, 38.95 ± 21.95, 30.18 ± 18.09, 15.67 ± 3.13 and 12.53 ± 2.0 respectively at 24 hr and on seventh, 14th, 21st and 28th days of post operative observation. Marked leucocytosis, noticed upto 14th day of admission, was reduced to normal ranges by 21st day post operatively. Dog No. $II_1$and II_3 showed extreme leucocytosis in the initial stages. In the latter case, which died on 16th day of observation, leucocytosis remained high throughout the available period of observation. Leucocytosis was marked in II_2 and II_5 and was moderate in II_4 and II_6 initially and these dogs had shown comparatively good clinical response to the treatment.

4.2.4.2. Differential Leucocyte Count

The differential leucocyte count (DLC) had shown a typical neutrophilia with a regenerative shift to left and a relative lymphopenia in all the six animals initially. The mean DLC (%) was as neutrophils 54 ± 6, band cells 23 ± 8, lymphocytes 20 ± 9, monocytes 2 ± 0, eosinophils 3 ± 1 and basophils 1 ± 0 on the preoperative day. On 28th postoperative day, it was as neutrophils 62 ± 9, band cells 3 ± 1, lymphocytes 35 ± 2, monocytes 2 ± 0, eosinophils 2 ± 2 and basophils 1 ± 0. Generally neutrophilia was marked to extreme till seventh postoperative day, which reduced gradually thereafter.

4.2.4.3. Haemoglobin Concentration

The mean haemoglobin concentration (gm/dl) recorded was 9.73 ± 2.54, preoperatively and 9.68 ± 2.55, 8.9 ± 2.88, 10.35 ± 2.68, 12.0 ± 1.2 and 12.37 ± 0.75 post operatively at 24 hrs and on seventh, 14th, 21st and 28th days respectively. Haemoglobin concentration was lower than normal range in all the animals preoperatively as well as post operatively except II_4 and II_6, but had shown gradual increase from 14th postoperative day onwards. Very low haemoglobin values were recorded in Dog No. II_1 and II_5 throughout the available period of observation.

4.2.4.4. Volume of Packed Red Cells

The mean volume of packed red cells (VPRC) (v%) was lower than the normal range in this group throughout the observation period. But a gradual increase to normal levels was noticed from 21st postoperative day onwards. The VPRC was 30.5 ± 7.31, 30.17 ± 7.49, 26.67 ± 8.98, 32.25 ± 9.64, 36.67 ± 5.03 and 38.0 ± 3.46 respectively on preoperative day, at 24 hr, on seventh, 14th, 21st and 28th day of post operative observation. The VPRC values were within the normal range in Dog No.II_4 and II_6 throughout the observation period.

4.2.4.5. Erythrocyte Sedimentation Rate

The average erythrocyte sedimentation rate (ESR) (mm/one hr) was 68.67 ± 38.81 pre operatively. Post operatively, at 24 hr and on seventh, 14th, 21st and 28th days the ESR were 75.17 ± 39.95, 76.67 ± 58.36, 32.52 ± 24.01, 16.0 ± 10.0 and 12.0 ± 5.29 respectively. Generally in this group the mean ESR values were elevated initially till 14th postoperative day and then returned to normal limits on subsequent observations. The ESR had shown wide variation ranging from 22 to 130 pre operatively and was very much higher than the normal range in case numbers II_1, II_2, II_3 and II_5.

4.2.5. Serum Biochemical Parameters (Table 8)

4.2.5.1. Blood Urea Nitrogen

The mean blood urea nitrogen (BUN) (mg/dl) was 52.0 ± 20.94 pre operatively and 55.67 ± 22.32, 49.0 ± 23.39, 44.5 ± 40.34, 25.33 ± 10.26 and 23.67 ± 7.51 at 24 hr

4.2.6. Hormonal Assay (Table 8)

4.2.6.1. Oestradiol

The mean serum oestradiol level (pg/ml) was 64.17 ± 27.69 preoperatively and 85.33 ± 21.39, 53.5 ± 30.2, 23.0 ± 6.22, 18.0 ± 2.0 and 18.67 ± 3.06 respectively at 24 hrs, and on seventh, 14th, 21st and 28th days postoperatively.

4.2.6.2. Progesterone

The Progesterone level (ng/ml) on an average was 6.18 ± 5.43 pre- operatively in this group. Postoperatively the Progesterone levels were 4.73 ± 2.73, 2.35 ± 1.27, 1.0 ± 0.23, 0.82 ± 0.37 and 0.58 ± 0.2 at 24 hr and on seventh, 14th, 21st and 28th day respectively.

4.2.7. Formol Gel Test (Table 10)

The Formol gel test was positive in 20 min in two dogs (II_3 and II_5), positive in 30 min in two (II_4 and II_6), positive in 40 min in one (II_1) and was negative upto 12 hours in another one (II_2) on preoperative day. It became negative in II_2, II_4 and II_6 towards the end of the observation period.

4.2.8. Radiographic Evaluation

4.2.8.1. Survey Radiography

On the survey radiographs taken in all the cases preoperatively, the uterus appeared as distended tubular structures of uniform radiopacity occupying majority of the space in the abdominal cavity.

4.2.8.2. Hysterography *(Table 17)*

Hysterography was performed in two dogs (II_2 and II_6), where the transcervical cannulation was successful.

4.2.8.2.1. Anaesthesia and control

The anaesthetic protocol selected was satisfactory for the transcervical cannulation and all the dogs had an uneventful recovery. The dogs were controlled on right lateral recumbency, which was found convenient for manipulations in transcervical cannulation.

4.2.8.2.2. Transcervical Cannulation Technique (Table 17)

Among the dogs of this group transcervical cannulation was successful in two dogs *viz.,* Dog No. II_2 and II_6 using Technique III and II respectively. Penetration of the vaginal fornix and accidental deposition of contrast material intraperitoneally was recorded in Dog No. II_1.

The difficulties encountered in Technique I, II and III were same as that in Group I. In addition to that the risk of penetration of the cannula was also observed.

4.2.8.2.3. Radiographic Observation

Dog No. II_1: On plain radiograph, uterine distension could be seen as a diffused grayish white mass. In the contrast radiograph, the catheter was found reached beyond the anterior vagina and the contrast material was found spread in various parts of peritoneal cavity in a spider web pattern. Transcervical cannulation was failed and accidental penetration of the cannula at vaginal fornix and intra peritoneal deposition of contrast material was evident in this case (Plate 22).

Dog No.II_2: Silhouette of moderately distended uterus could be seen anterior to the distended urinary bladder in the survey radiograph. Contrast Radiograph taken after transcervical cannulation with Technique III had shown uterus as a radiopaque strip with a few filling defects and smooth edged. Part of proctoscope and catheter were visible. Plain radiograph taken on 28th day of observation had the uterine image almost inappreciable.

Dog No.II_3: Image of moderately distended uterus was visible on the survey radiograph. Contrast material was not infused as catheterization was failed. Any reduction in the uterine size could not be appreciated in plain radiograph taken on seventh day of treatment.

Dog No. II_4: Uterine enlargement was not appreciable in the plain radiograph taken before treatment. Transcervical cannulation was failed with Technique III. Uterine distension was not evident in the plain radiograph taken on seventh and on 28th day.

Dog No. II_5: Slight distension of uterus was observed on the plain radiograph taken before treatment. Transcervical cannulation was not successful and contrast material could be seen accumulated in the anterior and middle vagina in the second radiograph taken. Slight distension of uterus was appreciated in that radiograph also.

Dog No. II_6: Appreciably enlarged uterine image, pushed anteriorly and overlapped by distended urinary bladder, with sacculations was seen in the plain radiograph taken before treatment. Transcervical cannulation was successful with Technique II. The contrast material outlined both the uterine horns and they appeared as two ribbon like strips with approximate width of 1.5 cm with longitudinal striations and uneven edges (Plate 23). On seventh day the size of the uterus imaged was reduced than preoperative. The uterine size became inappreciable on the plain radiograph taken on 28th day (Plate24).

4.2.9. Sonological Observations

Ultrasonography was conducted in Dog No. II_2, II_4 and II_6 preoperatively and on seventh and 28th postoperative days.

Dog No. II_2: Preoperatively the uterine horns were visible as distended, anechoic round structures with sacculations. On the seventh day the uterine distension was

reduced, walls thickened and irregularly shaped. By 28th day the size was regressed to small anechoic circles.

Dog No. II_4: The uterine horns were visible preoperatively as distended hypoechoic circles in the transverse scans with very thin walls. The size was found moderately regressed and with same echo texture on seventh day and was small, thick walled and stellate shaped anechoic structure on 28th day.

Dog No. II_6: Uterus could be seen as a moderately distended hypoechoic elongated mass on the first day (Plate 25). The size was found regressed to small hypoechoic circles on 28th day postoperatively (Plate 26).

4.2.10. Surgical Management

4.2.10.1. Transcervical Drainage (Table 17)

Passage and retention of transcervical catheter was performed in two cases (II_2 and II_6) where the transcervical cannulation was successful. In the former dog, catheter was found displaced on seventh day of observation. Drainage of pus through the catheter was moderate upto two days after catheterization and absent thereafter. In Dog No. II_6 the catheter was found out of position on fifth day and till then drainage of pus was observed.

4.2.10.2. Prostaglandin $F_{2\alpha}$ Therapy

Administration of $PGF_{2\alpha}$ in catheterized dogs did not produce any appreciable difference in uterine drainage. The dogs, after receiving injection of $PGF_{2\alpha}$, dinoprost tromethamine, had developed varying degrees of excitement, panting, salivation, nausea and vomiting within five minutes of the injection, which lasted for a maximum of 20 min. Some owners complained of the dog whining at night.

4.2.11. Outcome of the treatment (Table 11)

4.2.11.1. During the period of observation

Dog No. II_1, as the transcervical cannulation using Technique II and hence the intrauterine catheterization failed, was subjected to ovariohysterectomy on the 15th day, as no improvement could be noticed by the $PGF_{2\alpha}$ and other supportive therapies. It recovered subsequently.

In Dog No. II_2, the attempts for transcervical cannulation using Technique III and placement of intrauterine catheter were successful. Drainage through the catheter was reported only upto second day. The catheter was found misplaced on the seventh day observation. Clinically the condition of the dog was found improving subsequent to intrauterine catheterization and administration of $PGF_{2,\alpha}$ and the dog was recovered.

Dog No. II_3 failed to get the cervix catheterized by Technique I and died on the 16th day of admission despite of the treatment regimen of this group.

Dog No. II_4 transcervical cannulation via Technique II for hysterography and transcervical catheterization was not successful. But the dog had shown clinical improvement with $PGF_{2\alpha}$, antibiotics and other supportive therapy and was discharged healthy after 28 days.

Dog No. II_5, in which the transcervical cannulation with Technique II failed, was subjected to $PGF_{2\alpha}$, antibiotic and supportive therapy. Though it had shown slight clinical improvement initially, condition deteriorated by seventh day. Subsequently ovariohysterectomy was performed on the 10th day. But the dog died on 21st day of admission.

In Dog No. II_6, transcervical cannulation by Technique II and the intrauterine catheterization was successful. It showed clinical improvement on concurrent treatment with $PGF_{2\alpha}$ and antibiotics and was discharged as cured on 28th day.

4.2.11.2. Long Term observation

Information was not followed up after 28th day in dog II_1 and II_5, which were subjected to ovariohysterectomy and in dog II_3 that died on 16th day. Dog No. II_2 did

not show any oestrus upto a period of 12 months. In Dog No. II_4 no signs of any oestrus was noticed by the owner, but the condition recurred after nine months and the dog died. Dog No. II_6 had shown a healthy oestrus four months after the treatment but was not mated then and no recurrence was reported until six months after treatment.

Table 7. Clinical observations in dogs of Group II before and after treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day	Remarks
Abdominal Distension							
II_1	+++	++++	++	Ovariohysterectomy			++++ Highly distended and pear shaped +++ Marked distension ++ Moderate distension + Slight distension - No distension NA Observation not available
II_2	+	+	+	-	-	-	
II_3	++++	++++	++	+++	Died on 16th day		
II_4	+++	+++	++	+	-	-	
II_5	+++	+++	+++	Ovariohysterectomy			
II_6	+	+	-	-	-	-	
Vaginal Discharge							
II_1	++	++	++	Ovariohysterectomy			+++ Copious discharge ++ Moderate discharge + Scanty discharge - No discharge NA – Observation not available
II_2	+	+	+	-	-	-	
II_3	-	+	+	++	Died on 16th day		
II_4	++	++	+	-	-	-	
II_5	+	++	+	Ovariohysterectomy			
II_6	+	-	-	-	-	-	
Appearance of the Vulval Lips							
II_1	E	E	E	Ovariohysterectomy			E – Oedematous N – Normal NA – Observation not available
II_2	E	E	E	N	N	N	
II_3	N	N	N	N	Died on 16th day		
II_4	E	E	E	N	N	N	
II_5	E	E	E	Ovariohysterectomy			
II_6	N	N	N	N	N	N	
Polydipsia and Vomiting							
II_1	P & V	P & V	P	Ovariohysterectomy			P – Polydipsia V – Vomiting P & V- Polydipsia and vomiting NA – Observation not available
II_2	P	P	P	-	-	-	
II_3	P & V	P & V	P & V	P & V	Died on 16th day		
II_4	P	P	P	-	-	-	
II_5	P & V	P & V	P & V	Ovariohysterectomy			
II_6	P	P	-	-	-	-	

Table 8. Physiological, haematological, biochemical and hormonal parameters in dogs of Group II, before and after the treatment

Parameters	Before	24 hr	7th day	14th day	21st day	28th day
Physiological Parameters						
Rate of respiration (per min)	33.33 ± 3.72	32.67 ± 1.63	32.0 ± 3.1	32.75 ± 0.96	31.33 ± 1.15	31.33 ± 2.31
Pulse Rate (per min)	97.33 ± 7.45	95.17 ± 5.53	92.0 ± 3.1	89.75 ± 4.35	91.33 ± 1.15	92.0 ± 4.0
Rectal Temperature (^{0}C)	39.3 ± 0.5	39.23 ± 0.39	38.93 ± 0.35	38.5 ± 0.48	39.0 ± 0.35	38.8 ± 0.53
Haematological Parameters						
Total Leucocyte Count (x 10^3 /cmm)	42.37 ± 21.04	43.75 ± 21.82	38.95 ± 21.95	30.18 ± 18.09	15.67 ± 3.13	12.53 ± 2.0
Differential Leucocyte Count (%)						
Neutrophils	53 ± 6	52 ± 5	55 ± 6	60 ± 10	62 ± 4	59 ± 9
Band Cells	23 ± 8	29 ± 5	24 ± 10	16 ± 16	6 ± 3	3 ± 1
Lymphocytes	18 ± 9	16 ± 9	18 ± 8	20 ± 7	25 ± 3	33 ± 2
Monocytes	2 ± 0	1 ± 0	2 ± 1	0 ± 0	2 ± 1	2 ± 0
Eosinophils	3 ± 1	2 ± 0	1 ± 1	3 ± 1	4 ± 2	2 ± 2
Basophils	1 ± 0	0 ± 0	0 ± 0	1 ± 0	1 ± 0	1 ± 0
Haemoglobin concentration (g/dl)	9.73 ± 2.54	9.68 ± 2.55	8.9 ± 2.88	10.35 ± 2.68	12.0 ± 1.2	12.37 ± 0.75
Volume of Packed Red Cells (v%)	30.5 ± 7.31	30.17 ± 7.49	26.67 ± 8.98	32.25 ± 9.64	36.67 ± 5.03	38.0 ± 3.46
ErythrocyteSedimentation Rate (mm/ one hr)	68.67 ± 38.81	75.17 ± 39.95	76.675 ± 8.36	32.52 ± 4.01	16.0 ± 10.0	12.0 ± 5.29
Biochemical Parameters						
Blood Urea Nitrogen (mg/dl)	52.0 ± 20.94	55.67 ± 22.32	49.0 ± 23.39	44.5 ± 40.34	25.33 ± 10.26	23.67 ± 7.51
Creatinine (g/dl)	1.58 ± 0.68	1.77 ± 0.95	1.67 ± 1.03	1.63 ± 1.72	0.73 ± 0.23	0.67 ± 0.12
Alanine aminotransferase (IU/L)	50.17 ± 29.83	49.5 ± 28.41	48.33 ± 26.79	46.04 ± 4.21	23.67 ± 5.13	21.0 ± 5.0
Potassium (m mol/L)	4.27 ± 0.74	4.3 ± 0.82	4.78 ± 0.84	4.35 ± 0.68	4.13 ± 0.12	4.0 ± 0.35
Hormonal Assay						
Oestradiol (pg/ml)	64.17 ± 27.69	85.33 ± 21.39	53.5 ± 30.2	23.0 ± 6.22	18.0 ± 2.0	18.67 ± 3.06
Progesteron (ng/ml)	6.18 ± 5.43	4.73 ± 2.73	2.35 ± 1.27	1.0 ± 0.23	0.82 ± 0.37	0.58 ± 0.2

Table 9. Physiological parameters – Colour of visible mucous membrane in Group II before and after the treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
II_1	Pale	Pale	Pale	Ovariohysterectomy		
II_2	Congested	Congested	Pale	PR	PR	PR
II_3	PR	PR	Pale	Pale	Died on 16th day	
II_4	PR	PR	PR	PR	PR	PR
II_5	Pale	Pale	Pale	Ovariohysterectomy		
II_6	PR	PR	PR	PR	PR	PR

PR - Pale Roseate NA - Not available

Table 10. Observation in Formol gel test in Group II before and after treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
II_1	40 min	40 min	40 min	Ovariohysterectomy		
II_2	Negative	Negative	Negative	Negative	Negative	Negative
II_3	20 min	20 min	20 min	10 min	Died on 16th day	
II_4	30 min	30 min	Negative	Negative	Negative	Negative
II_5	20 min	20 min	10 min	Ovariohysterectomy		
II_6	30 min	30 min	30 min	Negative	Negative	Negative

Table 11. Outcome of the treatment in Group II

Animal No.	Transcervical drainage and its outcome	Next oestrus seen	Mated or not	Whelped or not	Pyometra - Recurrence
II_1	Failed, ovariohysterectomy on 10th day and recovered	NA	NA	NA	NA
II_2	Successful, catheter displaced on7th day, recovered	Not seen	NA	NA	Not upto 12 months
II_3	Failed. Patient died on 16th day	NA	NA	NA	NA
II_4	Failed, but recovered with $PGF_{2\alpha}$ therapy and antibiotics	Not seen	NA	NA	Yes, after 9 months
II_5	Failed, ovariohysterectomy on 10th day but died after 10days	NA	NA	NA	NA
II_6	Successful, catheter misplaced on 7th day and recovered	After 4 months	No	NA	Not upto 8 months

4.3. GROUP III

4.3.1. Anamnesis (Table 1)

4.3.1.1. *Breed*

Dogs of this group belonged to Cocker Spaniel (1), Dachshund (1), Labrador cross (1) and Spitz cross (1) and Spitz (2).

4.3.1.2. *Age*

Average age of dogs was 8.2 ± 3.3 years with a range of 4 to 12 years.

4.3.1.3. Body Weight

Body weight of the dogs in this group ranged from 8 to 29 kg.

4.3.1.4. Parity

Among these dogs two (III_1 and III_2) had whelped once, before the age of two years. Both of them were not mated afterwards. Remaining four dogs were nulliparous (III_3, III_4 and III_5) and never mated in any of the oestrus, except III_6.

4.3.1.5 Occurrence of last oestrus and mating

The dogs had shown oestrus signs, approximately on an average, 59.4 days back and except in one (III_3) in which the owner was ignorant about any recent oestrus. Any of the dogs of this group was not mated in last oestrus, except III_6.

4.3.1.6. Food Intake

Food intake was reduced in two dogs (III_1 and III_2) and absent in others. Food intake was gradually improved in all the dogs after ovariohysterectomy, except III_3, which died on the third day of surgery.

4.3.1.7. Polydipsia and Vomiting

Polydipsia and vomiting were reported in three dogs (III_2, III_5 and III_6) and only polydipsia in two (III_1 and III_4) and vomiting in one (III_3).

4.3.1.8. Vulval discharge

Purulent vulval discharge was reported in one dog (III_6); sanguineopurulent discharge in four (III_1, III_2, III_3 and III_5) and vulval discharge was not reported in one dog (III_4).

4.3.2. Clinical Observations (Table 12)

4.3.2.1. Abdominal distension

Abdomen was highly distended and pear shaped in one dog (III_5) on the preoperative day. In three dogs (III_1, III_2 and III_4) it was markedly distended, while two (III_3 and III_6) had moderate distension. Abdominal distension was not notable in all the cases after ovariohysterectomy.

4.3.2.2. Vulval discharge

Vaginal discharge was copious and purulent in one dog (III_6), moderate and sanguino-purulent in three (III_1, III_3 and III_5). It was scanty and sanguineopurulent in one (III_2) and absent in another one (III_4). Vaginal discharge ceased by seventh day in all cases, except in III_1 by 14^{th} day of observation.

4.3.2.3. Appearance of vulval lips

The vulval lips, except in one dog (III_2) were normal in appearance in all cases. In the said case, the vulval lips were oedematous and later became normal by about 14 days after ovariohysterectomy.

4.3.2.4. Polydipsia and Vomiting

Polydipsia and vomiting was present in three dogs (III_2, III_5 and III_6), polydipsia alone in two (III_1 and III_4) and vomiting alone in one (III_3) on the initial stages. These symptoms disappeared by seventh day in Dog No. III_3 and III_4 and by 14^{th} day in III_1, III_2 and III_6, except in III_5, which died on third postoperative day.

4.3.3. Physiological Parameters (Table 13)

4.3.3.1. Respiratory Rate

The mean respiratory rate (per min) was 33.33 ± 4.32 before treatment and 32.83 ± 4.83, 34.0 ± 1.41, 34.4 ± 2.19, 31.75 ± 2.06 and 31.0 ± 2.58 at 24 hr and on seventh, 14th, 21^{st} and 28^{th} day after ovariohysterectomy respectively. The variations in the respiratory rate were within the normal range.

4.3.3.2. Pulse Rate

The average pulse rate (per min) recorded was 99.0 ± 4.1 pre-operatively 97.67 ± 5.01, 95.6 ± 3.29, 93.8 ± 3.27, 96.25 ± 4.03 and 95.0 ± 1.83 respectively on 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} day post operatively. All the values of the pulse rate were within normal range.

4.3.3.3. Rectal Temperature

The average rectal temperature (°C) recorded was 39.2 ± 0.67 before treatment and 38.7 ± 0.71, 39.12 ± 0.41, 38.76 ± 0.17, 38.5 ± 0.2 and 38.6 ± 0.2 respectively at 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} days after the surgery. The average values were within normal range. Dog no. III_5, which died on third day after ovariohysterectomy, had shown hypothermia on the first postoperative day Dog no. III_4 had slightly increased temperature upto 14^{th} day observation. This animal had some suture reaction and wound disruption. All the other animals had shown mild to moderate hyperthermia, before and upto seventh day after treatment.

4.3.3.4. Colour of Visible Mucous Membrane (Table 14)

The colour of visible mucous membrane was pale in three dogs (III_2, III_5 and III_6), pale roseate in one (III_4) and congested in another two (III_1 and III_3). The congestion noticed was reduced by 24 hr in III_1 and by seventh day in III_3.

4.3.4. Haematological Parameters (Table 13)

4.3.4.1. Total Leucocyte Count

The average total leucocyte count (TLC) ($x10^3$ cells/c mm) was 55.77 ± 48.94 preoperatively and 56.86 ± 31.74, 23.12 ± 11.35, 11.64 ± 3.05, 10.6 ± 1.34 and 10.33 ± 0.67 respectively at 24 hr and on seventh, 14th, 21st and 28th days of post operative observation. Extreme leucocytosis noticed preoperatively, was reduced to moderate ranges by seventh day and to normal ranges by 14th day post operatively. Case III_1 and III_5 showed extreme leucocytosis in the initial stages. In the latter case, which died on third day after surgery. Leucocytosis was moderate in III_2 and III_4 and III_6 and was within normal range in III_3 initially.

4.3.4.2. Differential Leucocyte Count

The differential leucocyte count (DLC) had shown a typical neutrophelia with a regenerative shift to left and a relative lymphopenia in all the six animals initially. The mean DLC (%) was as neutrophils 56 ± 16, band cells 22 ± 16, lymphocytes 16 ± 7, monocytes 2 ± 1, eosinophils 6 ± 3 and basophils 1 ± 0 on the preoperative day. On 28th postoperative day, it was as neutrophils 56 ± 5, band cells 5 ± 2, lymphocytes 31 ± 2, monocytes 2 ± 1, eosinophils 6 ± 3 and basophils 1 ± 0. Generally neutrophilia was marked to extreme 24 hr postoperatively, which reduced gradually thereafter.

4.3.4.3. Haemoglobin Concentration

The mean haemoglobin concentration (gm/dl) recorded was 10.78 ± 3.57, preoperatively and 8.74 ± 2.06, 9.48 ± 2.39, 11.02 ± 1.02, 11.88 ± 0.71 and 12.05 ± 1.0 post operatively at 24 hrs and on seventh, 14th, 21st and 28th days respectively. Haemoglobin concentration was lower than normal range in all the animals

preoperatively as well as postoperatively except III_1, III_3 and III_4, but had shown gradual increase from 14th postoperative day onwards. Very low haemoglobin values were recorded in Dog No. III_5 and III_6.

4.3.4.4. Volume of Packed Red Cells

The mean volume of packed red cells (VPRC) (v%) was lower than the normal range in this group throughout the observation period. But a gradual increase to normal levels was noticed from 21st postoperative day onwards. The VPRC was 30.83 ± 9.26, 26.6 ± 6.88, 29.0 ± 6.71, 33.4 ± 3.13, 36.0 ± 2.94 and 36.75 ± 3.2 respectively on preoperative day, at 24 hr, on seventh, 14th, 21st and 28th day of post operative days. The VPRC values were within the normal range in Dog No. III_1 and III_3 throughout the observation period.

4.3.4.5. Erythrocyte Sedimentation Rate

The average erythrocyte sedimentation rate (ESR) (mm/one hr) was 62.83 ± 34.27 pre operatively. Postoperatively, at 24 hr and on seventh, 14th, 21st and 28th days the ESR were 63.63 ± 32.96, 31.92 ± 22, 13.2 ± 9.23, 8.08 ± 5.52 and 4.88± 3.17 respectively. Generally in this group the mean ESR values were elevated initially till seventh postoperative day and then returned to normal limits on subsequent observations. The ESR had shown wide variation ranging from 22 to 120 preoperatively and was very much higher than the normal range in case numbers III_1, III_4, and III_6 and extremely high value in III_5, which died on third day postoperatively.

4.3.5. Serum Biochemical Parameters (Table 13)

4.3.5.1. Blood Urea Nitrogen

The mean blood urea nitrogen (BUN) (mg/dl) was 74.0 ± 71.45 pre operatively and 76.0 ± 61.49, 36.5 ± 10.88, 23.2 ± 4.15, 19.33 ± 3.06 and 22.15 ± 5.76 at 24 hr and on seventh, 14th, 21st and 28th days post operatively. The BUN values had shown a marginal increase in all the dogs on the first day, except in III_5 that had extremely high

value (219gm/dl) and died on third day after surgery. In other cases it gradually returned to normal range by seventh postoperative day.

4.3.5.2. Serum Creatinine

Serum creatinine was within normal range in all the dogs except the Dog No. III_5 (3.2 mg/dl), which died on third day. The mean Serum Creatinine concentration (mg/dl) in this group was 1.67 ± 0.85 preoperatively and 2.08 ± 0.97, 1.1 ± 0.42, 1.08 ± 0.27, 0.93 ± 0.42 and 0.8 ± 0.16 postoperatively in respective observations made at 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} days.

4.3.5.3. Alanine aminotransferase

The mean value of alanine aminotransferase (ALT) (IU/L) obtained in this group was 52.0 ± 22.2 preoperatively and 53.67 ± 21.59, 36.75 ± 7.63, 35.2 ± 3.03, 31.67 ± 6.66 and 30.5 ± 5.26 postoperatively at 24 hr and on seventh, 14^{th}, 21^{st} and 28^{th} days respectively. All the animals had shown homogenous values slightly higher in the normal range and reduced during the course of observation, except Dog No. III_5, which had higher values throughout the available observation period.

4.3.5.4. Serum Potassium

The mean serum potassium level (m mol/L) was 5.22 ± 0.67 pre operatively and 5.2 ± 0.64, 3.98 ± 0.71, 3.84 ± 0.55, 3.7 ± 0.26 and 4.0 ± 0.74 respectively at 24 hrs and on seventh, 14^{th}, 21^{st} and 28^{th} days post operatively. The values before and after treatment remained within the normal range.

4.3.6. Hormonal Assay (Table 13)

4.3.6.1. Oestradiol

The mean oestradiol concentration (pg/ml) was 90.63 ± 45.63 preoperatively. Postoperative values had shown a sharp decline. The oestradiol levels were28.67 ± 8.5 at 24 hr

and 10.4 ± 2.88, 9.2 ± 3.56, 9.6 ± 1.79 and 8.8 ± 1.92 respectively on seventh, 14th, 21st and 28th postoperative days.

4.3.6.2. Progesterone

The Progesterone level (ng/ml) on an average was 18.26 ± 23.07 preoperatively in this group. The Progesterone concentration was less than 1.0 ng/ml in all the dogs on all postoperative observation.

4.3.7. Formol Gel Test (Table 15)

The Formol Gel test was positive in 10 min in one dog (III_5); 20 min in two (III_1, III_3 and III_4); positive in 30 min in one (III_6) and positive in 40 min in another one (III_2) on preoperative day. It became negative by 14th postoperative day in all animals.

4.3.8. Radiographic Evaluation

4.3.8.1. Survey Radiography

On the survey radiographs taken in all the cases preoperatively, the uterus appeared as distended tubular structures of uniform radiopacity occupying majority of the space in the abdominal cavity.

4.3.8.2. Hysterography (Table 17)

Hysterography was performed in three dogs (III_4, III_5 and III_6), where the transcervical cannulation was successful. Inside the uterus the contrast material was not always found easily dispersed because of the thick and tenacious uterine contents, as found later after ovariohysterectomy (Plate 29)

4.3.8.2.1. Anaesthesia and control

The anaesthetic protocol selected was satisfactory for the transcervical cannulation and all the dogs had an uneventful recovery. The dogs were controlled on

right lateral recumbency, which was found convenient for manipulations in transcervical cannulation.

4.3.8.2.2. Transcervical Cannulation Technique (Table17)

Transcervical cannulation was successful in three dogs (III_2, III_5 and III_6) using Technique II in former two and Technique I in the latter.

Technical difficulties encountered were as the same in Group I.

4.3.8.2.3. Radiographic Observations

Dog No. III_1: Distended uterine loops with sacculations could be identified in the lower abdomen in the scout radiograph of abdomen. Image of the failed transcervical catheterization and spread of contrast material into the vaginal cavity could be seen in the contrast radiograph.

Dog No. III_2: The survey radiograph had shown moderate uterine distension with sacculations. In the contrast radiograph seepage of contrast material into one horn of uterus could be seen a wave like strip with even edges.

Dog No. III_3: Distended uterine sacculations filled lower posterior abdomen, on the plain radiograph. Cannulation was failed and the image of cannula and the contrast material around it in the anterior vagina was noticed in the contrast radiograph.

Dog No. III_4: The distended uterine silhouette with sacculations could be seen on the ventral aspect of abdominal cavity. Transcervical cannulation was failed and the image of the cannula with the contrast material filled in the mid vagina could be seen in the second radiograph.

Dog No. III_5: Grossly distended uterus lying close to ventral abdominal wall was imaged on the plain radiograph (Plate 27). In the contrast radiograph, most of the contrast material was found in the mid vagina and with some infiltration into the uterine

body. The uterine body appeared as a globular structure with even borders. Density of contrast medium was slightly decreased due to mixing of uterine contents with the contrast material (Plate28).

Dog No. III_6: Image of moderately distended uterus with sacculations and posterior bending could be seen on the survey radiograph. In the contrast radiography infusion of small quantity of the contrast medium into the uterine body so that the posterior part of the uterus alone was imaged and it appeared as a small spiral.

4.3.9. Sonological Observations

Ultrasonography was conducted in three dogs (III_1, III_4 and III_5) preoperatively. In all these three dogs the uterus appeared as enlarged round anechoic structures with thin walls.

4.3.10. Surgical Management

4.3.10.1. Ovariohysterectomy

Ovariohysterectomy was performed in all the six animals following standard surgical procedure. The procedure was uneventful in all dogs.

4.3.10.2. Complications, if any

Dog No. III_4 developed suture reactions to the catgut used for closing the muscle layers and resulted in wound dehiscence by 14th day, which resutured and subsequent healed. Dog No. III_5 died on the third day of ovariohysterectomy. All the other dogs had an uneventful recovery. Specific complications or difficulties were not observed during or after the surgical procedure.

4.3.11. Outcome of the treatment (Table 16)

4.3.11.1 During the period of observation

Dog No. III_1, as the transcervical cannulation using Technique I and hence the intrauterine cauterization was failed, was subjected to ovariohysterectomy. It recovered subsequently.

In Dog No. III_2, the attempts for transcervical cannulation using Technique II and hysterography were successful. The dog recovered subsequent to ovariohysterectomy and discharged by 28th day.

Dog No. III_3 failed to get the cervix catheterized by Technique II. It was subjected to ovariohysterectomy next day and recovered eventually.

Dog No. III_4 transcervical cannulation via Technique II for hysterography and intrauterine catheterization was not successful. Ovariohysterectomy was performed in this dog, which developed reaction to the catgut used for suturing the muscle. Wound dehiscence and resuturing was followed and it recovered later.

Dog No. III_5, in which the transcervical cannulation and hysterography with Technique II was successful. But the dog died on the third day subsequent to ovariohysterectomy.

In Dog No. III_6, transcervical cannulation by Technique I and hysterography were successful. The dog recovered uneventfully after ovariohysterectomy.

4.3.11.2. Long Term observation

All the recovered dogs remained healthy during the period of observation.

Table 12. Clinical observations in dogs of Group III before and after ovariohysterectomy

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day	Remarks
Abdominal Distension							
III_1	+++	-	-	-	-	-	++++ Highly distended and pear shaped +++ Marked distension ++ Moderate distension + Slight distension - No distension NA Observation not anvailable
III_2	+++	-		-	NA	-	
III_3	++	-	-	-	-	-	
III_4	+++	-	-	-	-	-	
III_5	++++	-	Dog died on 3rd day				
III_6	++	-	-	-	-	NA	
Vaginal Discharge							
III_1	++	+	+	-	-	-	+++ Copious discharge ++ Moderate discharge + Scanty discharge - No discharge NA – Observation not available
III_2	+	-	-	-	NA	-	
III_3	++	+	-	-	-	-	
III_4	-	+	-	-	-	-	
III_5	++	+	Dog died on 3rd day				
III_6	+++	+	-	-	-	NA	
Appearance of the Vulval Lips							
III_1	E	E	N	N	N	N	E – Oedematous N – Normal NA – Observation not available
III_2	N	N	N	N	NA	N	
III_3	E	E	E	N	N	N	
III_4	E	E	N	N	N	N	
III_5	E	E	Dog died on 3rd day				
III_6	E	E	E	N	N	NA	
Polydipsia and Vomiting							
III_1	P	V	-	-	-	-	P – Polydipsia V – Vomiting P & V- Polydipsia and vomiting NA – Observation not available
III_2	P & V	V	-	-	NA		
III_3	V	-	-	-	-	-	
III_4	P	-	-	-	-	-	
III_5	P & V	P & V	Dog died on 3rd day				
III_6	P & V	V	-	-	-	NA	

Table 13. Physiological, haematological, biochemical and hormonal parameters in dogs of Group III, before and after the treatment

Parameters	Before	24 hr	7th day	14th day	21st day	28th day
Physiological Parameters						
Rate of respiration (per min)	33.33 ± 4.32	32.83 ± 4.83	34.0 ± 1.41	34.4 ± 2.19	31.75 ± 2.06	31.0 ± 2.58
Pulse Rate (per min)	99.0 ± 4.1	97.67 ± 5.01	95.6 ± 3.29	93.8 ± 3.27	96.25 ± 4.03	95.0 ± 1.83
Rectal Temperature (^{0}C)	39.2 ± 0.67	38.7 ± 0.71	39.12 ± 0.41	38.76 ± 0.17	38.5 ± 0.2	38.6 ± 0.2
Haematological Parameters						
Total Leucocyte Count (x 10^3 /cmm)	55.77 ± 48.94	56.86 ± 31.74	23.12 ± 11.35	11.64 ± 3.05	10.6 ± 1.34	10.33 ± 0.67
Differential Leucocyte Count (%)						
Neutrophils	55 ± 16	61 ± 12	62 ± 4	60 ± 5	57 ± 3	56 ± 5
Band Cells	22 ± 16	20 ± 12	11 ± 7	8 ± 3	8 ± 2	5 ± 2
Lymphocytes	15 ± 7	16 ± 5	23 ± 3	30 ± 5	29 ± 3	31 ± 2
Monocytes	2 ± 1	2 ± 1	2 ± 1	1 ± 1	2 ± 1	2 ± 1
Eosinophils	5 ± 3	1 ± 1	3 ± 1	3 ± 2	3 ± 1	5 ± 3
Basophils	1 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	1 ± 0
Haemoglobin concentration (g/dl)	10.78 ± 3.57	8.74 ± 2.06	9.48 ± 2.39	11.02 ± 1.02	11.88 ± 0.71	12.0 ± 51.0
Volume of Packed Red Cells (v%)	30.83 ± 9.26	26.6 ± 6.88	29.0 ± 6.71	33.4 ± 3.13	36.0 ± 2.94	36.75 ± 3.2
ErythrocyteSedimentation Rate (mm/one hr)	62.83 ± 34.27	63.63 ± 2.96	31.92 ± 2.0	13.2 ± 9.23	8.08 ± 5.52	4.88 ± 3.17
Biochemical Parameters						
Blood Urea Nitrogen (mg/dl)	74.0 ± 71.45	76.0 ± 61.49	36.5 ± 10.88	23.2 ± 4.15	19.33 ± 3.06	22.15 ± 5.76
Creatinine (g/dl)	1.67 ± 0.85	2.08 ± 0.97	1.1 ± 0.42	1.08 ± 0.27	0.93 ± 0.42	0.8 ± 0.16
Alanine aminotransferase (IU/L)	52.0 ± 22.2	53.67 ± 21.59	36.7 ± 57.63	35.2 ± 3.03	31.67 ± 6.66	30.5 ± 5.26
Potassium (m mol/L)	5.22 ± 0.67	5.2 ± 0.64	3.98 ± 0.71	3.84 ± 0.55	3.7 ± 0.26	4.0 ± 0.73
Hormonal Assay						
Oestradiol (pg/ml)	90.6 ± 345.63	28.67 ± 8.5	10.4 ±2.88	9.2 ±3.56	9.6 ±1.79	8.8 ±1.92
Progesteron (ng/ml)	18.26 ± 23.07	< 1.0 in all these observations				

Table 14. Physiological parameters – Colour of mucous membrane in Group III before and after the treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
III 1	Congested	PR	PR	PR	PR	PR
III 2	Pale	Pale	Pale	PR	NA	PR
III 3	Congested	Congested	PR	PR	PR	PR
III 4	PR	PR	PR	PR	PR	PR
III 5	Pale	Pale	Dog died on 3rd day			
III 6	Pale	Pale	Pale	PR	PR	NA

PR Pale Roseate NA Not available

Table 15. Observation in Formol gel test in Group III before and after the treatment

Animal No.	Before	24 hr after	7th day	14th day	21st day	28th day
III 1	20 min	20 min	Negative	Negative	Negative	Negative
III 2	40 min	40 min	Negative	Negative	NA	Negative
III 3	20 min	20min	Negative	Negative	Negative	Negative
III 4	20 min	20 min	60min	Negative	Negative	Negative
III 5	10 min	10 min	Dog died on 3rd day			
III 6	30 min	30 min	30 min	Negative	Negative	NA

Table 16. Outcome of the treatment in Group III

Animal No.	Ovariohysterectomy and its outcome	Next oestrus seen	Mated or not	Whelped or not	Pyometra - Recurrence
III 1	Recovered uneventfully	NA	NA	NA	NA
III 2	Recovered uneventfully	NA	NA	NA	NA
III 3	Recovered uneventfully	NA	NA	NA	NA
III 4	Recovered uneventfully, except for suture disruption	NA	NA	NA	NA
III 5	Recovered uneventfully	NA	NA	NA	NA
III 6	Recovered uneventfully	NA	NA	NA	NA

Table 17. Details of transcervical cannulation, hysterography and transcervical drainage in dogs of Group I, II and III.

Group	Dog No.	Technique of transcervical cannulation successful	Hysterography (Successful or not)	Transcervical drainage (Successful or not)
I	I_1	None	Not	Not
	I_2	None	Not	Not
	I_3	None	Not	Not
	I_4	Technique I	Successful	Successful
	I_5	None	Not	Not
	I_6	Technique III	Successful	Successful
II	II_1	None	Not	Not
	II_2	Technique III	Successful	Successful
	II_3	None	Not	Not
	II_4	None	Not	Not
	II_5	None	Not	Not
	II_6	Technique II	Successful	Successful
III	III_1	None	Not	Not attempted
	III_2	Technique II	Successful	Not attempted
	III_3	None	Not	Not attempted
	III_4	None	Not	Not attempted
	III_5	Technique II	Successful	Not attempted
	III_6	Technique I	Successful	Not attempted

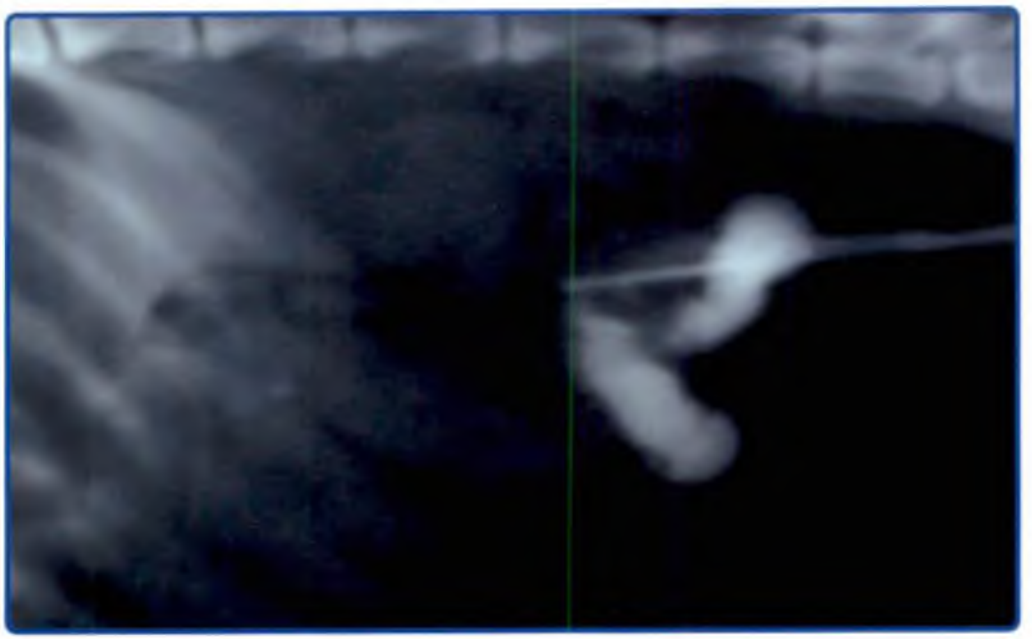


Plate 18. Hysterogram of Dog No, I_4 - Distended uterus outlined with contrast medium

Plate 19. Skiagram of abdomen in Dog No. I_4 on 28th postoperative day

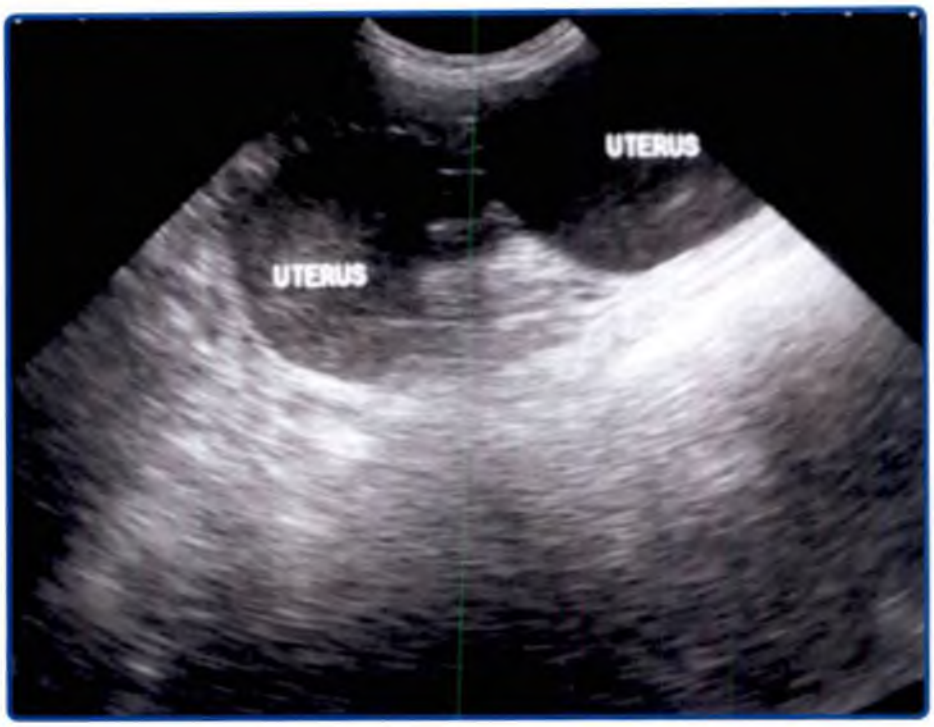


Plate 20. Sonogram in Dog. No. I_4 showing distended uterus before treatment

Plate 21. Sonogram in Dog. No. I_4 on 28th postoperative day showing regressed uterus

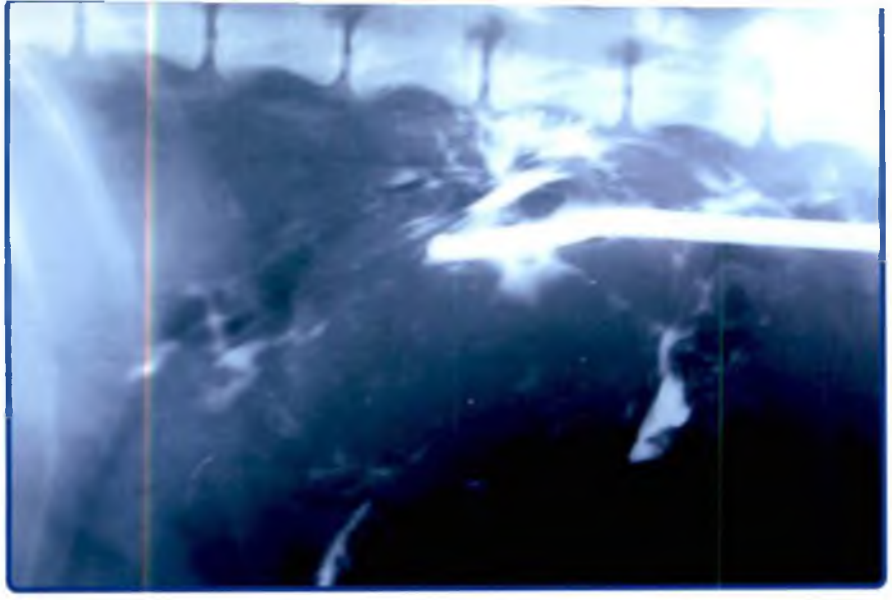


Plate 22. Skiagram showing penetration of cannula and intraperitoneal deposition of contrast medium in Dog No. II_1

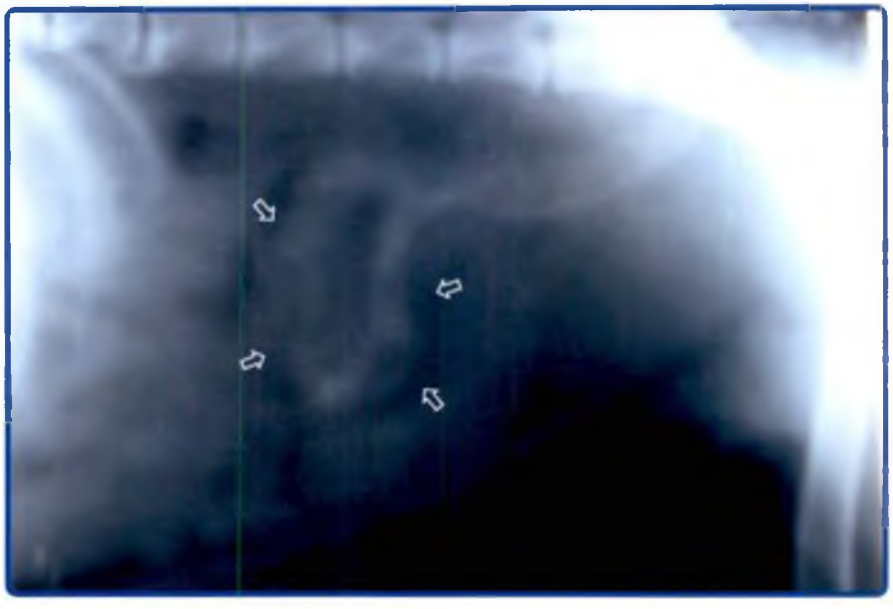


Plate 23. Hysterogram of Dog No. II_6 – Distended uterus outlined with contrast medium

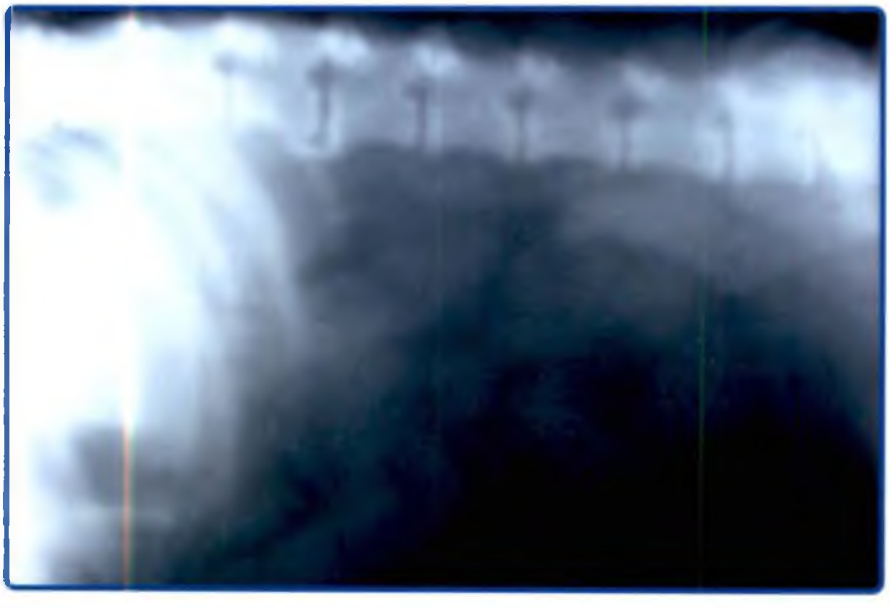


Plate 24. Skiagram of abdomen in dog No. II_6 on 28th postoperative day

Plate 25. Sonogram showing distended uterus preoperatively in Dog No. II_6.

Plate 26. Sonogram showing regression of uterine size on 28th day postoperatively in Dog No. II_6.

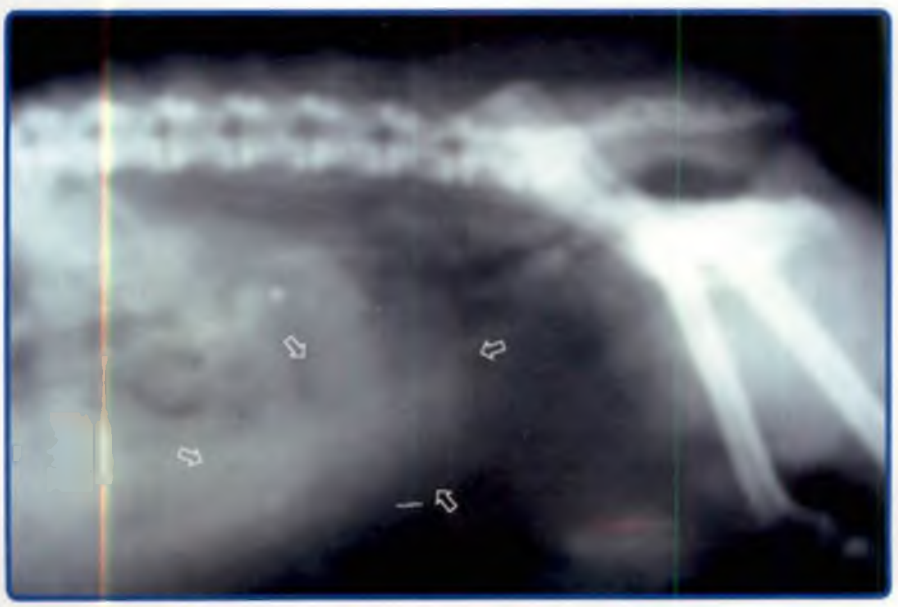


Plate 27. Skiagram showing distended uterus preoperatively in Dog No. III_5

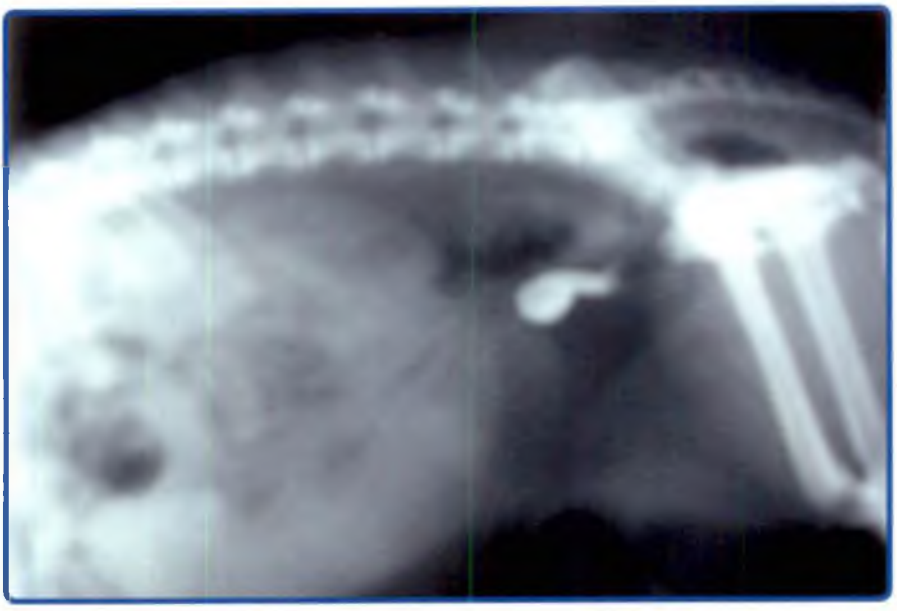


Plate 28. Hysterogram in Dog No.III_5 – Uterine body outlined by contrast medium

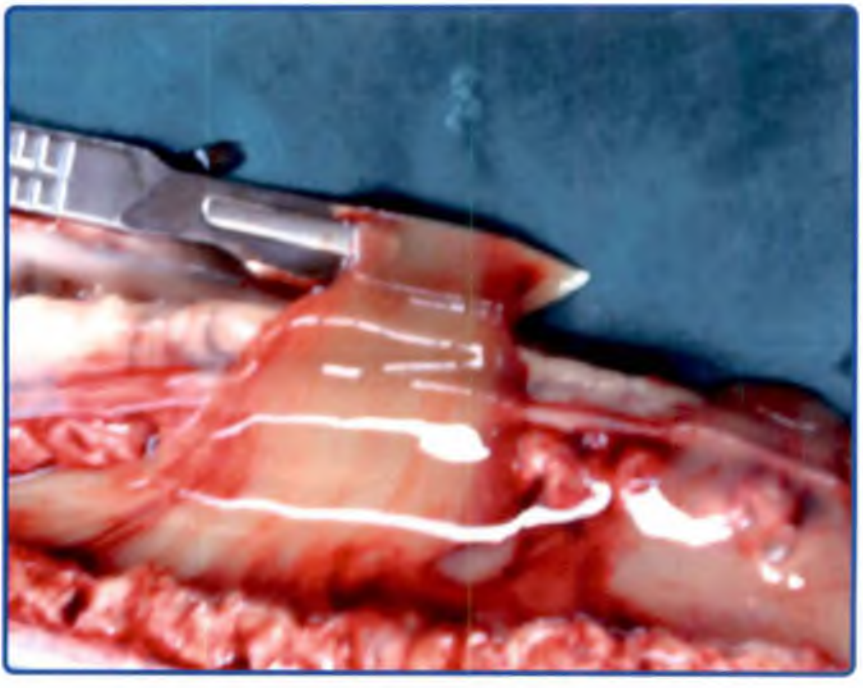


Plate 29. Uterine content pasty and tenacious

DISCUSSION

5. DISCUSSION

Eighteen female dogs of various age and breeds presented to the College Veterinary Hospitals, Mannuthy and Kokkalai with the history and clinical signs suggestive of pyometra were selected for the study. These dogs were randomly divided into three group *viz.,* Group I, II and III, consisting of six each.

All the dogs belonging to the three groups were subjected to physiological, haematological, biochemical and clinical examination and detailed radiographic evaluation to confirm the diagnosis.

Surgical management of pyometra was carried out in Group I, II and III with transcervical drainage, transcervical drainage with administration of prostaglandin $F_{2\alpha}$ and ovariohysterectomy respectively.

The results of the study are discussed.

5.1. MAIN ITEMS OF OBSERVATION

5.1.1. Anamnesis (Table 1)

5.1.1.1. Breed (Fig. 1)

The 18 dogs selected for the study belonged to various breeds like Spitz (6), German Shepherd Dog (3), Dachshund (2), Crossbreds (2), Cocker Spaniel (1), Dalmatian (1), Labrador Retriever (2) and Lhaza Apso (1). Almost a similar order of affection among different breeds was reported by Roy (2002). Increased proportion of affection in Spitz, German Shepherd, Labrador etc. may be attributed to their proportion in dog population in and around this geographic area (Egenvall *et al.*, 2001). Nelson *et al.* (1982), Lagerstedt *et al.* (1987) and Gilbert *et al.* (1989) reported incidence of pyometra in various breeds and at various places. Niskanen and Thrusfield (1998) and Smith (2006) came out with an increasing order of affection as

Golden Retriever, Miniature Schnauzer, Irish Terrier, St. Bernard etc. Sen (1998) reported the incidence of pyometra in Spitz, Lhaza Apso, non-descript, Cocker Spaniel, Dachshund and Dobermann Pinscher in the descending order. But the incidence of pyometra was reported high in rough Collies, Rottweiler, St. Bernard, Cavalier King Charles Spaniel, Golden Retrievers etc. among a population of 2,00,000 dogs over two years of observation in Sweden (Egenvall *et al.*, 2001).

5.1.1.2. Age (Fig. 2)

The age of the affected dogs in this study ranged from four to 15 years (9.7 ± 3.5 years) with a median of 9.5 years. This observation agrees with the report of Dow (1957) who got average age of 8.2 years and only 12% of them below the age of 6 years. The age of affection was 8 months to 12 years according to Nelson *et al.* (1982); 8.7 ± 3.0 years with a range of 4 months to 16 years, as per the report of Stone *et al.* (1988); 0.75 years to 14 year with a mean 3.19 years by Gilbert *et al.* (1989); seven year with a range of one to 14 years among 103 bitches, according to Sevelius *et al.* (1990); a mean of 8.5 years with a range of one to 18 years in a study of 953 pyometra cases according to Niskanen and Thrusfield (1998); six to 13 years as per Sen (1998); 8.4 ± 2.8 years with a range of one to 14 years as reported by Dhaliwal *et al.* (1998) 8.8 years with a range of one to 14 years in 13 bitches as per Dhaliwal *et al.* (1999) and 9.36 ± 0.35 years according to Smith (2006). An average of 23-24% of bitches might have experienced pyometra by 10 years of age according to Egenvall *et al.* (2001). Though pyometra was traditionally described as disorder of middle aged dogs, indiscriminate use of oestrogens in mismating had brought down the age to a mean of 2.1 years (Feldman and Nelson,1996).

5.1.1.3. Body Weight

The body weight of the 18 selected dogs ranged from six to 37 kg. Body weight depends on breed and many other factors but can be used as an indicator of the body condition if a previously measured body weight of the same dog is known.

5.1.1.4. Parity (Fig. 3)

Among the 18 dogs selected in this study, seven dogs (38%) whelped once in the earlier phases of their life and remaining 11 (62%) were nulliparous. This is in agreement with the fact that pyometra is a disease mostly affecting nulliparous or those which are not regularly used for breeding. Dow (1957) reported only 27% of the bitches affected with pyometra whelped once and only7% were multiparous. According to Gilbert *et al.* (1989) out of 40 bitches with pyometra, 19 bitches were nulliparous, seven bitches whelped 1-3 litters and the remaining 14 bitches had an unknown breeding history. According to Sevelius *et al.* (1990) only 13 out of 83 dogs with pyometra whelped before. As reported by Dhaliwal *et al.* (1998) 32 out of 34 bitches with pyometra were nulliparous. According to Niskanen and Thrusfield (1998) 925 out of 935 dogs (95%) with pyometra were nulliparous and only 10 were primiparous or multiparous. But according to Sen (1998) eight out of 12 bitches affected with pyometra was multiparous.

5.1.1.5. Occurrence of Last Oestrus and Mating (Fig. 4)

Except in four cases, regular cycling was reported in all the dogs and last oestrus was observed on an average of 63.4 days approximately before the expression of present symptoms, and the period ranged from 21 to 180 days with a median of 45 days. Only two of these dogs had the history of mating in that oestrus. This shows that most of the dogs developed pyometra during or towards the end of luteal phase. This is in agreement with most of the reports. Dow (1957) reported occurrence of pyometra 30 ± 14 (5 to 80 days) days after oestrus in 100 bitches. Jackson (1979) reported this period as two weeks, Nelson *et al.* (1982) as four to ten weeks, less than two months by Gilbert *et al.* (1989), eight weeks or less by Sevelius *et al.* (1990), four to eight weeks by Feldman and Nelson (1996), six to eight weeks by Sen (1998), average of 10.4 weeks with a range of one to 28 weeks by Dhaliwal *et al.* (1999) and four weeks to four months by Smith (2006).

5.1.1.6. Food Intake

Food intake was either reduced (10 dogs, 55%) or absent (eight dogs, 45 %) among the dogs of this study. This is an observation similar to that of Dow (1957), Nelson *et al.* (1982), Stone *et al.* (1988), Gilbert *et al.* (1989), Memon and Mickelsen (1993), Ayyappan *et al.* (1995), Feldman and Nelson (1996), Sen (1998), Roy (2002), Zaragoza *et al.* (2004) and Smith (2006).

5.1.1.7. Polydipsia and Vomiting

Out of 18 dogs, ten had polydipsia and vomiting (56%), polydipsia alone in six dogs (33%) and vomiting alone in two dogs (11%). Dow (1957) reported increased thirst and frequent vomiting in dogs with closed cervix pyometra. Vomiting was not evident in open cervix pyometra. Jackson (1979), Nelson *et al.* (1982), Stone *et al.* (1988), Gilbert *et al.* (1989), Memon and Mickelsen (1993), Ayyappan *et al.* (1995), Feldman and Nelson (1996), Sen (1998), Roy (2002) and Smith (2006) reported both polydipsia and vomiting or either of them alone in bitches affected with pyometra. Vomiting in 33% and polydipsia and polyurea in 86% of the bitches affected with pyometra was reported by Zaragoza *et al.* (2004). But according to Sevelius *et al.* (1990) one third of the cases studied, lacked these symptoms.

5.1.1.8. Vulval Discharge

Out of the 18 selected dogs with pyometra, seven dogs (38.8%) had the history of sanguineopurulent vulval discharge, eight (44.4%) had purulent discharge and discharge was not reported in three dogs (16.6%). According Dow (1957) the vaginal discharge varied with the open and closed cervix pyometra. The colour of the discharge varied from glairy mucoid, yellow to green to reddish brown with blood. Purulent vaginal discharge had been reported also by Jackson (1979), Nelson *et al.* (1982), Gilbert *et al.* (1989), Sevelius *et al.* (1990) and Ayyappan *et al.* (1995). Feldman and Nelson (1996) and Sen (1998) reported serosanguineous or mucopurulent vulval discharge. According to Dhaliwal *et al.* (1998) vaginal discharge was a symptom in 88.2% cases of pyometra. Vaginal discharge was found in majority of the

cases with pyometra with a thin consistency and light chocolate colour (Roy, 2002). As reported by Zaragoza *et al.* (2004) four dogs out of 15 had purulent vaginal discharge, four had serosanguineous discharge two had mucopurulent discharge and five were not showing any vaginal discharge at all. Vaginal discharge if present was purulent, sanguineous purulent, mucoid or severe frank haemorrhage as per the report of Smith (2006).

5.1.2. Clinical Observations (Table 2,7 and 12)

In four dogs (22.2%), the abdominal distention was high and pear shaped. Marked distension of abdomen was noticed in 44.4% (eight dogs) moderate distension in 22.2% (four cases) of the selected cases. It was slight in 11.1% (two cases). In the recovered animals of Group I and II a reduction in abdominal distention was recorded from 14th day onwards.

Copious purulent vaginal discharge was observed in four dogs (22.2%) out of the18 dogs on the day of admimssion. Discharge was moderate and purulent in two dogs (11.1%). It was scanty and purulent in two dogs (11.1%), moderate and sanguineopurulent in five cases (27.7%) and scanty and sanguineopurulent in two dogs (11.1%). Vaginal discharge was absent in three cases (16.6%). In recovered cases of Group I and II the vulval discharge became scanty by 14th day and was absent on 28th day. It was absent in all dogs of Group III except one on the seventh postoperative day observation.

The vulval lips were oedematous in all the dogs (77.8%) except in four (22.2%). In those recovered cases of Group I, the vulval oedema remained so throughout the period of observation, but it became normal by 14th day in those of Group II and III.

Polydipsia and vomiting were stopped by 14th day in recovered dogs of Group I and II and by seventh day in those of Group III.

Markedly distended abdomen with pear shape, abdominal tenseness with or without purulent yellowish green, chocolate coloured or reddish brown blood stained vulval discharge, vulval oedema and palpable enlarged uterus were frequent signs noticed in dogs with pyometra (Dow, 1957, Jackson, 1979, Nelson *et al.*, 1982, Gilbert *et al.*, 1989, Sevelius *et al.*, 1990, Memon and Mickelsen, 1993, Ayyappan *et al.*, 1995, Feldman and Nelson 1996, Zaragoza *et al.*, 2004, Roy, 2002 and Smith, 2006). But none of the reports on intrauterine drainage gave any information regarding these symptoms subsequent to treatment. Stoppage of vaginal discharge and reduction in uterine size with $PGF_{2\alpha}$ treatment was reported in pyometra by Nelson *and* Feldman, (1986), Memon and Mickelsen (1993), Azim *et al.* (1995) and Sridevi *et al.* (2000).

5.1.3. Physiological Parameters (Table 3, 8 and 13)

Both the respiratory rate and pulse rate were within normal range in the dogs of all the groups throughout the observation period (Fig.5 and 6). Slight elevation in mean rectal temperature was recorded before the surgical management in Group II and III, while it was within normal range in Group I. The elevated rectal temperatures fell back to normal range by seventh postoperative day (Fig 7). Three dogs (I_3, II_3 and III_5), which had shown hypothermia during the observation period, died subsequently. Hyperthermia had reported in most of the cases by Dow (1957), Jackson (1979), Nelson *et al.* (1982), Memon and Mickelsen (1993), Feldman and Nelson (1996), Heine *et al.* (2001) and Roy (2002). But elevated body temperature was found only in 16% of bitches with pyometra by Sevelius *et al.* (1990) in 53% of the cases by Zaragoza *et al.* (2004). Ayyappan *et al.* (1995) reported a case of a bitch with pyometra having subnormal rectal temperature, which was attributed to the systemic toxaemia. Sen (1998) reported elevation of body temperature by 1 or 2 ^{0} F initially which later returned to normal or subnormal. The influence of intrauterine drainage on the physiological parameters is not well documented. Sridevi *et al.* (2000) reported a reduction in rectal temperature in pyometra subsequent to treatment with $PGF_{2\alpha}$.

The visible mucous membrane was congested in three (17%), pale roseate in eight (44%) dogs and pale in seven (39%) dogs. Ayyappan *et al.* (1995) reported

congested visible mucous membrane in one case of pyometra. According to Zaragoza *et al.* (2004), out of 15 bitches with pyometra mucous membrane was congested in three, pale in other three and normal in the rest. The colour of visible mucous membrane came back to normal towards the end of observation period in recovered cases of the three groups.

5.1.4. Haematological Parameters (Table 3,8 and 13)

5.1.4.1. Total Leucocyte Count (Fig. 8)

All the dogs of the three groups had shown marked to extreme leucocytosis before the surgical management. (Schalm *et al.*, 2000 and Benjamin, 1978). This observation was in agreement with that of Dow (1957), Renton *et al.* (1971), Jackson (1979), Nelson *et al.* (1982), Meyers-Wallen *et al.* (1986), Colombo *et al.* (1986), De Schepper *et al.* (1987a&b), Stone *et al.* (1988), Memon and Mickelsen (1993), Gandotra *et al.* (1994), Jayathangaraj *et al.* (1994), Ayyappan *et al.* (1995), Mojziosova and Valocky (2000), Ki *et al.* (2000), Rekha *et al.* (2000), Heine *et al.* (2001), Faldyna *et al.* (2001) and Zaragoza *et al.* (2004). Brec *et al.* (1988) opined that the degree of uterine distension was significantly correlated with the number of WBC. TLC was variable and generally increased in closed-cervix pyometra, according to Feldman and Nelson (1996). Sevelius *et al.* (1990) reported that 28% of the cases with pyometra had normal WBC count and differential count, 36% had leucocytosis with normal differential count and 12% had normal WBC count with left shift. TLC became moderate by 14th day and normal by 28th day in recovered dogs of Group I and II. It became moderate by seventh day and normal by 14th day postoperatively in Group III. The reduction in mean values towards the end of observation period may be an indication of reduced inflammatory response and uterine distension as a result of uterine drainage. Information regarding the changes in TLC in pyometra subsequent to intrauterine drainage with or without $PGF_{2\alpha}$ is not available in the reviewed literature. Reduction in TLC subsequent to $PGF_{2\alpha}$ treatment alone had been reported by De Schepper *et al.* (1987b), Arnold *et al.* (1988), Azim *et al.* (1995) and Gobello *et al.* (2003). Similar

results subsequent to ovariohysterectomy was also reported (Feldman and Nelson, 1996, Mojzisova and Valocky, 2000, Rekha *et al.,* 2000).

5.1.4.2. Differential Leucocyte Count

All dogs of the three groups had shown marked to extreme neutrophilia with shift to left, slight monocytosis and a relative lymphopenia on the first observation. This was in agreement with the observations of Dow (1957), Schalm et al. (2000), Nelson *et al.* (1982), De Schepper *et al.* (1987a), Gilbert *et al.* (1989), Memon and Mickelsen (1993), Gandotra *et al.* (1994), Ayyappan *et al.* (1995), Feldman and Nelson (1996), Mojzisova and Valocky (2000) and Rekha *et al.* (2000). Among 50 bitches with pyometra, normal WBC and differential count in 28%, elevated WBC count and left shift in 24%, leucocytosis with normal differential count in 36%, normal differential count and normal WBC count with shift to left in 12% was reported by Sevelius *et al.* (1990). Faldyna *et al.* (2001) reported a severe increase in absolute counts of neutrophils and monocytes, found a low percentage of phagocytosing neutrophils and monocytes. Lymphopenia with a suppression of lymphocyte activity directly proportional to the severity of the disease was also reported. The neutrophilia and shift to left had shown a gradual decline from the 14^{th} preoperative day onwards and reached to normal ranges by the end of the observation period in recovered dogs of Group I and II. This can be attributed to the reduction in inflammatory process and regression of uterine distension subsequent to the transcervical drainage. Literature reviewed on uterine drainage in pyometra did not have data to substantiate this finding. Gobello *et al,* (2003) had reported return of DLC to normal ranges subsequent to $PGF_{2\alpha}$ therapy. In Group III DLC had shown reduction from seventh postoperative day onwards. This return to the normal levels may be because of the reduction in inflammatory process as a response to removal of the distended uterus (Mojzisova and Valocky, 2000 and Rekha *et al.,* 2000).

5.1.4.3. Haemoglobin Concentration (Fig. 9)

The mean haemoglobin concentration was lower than the normal range in three groups, on the first observation. (Schalm *et al.,* 2000, Benjamin, 1978 and Willard *et*

al., 1989). Individually, five dogs (II_4, II_6, III_1, III_3 and III_4) had haemoglobin concentration within the normal range. In five cases (I_3, II_1 and II_5, III_5 and III_6) it was less than 7.5 g/dl. Dow (1957) and Memon and Mickelsen (1993) reported normal haemoglobin levels in bitches with pyometra. Gandotra *et al.* (1994) reported slight decrease in haemoglobin concentration and very low values by Ayyappan *et al.* (1995). The drop haemoglobin concentration at 24 hr observation in Group III can be attributed to blood loss and dilution due to fluid administration during surgery. The mean as well as individual concentration of haemoglobin had shown a gradual increase throughout the period of observation in the recovered animals of the three groups might be indicative of the effectiveness of the treatment. The return to normal ranges was earlier and better in Group III dogs.

5.1.4.4. Volume of Packed Red Cells (Fig. 10)

In the present study, the mean volume of packed red cells in the three groups were moderately low compared to referral values (Schalm *et al.*, 2000, Benjamin, 1978 and Willard *et al.*, 1989). VPRC values were lower than 25% in four cases. In all the groups a gradual increase the mean value was observed from the 21st postoperative day onwards.

A reduction in volume of packed red cells had been reported in pyometra by Meyers-Wallen *et al.* (1986). De Schepper *et al.* (1987a) reported non-regenerative normocytic, normochromic anaemia in 57% and non-regenerative microcytic hypochromic anaemia in 12% of the dogs with pyometra. Possible causes of the anaemia may be depression of bone marrow by endotoxaemia, loss of erythrocytes in pus by diapedesis or by shortened life of circulating erythrocytes. Stone *et al.* (1988) reported reduced PCV values (21 to 48%) in a study conducted in 27 bitches with pyometra and 26 to 35% of the dogs were considered anaemic. PCV less than 30 to 35% was reported in pyometra by Schalm et al. (2000). Mild to moderate anaemia (with PCV less than 40%) was found in 60% of the dogs with pyometra and among them 19% had PCV less than 30% (Sevelius *et al.*, 1990), PCV of 34% (Memon and Mickelsen, 1993) 24% (Ayyappan *et al.*, 1995) and 36.94% (Zaragoza *et al.*, 2004) were also reported.

5.1.4.5. Erythrocyte Sedimentation Rate (Fig. 11)

The three groups of dogs had shown an extremely high erythrocyte sedimentation rate on the first observation (Benjamin, 1978). ESR between 10 and 55 mm/hr was found in bitches with acute inflammatory cystic endometrial hyperplasia and 8 to 40 mm/hr in chronic endometritis by Dow (1957). An elevated ESR to the tune of 31 mm/hr had been reported by Ayyappan *et al.* (1995). The ESR reduced to moderate levels by 21st day and to normal ranges by 28th day in recovered cases of Group I and II. Group III animals achieved an earlier reduction in ESR by 14th day compared to other groups. This can be attributed to the reduction in toxaemia subsequent to drainage of uterine contents or extirpation of the distended uterus. In dogs, which had shown exceptionally high values of ESR, clinical improvement was poor in the three groups.

5.1.5. Serum Biochemical Parameters (Table 3,8 and 13)

5.1.5.1.Blood Urea Nitrogen (Fig.12)

The mean blood urea nitrogen was elevated from normal ranges (Benjamin, 1978 and Willard *et al.*, 1989) in all the groups. Exceptionally high values were noted in Dog No. I_3 (265 mg/dl) and III_5 (219 mg/dl), which succumbed to death earlier in the course of treatment. An increase in BUN values was reported in pyometra (Dow, 1957, Schalm *et al.*, 2000 and Colombo *et al.* 1986). An increased possibility of death in such animals was reported by Renton *et al.* (1971) and *Ki et al.* (2000). Changes in renal function with increased BUN were reported by Borresen (1980), Borresen (1984), Brec *et al.* (1988), De Schepper *et al.* (1989), Heine *et al.* (2001) and Zaragoza *et al.* (2004). An increase in Serum Urea Nitrogen was observed in dog with pyometra and azotemia by Stone *et al.* (1988). An elevated BUN value was reported only in two out of 83 dogs with pyometra (Sevelius *et al.*, 1990), in one dog with concurrent congestive heart failure (Jayathankaraj *et al.*, 1994) and myocarditis (Ayyappan *et al.*, 1995). Normal level of BUN was reported in pyometra by Jackson (1979) and Meyers-Wallen *et al.* (1986). The recovered dogs of Group I and II had shown gradual reduction in BUN values from observations on seventh postoperative day onwards and reached

normal ranges in 21st day observations. But dogs of Group III had shown an earlier regaining of normal values, by seventh postoperative day. This can be attributed to the removal of influence of the toxic load on renal function subsequent to uterine drainage or ovariohysterectomy.

5.1.5.2. Creatinine (Fig. 13)

The mean serum creatinine level was elevated but remained within normal range in Group I, II and III, before as well as after the surgical management. A gradual and progressive reduction in the mean serum creatinine level was evident in the three groups during the observation period. Two dogs which had shown increased creatinine levels (I_3 and II_3) died during the course of observation. Impairment of renal function and elevated creatinine levels were reported by Borresen (1980), Borresen (1984), Colombo *et al.* (1986), Ki *et al.* (2000) and Heine *et al.* (2001) and Meyers-Wallen *et al.* (1986). An increase in serum creatinine levels was reported in bitches with pyometra having signs of glomerular and tubular lesions by De Schepper *et al.* (1989). Slightly elevated creatinine levels were reported in dogs having pyometra and concurrent congestive heart failure (Jayathangaraj *et al.,* 1994) and myocarditis (Ayyappan *et al.*, 1995). Stone *et al.* (1988) reported cases of pyometra with a mean creatinine value of 1.1 ± 0.9 mg/dl (range 0.4 to 4.2 mg/dl) in 27 bitches with pyometra and it was found elevated in those with azotemia. Zaragoza *et al.* (2004) also reported normal serum creatinine levels in bitches affected with pyometra.

In general, pyometra could induce acute reversible renal lesions (Borresen, 1980, Borresen, 1984 and Heine *et al.*, 2001). Renal failure in 24 out of 131 bitches with pyometra was reported by De Cock *et al.* (1987). Renal dysfunction without associated morphological abnormalities developed frequently in dogs with pyometra (Stone *et al.*, 1988). They also observed a reduction upto 30% in Glomerular Filtration Rate, which indicated the presence of some factor associated with pyometra that reduce renal perfusion. A decreased specific gravity of urine was attributed to inability of the tubules to concentrate the urine. Tubulointerstitial nephritis was reported in 20 out of 27 bitches studied, 11 dogs had glomerular lesions and two had severe glomerulitis and

tubulointerstitial nephritis. Brec *et al.* (1988) suggested that renal failure was more frequently observed in bitches with a greatly enlarged uterus than those with normal or slightly enlarged uterus. De Schepper *et al.* (1989) concluded from their study that bitches with pyometra may have two sequence of events with regard to renal function as (1) pyometra → protein-urea → γ-glutamyl transferasuria → uraemia or (2) pyometra → no renal disease → glomericular dysfunction → proximal tubular disease → renal failure.

The renal lesions in pyometra were characterized by glomerulonephritis and tubular damage caused by deposition of immune complexes in glomeruli. It was evidenced by presence of low molecular weight proteins in urine (Schalm *et al.*, 2000, Feldman and Nelson, 1996 and Zaragoza *et al.*, 2004). Renton *et al.* (1971) and Ki *et al.* (2000) had observed that bitches with pyometra having increased BUN and creatinine concentrations died after ovariohysterectomy. They concluded that the recovery rate with ovariohysterectomy could be predicted with their biochemical profile in bitches with pyometra. In contrary to the above observations, Sevelius *et al.* (1990) opined that renal dysfunction was not evident in their study involving 103 bitches with pyometra or endometritis.

5.1.5.3. Alanine aminotransferase (Fig. 14)

The dogs of Group I, II and III had shown slightly elevated levels of serum alanine aminotransferase level than the normal range (Benjamin, 1978) on the first day of observation. In three cases (I_3, II_3 and III_5), the ALT was found increased very much which influenced the mean values of the corresponding groups. These three dogs died during the postoperative period. ALT is an intracellular hepatic enzyme that will be detected in increased levels only in case of severe hepatic damage. Liver derangement was identified as a part of pyometra syndrome by assessment of symptoms and serum enzymes (Borresen, 1980). Moderate to great increase in ALT value in pyometra had been reported by Nelson *et al.* (1982), Colombo *et al.* (1986), Feldman and Nelson (1996) and Ki *et al.* (2000). But a decrease in ALT value in bitches with pyometra was reported by De Schepper *et al.* (1987b). Similarly, Sevelius *et al.* (1990) did not

consider serum ALT elevation as a classical observation in pyometra, as increase ALT values were found only in seven out of 103 dogs with pyometra. Ki *et al.* (2000) opined that an elevated ALT value along with an increase in other biochemical parameters predict a poor prognosis in ovariohysterectomy in pyometra. Mean ALT values in the recovered dogs of the three groups returned to normal ranges in the observations made on 21st postoperative day. This may be because of reduction of toxic load on the liver subsequent to reduction in uterine contents through transcervical drainage or ovariohysterectomy.

5.1.5.4. Serum Potassium (Fig. 15)

The mean serum potassium levels were found within the normal range in the three groups throughout the observation period. (Benjamin, 1978 and Willard *et al.*, 1989). Borresen (1984) reported electrolyte disturbances in pyometra. But the findings of Stone *et al.* (1988) who received normal serum potassium in bitches affected with pyometra, agrees with the observations in this study. Ki *et al.* (2000) reported death after ovariohysterectomy in bitches with pyometra that had increased potassium levels along with increase in other biochemical parameters. The results of the present study also gave a comparatively elevated serum potassium levels in three dogs (I_3, II_3 and III_5), which died during the course of observation.

5.1.6. Formol Gel Test (Table 5, 10,15)

A positive Formol gel test is attributed to an increase in globulin fractions in serum and it can be employed for a tentative diagnosis of pyometra (Ayyappan *et al.*, 1992). An increase in serum globulin levels in pyometra was reported (Stone *et al.*, 1988, Nelson *et al.*, 1982 and Ayyappan *et al.*, 1995). In the present study, Formol gel test was positive in 10 min in four cases, in 20 min in five cases, in 30 min. in four cases, in 40 min in three cases and negative upto 12 hr in two cases (Christensen and Cole, 1960). The test in the recovered dogs of Group I and II became negative by seventh day and in dogs of Group III, three became negative by seventh and two by 14th postoperative days.

5.1.7. HormonalAssay (Table 3, 8 and 13)

***5.1.7.1. Oestradiol** (Fig. 16)*

The mean plasma oestradiol concentration (pg/ml) on the first day of observation was 95.05 ± 65.77, 64.17 ± 27.69 and 90.63 ± 45.63 in Group I, II and III respectively. Within the group the individual values had shown wide variations, which influenced the mean values. Screening of available literature does not give a consistent picture regarding the serum oestradiol level in bitches with pyometra. It may be because the oestradiol levels are depending on the stage of oestrus cycle when the case was presented or the presence of follicular cysts. A high variation in oestradiol concentration (from 10 to 130 pg/ml) was reported in dogs with cystic endometrial hyperplasia-pyometra complex (De Cock *et al.* (1997)), which was found agreeing to the present observations. Hadley (1975) reported conjugated oestrogen concentrations within normal range in 13 bitches with pyometra. Plasma 17 β oestradiol levels below 5 pg/ml were obtained in bitches with pyometra, which were supposed to be in mid or late metoestrus or in anoestrus (Dhaliwal *et al.*, 1999). The present observations are in agreement with that of De Bosschere *et al.* (2001). According to Ververidis *et al.* (2004) bitches with spontaneous cystic endometrial hyperplasia - pyometra had significantly high concentration of oestradiol (3.7 to 23 pg ml^{-1}) compared to normal bitches in same stage of oestrus cycle. A gradual reduction in the oestradiol concentration recorded through the observation period in Group I and II may be because of the progression of the individual animals to the luteal phase of oestrus cycle. A sharp reduction in oestradiol level was noted in Group III at 24 hr postoperatively and it remained so in the subsequent observations.

***5.1.7.2. Progesterone** (Fig. 17)*

The average progesterone concentration (ng/ml) was 2.81 ± 1.69, 6.18 ± 5.43 and 18.26 ± 23.07 respectively in Group I, II and III before the surgical management. Just like oestradiol concentration, progesterone levels also had shown wide variation, may be depending on the stage of oestrus cycle when the case is presented (Willard *et al.*, 1989, Feldman and Nelson, 1996 and De Cock *et al.* 1997). Hadley (1975) reported

normal progesterone levels in pyometra. According to Chaffaux and Thibier (1978) progesterone levels need not be higher or prolonged for the development of pyometra. Lower concentrations of progesterone in pyometra were reported by Renton *et al.* (1993). According to Ververidis *et al.* (2004) there was no significant difference in progesterone levels in bitches with pyometra and normal bitches. The value had a range of 0.36 to 32 ng ml^{-1} depending upon the stage of ovarian cycle. But Austad *et al.* (1979) found increased levels or signs of luteal activity in macroscopic ovarian morphology in bitches with pyometra. Observations of Nelson *et al.* (1982) that the progesterone levels in bitches with pyometra varied from 0.08 to 10.2 ng/ml with a mean of 3.38 mg/ml and a median of 2.4 ng/ml is also supporting the above opinion. They suggested plasma progesterone level above 0.5 ng/ml as an indication of luteal activity. Meyers-Wallen *et al.* (1986) received progesterone levels from 0.6 to 23.2 ng/ml with a mean of 3.91 ng/ml in 10 bitches with open pyometra. It was 0.04 to 9.58 ng/ml for Arnold *et al.* (1988) and higher concentrations were reported by Vandeplassche *et al.* (1991). Dhaliwal *et al.* (1999) reported plasma progesterone concentration in 13 bitches as 14.0 ± 10.9 ng/ml with a wide range of <0.5 to 33 ng/ml. In recovered animals of Group I and II the progesterone levels had shown significant progressive reductions during the period of observation. It may be because of the progression of the individual animals to the next stage in oestrus cycle or may be because of the luteolytic effect of $PGF_{2\alpha}$ in dogs of Group II. Arnold *et al.* (1988) reported a reduction in progesterone levels subsequent to $PGF_{2\alpha}$ therapy in pyometra. But reports in the reviewed literature, to substantiate this reduction following uterine catheterization and drainage are scarce. In Group III the progesterone level had shown a sharp decline subsequent to the surgical removal of the ovaries and uterus and the values remained so in the subsequent observations.

5.1.8. Radiographic Evaluation

5.1.8.1. Survey Radiography

Survey radiographs in all the cases of three groups were satisfactory in producing a definite image of the distended uterus. The uterus appeared as a distended

tubular structure of uniform radiopacity, often with sacculations, occupying the major space of the abdominal cavity, pushing aside the intestinal loops.

5.1.8.2. Hysterography

Hysterography could be performed only in seven (38.8 %) dogs out of the 18 studied, depending upon the feasibility of transcervical cannulation. Among those cases, the full extend of the distended uterine lumen could not be outlined by the contrast medium in any of the cases. In three dogs (I_4, II_2 and II_6) the distribution of the contrast medium was comparatively better; but in others it was partial. It might be due to the thick and tenacious nature of the uterine contents or insufficient volume of contrast medium infused.

5.1.8.2.1. Anaesthesia and control

The anaesthetic protocol selected in this study, xylazine (1mg/kg) - ketamine (10 mg/kg) anaesthesia with atropine (0.045 mg/kg) premedication, was satisfactory for the transcervical cannulation by giving adequate muscle relaxation for the transabdominal manipulations. All the dogs had an uneventful recovery. The dogs were controlled on right lateral recumbency, which was found convenient for manipulations in transcervical cannulation.

5.1.8.2.2. Transcervical Cannulation Techniques (Table 17)

The three techniques *viz.*, Technique I, II and III for transcervical cannulation were attempted in each case.

5.1.8.2.2.1. Technique I

An instrument, a guiding device with a rigid wire loop at the end and cannula to fit into its lumen, was fabricated following the reports of Lagerstedt and Obel (1987). Three instruments with different wire loop sizes were fabricated to suit dogs of different size.

Transcervical cannulation was attempted using this technique in all selected cases and was successful only in two dogs *viz.*, I_4 and III_6 (11 %).

The major difficulty encountered in this technique was the lack of reachability of the expanded wire loop upto the vaginal fornix. The anterior vagina in canine is generally narrower than the mid vagina. The presence of dorsal median paracervical fold made the access to the *portio vaginalis* still difficult (Johnston *et al.*, 2001). Alignment of the lumen of cervix and the cannula was found difficult, both with the wire loop as well as with transabdominal palpation. Locating the *os* of cervix by feeling movement of tip of cannula was also difficult as the size of cervix was too small to hold. Location and gripping of the cervix and uterine body transabdominally was also found difficult, especially in obese dogs (Farstad, 1984). Narrow paracervix during dioestrus and anoestrus may also be a reason for failure (Lagerstedt and Obel, 1987 and Watts and Wright, 1995).

5.1.8.2.2.2. Technique II

In this technique intrauterine insemination technique using Scandinavian AI cannula as narrated by Linde-Forsberg (2001) was attempted. A 38 cm long stainless steel cannula with 3 mm outer diameter tapered to 1 mm blunt tip with hole having a bore size of 0.75 mm was used.

Transcervical cannulation was attempted using this technique in all selected cases and was successful only in three dogs *viz.*, II_6, III_2 and III_5 (16.6 %).

Locating the *os* of cervix by feeling movement of tip of cannula was difficult as the size of cervix was too small. Location and gripping of the cervix and uterine body transabdominally was also found difficult, especially in obese dogs (Farstad, 1984). Narrow paracervix (Johnston *et al.*, 2001) especially during dioestrus and anoestrus may be another reason for failure (Lagerstedt and Obel, 1987 and Watts and Wright, 1995). According to Linde-Forsberg (2001) this technique require skill especially in nulliparous dogs.

In Dog No. II_1 accidental penetration of the cannula at vaginal fornix was evident on the contrast radiograph. With this technique the risk of penetration if performed blindly with force had been reported by Linde-Forsberg (2001).

5.1.8.2.2.3. Technique III

A human, graduated rigid ordinary proctoscope of 28 cm length with an outer diameter of 2.2 cm, tapered to 1.7 cm at the cranial end, fixed with a high luminescent Light Emitting Diode inside its lumen towards the cranial end was used as a vaginal speculum. Through which a six French sized infant feeding tube with a rigid stainless steel stillette was passed to catheterize the uterus with simultaneous viewing and abdominal palpation.

Transcervical cannulation was attempted using this technique in all selected cases. It was found possible to pass the speculum through the vulva and vagina only in dogs above 20 kg body weight (seven out of 18 dogs). The technique was successful only in two dogs *viz.*, I_6 and II_2 (11 %).

In this technique, proctoscope could be introduced only upto the anterior vagina because of the narrow anterior vagina and paracervix with dorsal median fold (Johnston *et al.*, 2001). During dioestrus and anoestrus, in which periods most of the cases of pyometra were presented, paracervix will be narrower and passage through it will be difficult (Watts and Wright, 1995). Inadequate external fixation of cervix due to large abdomen also made the cannulation difficult (Farstad, 1984).

Among the three techniques *viz.*, Technique I, II and III, of transcervical cannulation attempted, Technique II gave comparatively good results (Fig. 18). Technique II appeared to be more practicable with least instrumentation and facilities, though it had an incidence of penetration at the vaginal fornix. Technique I and III produced similar results. But among them, Technique III was felt more satisfactory on application because of the visibility of the anterior vagina with the illumination provided.

On screening the available literature, only a very few works of transcervical cannulation and hysterography could be found. First reported work was by Cobb (1959) who claimed success in outlining the uterus in different stages of normal cycles and in pathologies employing an ordinary bitch urinary catheter attached with a cuff cut from Maggil's endotracheal tube. Farstad (1984), who successfully conducted intrauterine insemination in bitches, opined that the failure to cannulate uterus in a few was because of extremely narrow cervical canal and inadequate external fixation of cervix in dogs with large abdomen. Lagerstedt and Obel (1987) who claimed 95% success for transcervical cannulation of uterus suggested the reasons for failure as hypertrophic cervix, narrowing of cranial vagina, bent vagina and vaginal constriction. In that report the presence of dorsal median paracervical folds was no mentioned, which posed a major difficulty in the present work performed according to their technique. It was opined that instrumental approach to canine vagina was different than in other species, owing to the anatomical peculiarities. Lack of fluoroscopic equipment and need for general anaesthesia were mentioned as limitation for the method. Fougner (1989) described a method of intrauterine deposition semen used in fox breeding using a plastic speculum with a slender metal catheter, slightly angled at the tip guided by transabdominal fixing and guidance of the cervix. According to Watts and Wright (1995), who performed transcervical cannulation of uterus in bitches with the help of endoscope, the success in the procedure greatly depended upon the experience of the operator, stage of reproductive cycle and size of the bitch and cannula used. During dioestrus and anoestrus the paracervix was found narrow. Linde-Forsberg (2001) opined that transcervical cannulation of uterus require some practice especially in nulliparous dog. It involved some amount of risk due to the chance of perforation if performed blindly or with force.

5.1.8.2.3. Radiographic Observations

Survey radiographs were taken in all cases before the surgical management and in recovered cases of Group I and II on seventh and 28th postoperative days. It clearly imaged the shadow of the uterus if distended. The distended uterus generally appeared with uniform radiopecity and sacculations. It often folded back at the anterior parts

occupying the major part of the abdomen pushing aside the intestinal loops. In recovered cases of Group I and II, the uterine size was inappreciable on plain radiographs taken on 28th postoperative day. Plain radiography was used by many workers as tool to confirm the diagnosis of pyometra (Dow, 1957, Renton *et al.*, 1971 and Jackson, 1979). Brec *et al.* (1988) compared the diameter of uterine shadow to the length of second lumbar vertebrae. Reports on uterine size following transcervical drainage is scarce in the reviewed literature.

Hysterography was successful in seven out of the 18 dogs selected (38.9 %) depending on the practicability of transcervical cannulation. Hysterogram in Dog No. I_4, II_2 and II_6 gave comparatively uniform image of the most of the parts of the lumen of uterine horns. It expressed the size of uterine lumen and nature of the walls to some extend. In I_4 the image of uterus had serrated edges indicative of glandular hyperplasia. In II_2 the image of the uterus was even edged. In II_6 the border of the image appeared uneven, with longitudinal striations. But in other cases the images appeared partial or incomplete. It can be due to an inadequate volume or strength of the contrast medium or due to the consistency of the uterine continents. In certain cases the uterine contents were very thick and pasty or tenacious as found later after ovariohysterectomy. This might have restricted the uniform distribution of the contrast material inside the uterus (Plate 29).

Reports on hysterography, especially in pyometra were rare in the available literature. Hysterographic study of bitches in various stages of oestrus cycle was reported in 80 dogs by Cobb (1959). Hysterography in three bitches affected with cystic hyperplastic endometritis had been described by Cobb and Archibald (1959). Uterus was outlined with longitudinal streaks of various diameters and stellate outline at cross sections was found in one case; grossly distended uterus with corrugations in other two dogs. Funkquist *et al.* (1985) claimed success in 26 out of 28 normal bitches for hysterography. In 13 bitches with cystic endometrial hyperplasia pyometra, hysterography revealed rough inner surface with numerous filling defects, sac like dilatations. Lagerstedt (1993a) described hysterographic lesions in uterine pathologies except in pyometra and correlated them with macroscopic appearance after

ovariohysterectomy. Lagerstedt (1993b) claimed success in 83 out of 93 attempts of hysterography in various stages of oestrus cycle in normal bitches. But no reports could be traced among the screened literature giving hysterographic evaluation of uterine size following transcervical drainage.

5.1.9. Sonological Observation

Ultrasonography was conducted in three dogs of each group preoperatively and in three dogs each from Group I and II on seventh and 28th postoperative days. Distended uterus with hypoechoic or anechoic texture was recorded in all the cases preoperatively and the results were satisfactory is assessing the condition of the uterus. This was in agreement with the reports of England and Allen (1989), Fayer-Hosken *et al.* (1991) and Zoldag (1992). The size of the uterus was reduced following transcervical drainage in recovered cases and walls appeared thick in few cases and inappreciable in others on 28th postoperative day. Any reports regarding the sonological assessment of uterine size in transcervical drainage of uterus with or without $PGF_{2\alpha}$ therapy is not available with the reviewed literature. Regression of uterine size assessed by ultrasonography following $PGF_{2\alpha}$ therapy alone was reported by Sridevi *et al.* (2001).

5.2. SURGICAL MANAGEMENT

5.2.1. Group I (Table 6)

In dogs of Group I passage and retention of transcervical catheter was attempted and found successful in two cases (33.3 %) (I_4 and I_6), in which the transcervical cannulation was feasible (Table 17). In the former case on seventh day of observation, the catheter was found displaced from the uterus and was protruding out through the vulval lips. In the latter case catheter was mutilated and removed by the dog on the fifth day. Till then drainage through the catheter was observed. Other cases, in which transcervical drainage was not successful, were subjected to ovariohysterectomy.

Reports on successful placement of indwelling transcervical catheter for uterine drainage in pyometra were scarce in the reviewed literature. Placement of intrauterine catheter and drainage of uterine contents for five to15 days and subsequent recovery was claimed in nine out of 12 bitches with pyometra by Funkquist *et al.* (1983) and in three bitches by Lagerstedt *et al.* (1987). Former had complications like mistakenly placed catheter in one horn alone in one case and perforation of uterine wall in other. In some cases the catheters were expelled spontaneously or the dog bitten and removed it. It was opined that the regression of uterine size might be due to mechanical stimulation of uterine wall by the catheter or by the osmotic stimulation by the contrast material. Anyhow prognosis of intrauterine drainage was not found favourable in old dogs than in young dogs. Cobb (1959) drained the uterus using a metallic urinary catheter before surgery. Meyers-Wallen *et al.* (1986) described temporary placement of transcervical catheter through laparotomy and flushing of the uterine lumen. Feldman and Nelson (1996) opined that, drainage of the uterine contents in pyometra through transcervically placed catheters was not practical, need complex instrumentation, skill and luck and might be often life threatening, and hence not recommending that treatment.

5.2.2. Group II (Table 11)

5.2.2.1. Transcervical Drainage

Passage and retention of intrauterine catheter was attempted and found successful only in two cases (II_2 and II_6) (33.3%) in which the transcervical cannulation was feasible (Table 17). The catheter was found misplaced on seventh day of observation in both the cases. Drainage of pus through the catheter was not observed beyond two days in the former case and in the latter drainage of pus was noticed till it was removed.

5.2.2.2. Prostaglandin $F_{2\alpha}$ Therapy

5.2.2.2.1.Dose

In addition these dogs received $PGF_{2\alpha}$, dinoprost tromethamine, at the rate of 30 µg/kg body weight intramuscularly, twice daily for five days. Administration of $PGF_{2\alpha}$ in catheterized dogs did not produce any appreciable difference in uterine drainage.

A lot of works using various dosage levels and different analogues of Prostaglandin $F_{2\alpha}$ had been conducted to treat pyometra. Sokolowski (1980) tried 100 to 1000 mcg/kg body weight in bitches with pyometra and suggested 250 mcg/kg body weight as an optimal dose to minimize the side effects. Nelson *et al.* (1982) used dinoprost at the dose rates of 0.10 mg/kg, 0.25 mg/kg and 0.50 mg/kg subcutaneously, once daily and suggested that the severity of the reaction were not dose related and possibility of refractoriness to the myotonic effect of $PGF_{2\alpha}$ on repetitive and increasing doses. Meyers-Wallen *et al.* (1986) successfully treated pyometra with $PGF_{2\alpha}$ at the rate of 0.25 and 0.50 mg/kg body weight subcutaneously, once daily for three days. Lagerstedt *et al.* (1987) reported failure of $PGF_{2\alpha}$ therapy in three cases of pyometra at the dose rate of 0.25 mg/kg body weight. Treatment with $PGF_{2\alpha}$ at the rate of 26.8 to 258 µg/kg (Gilbert *et al.* (1989), 20 µg/kg (Arnold *et al.*, 1988, Hubler, 1991), 0.25 mg/kg (Memon and Mickelsen, 1993), 10 µg/kg (Azim *et al.*, 1995). Feldman and Nelson (1996) recommended the protocol for use of natural $PGF_{2\alpha}$ starting with a dose of 0.1 mg/kg subcutaneously once and subsequently increased to 0.25 mg/kg once daily by third day upto seventh day. Other dose protocols used were 30 µg/kg (Sridevi *et al.*, 2000), 0.1 to 0.25 mg/kg (Roy, 2002) and 10 mg/kg and 1µg/kg (Gobello *et al,* 2003). Generally treatment with low dose $PGF_{2\alpha}$ was found to produce encouraging results with least side effects (Sridevi *et al.*, 2000).

5.2.2.2.2. Effects

Administration of $PGF_{2\alpha}$ in catheterized dogs did not produce any appreciable difference in uterine drainage. Any report on the combined effects of transcervical

catheterization and $PGF_{2\alpha}$ therapy in pyometra were not available with the reviewed literature.

5.2.2.2.3. Side Effects

All the dogs, which received $PGF_{2\alpha}$, dinoprost tromethamine, had developed varying degrees of panting, excitement, salivation, vomiting and nausea within five minutes of the injection, which lasted for a maximum of 20 min. Some owners complained of the dog whining at the night. Similar side effects had been reported by Coulson (1979), Sokolowski (1980), Nelson *et al.* (1982), Meyers-Wallen *et al.* (1986), Memon and Mickelsen (1993), Azim *et al.* (1995), Feldman and Nelson (1996), Roy (2002) and Kirihara *et al.* (2005). A case of rupture of uterus subsequent to $PGF_{2\alpha}$ treatment in pyometra was reported by Jackson (1979) and Nelson *et al.* (1982). Any such side effects were not found when low dose $PGF_{2\alpha}$ therapy was used (Arnold *et al.*, 1988, Sridevi *et al.*, 2000 and Gobello *et al.*, 2003).

5.2.3. Group III (Table 16)

Ovariohysterectomy was performed in all the dogs of this group under general anaesthesia following standard surgical procedure (Hedlund, 2002). The procedure was uneventful in all the cases.

5.3. Outcome of the Treatment (Table 6,11 and 15)

In Group I transcervical drainage was successful in two out of six cases (33.3%) and both these animals were cured and discharged at the end of the treatment period. Comparable results were reported by Funkquist *et al.* (1983) and Lagerstedt *et al.* (1987). According to them the length of drainage period and the outcome were not related; the mechanical stimulation of uterine wall with the catheter or osmotic stimulation by contrast material promoted the resolution of uterus and the drainage had less favourable prognosis in old animals than in young. The dogs, in which

transcervical cannulation was not successful, were either subjected to ovariohysterectomy or succumbed to death during the observation period.

In Group II similar results (33.3%) were obtained with transcervical drainage coupled with $PGF_{2\alpha}$ therapy. Comparable results are not available with the same treatment in the reviewed literature. Another dog in that group which had unsuccessful transcervical drainage was cured at the end of the observation period with $PGF_{2\alpha}$ and other supportive therapy alone. This can be attributed to uterine drainage in response to $PGF_{2\alpha}$ treatment. (Sokolowski, 1980, Nelson *et al.* (1982), Meyers-Wallen *et al.*, 1986, Arnold *et al.*, 1988, Hubler, 1991,Memon and Mickelsen, 1993, Azim *et al.*, 1995, Feldman and Nelson, 1996, Sridevi *et al.* 2000, Roy, 2002, Gobello *et al.*, 2003 and Kirihara *et al.*, 2005). The rest of the dogs in both these groups were either succumbed to death or subjected to ovariohysterectomy. Cases refractory to $PGF_{2\alpha}$ therapy was reported by Sokolowski (1980), Nelson *et al.* (1982), Lagerstedt *et al.* (1987), Arnold *et al.* (1988) and Hubler (1991). Gilbert *et al.* (1989) suggest that (1) failure to get clinical remission with $PGF_{2\alpha}$ within 6 day of treatment indicate poor prognosis and least chance of recovery of breeding potential, (2) mating should be encouraged in the first oestrus after treatment and should be accompanied by antibacterial therapy and (3) success should be regarded as temporary.

Ovariohysterectmy was most recommended and proven treatment in canine pyometra (Nelson and Feldman, 1996). In Group III all the dogs (83.3 %) recovered uneventfully after ovariohysterectomy except one. That dog died after ovariohysterectomy had exceptionally high haematological and biochemical values. This was in agreement with the opinion of Ki *et al.* (2000). Mortality rate after surgical treatment of pyometra was approximately five to eight percent, according to Hedlund, (2002).

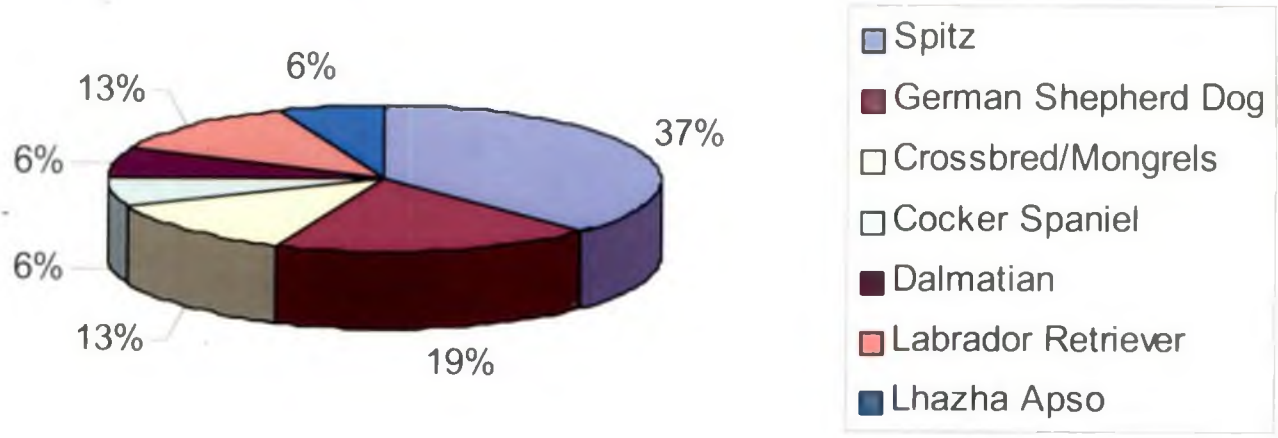


Fig. 1. Breed-wise distribution in dogs selected for the study

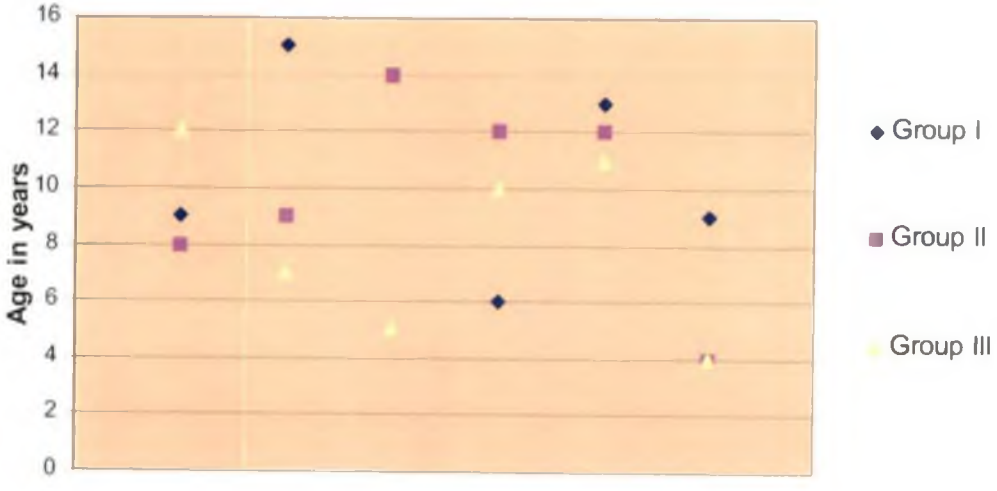


Fig. 2. Age-wise distribution of dogs selected for the study

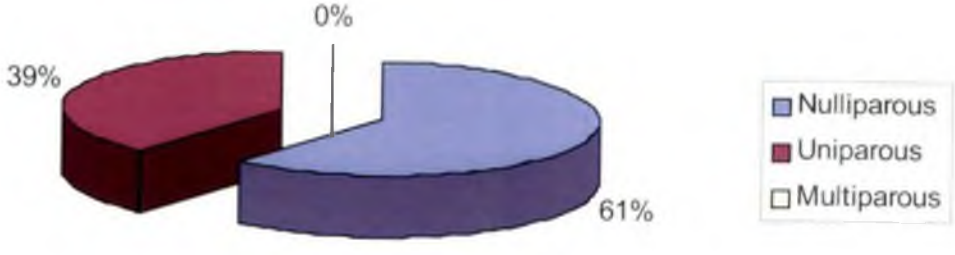


Fig. 3. Parity-wise distribution of dogs selected for the study

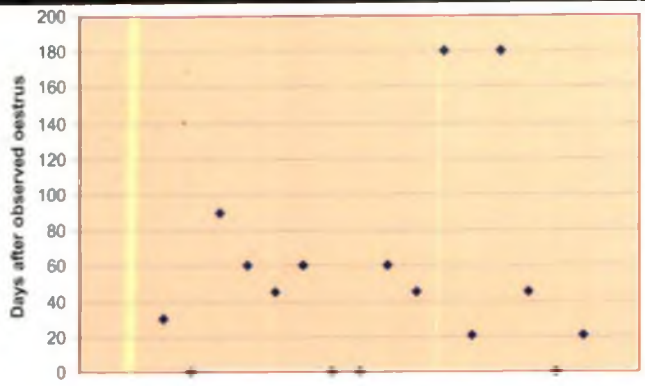


Fig. 4. Occurrence of previous oestrus in dogs selected for the study

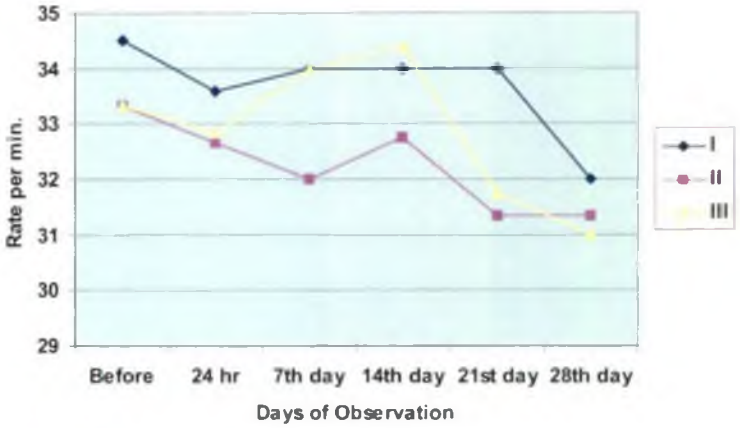


Fig. 5. Respiratory rate in Group I, II and III during the period of observation

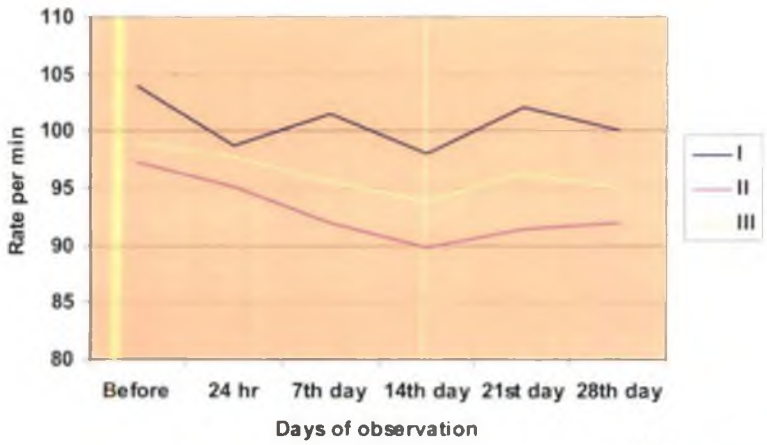


Fig. 6. Pulse rate in Group I, II and III during the period of observation

Fig. 7. Rectal temperature in Group I, II and III during the period of observation

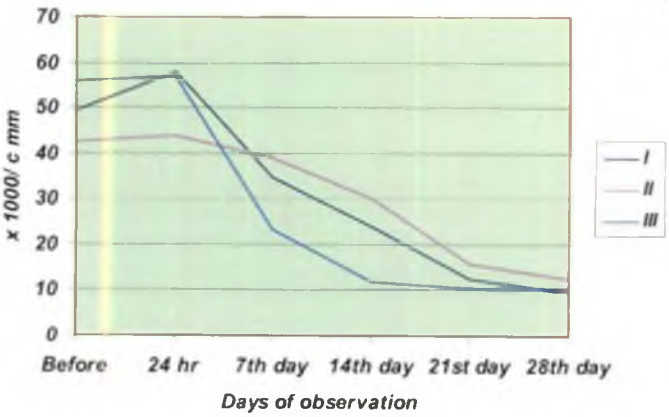


Fig. 8. Total leucocyte count in Group I, II and III during the period of observation

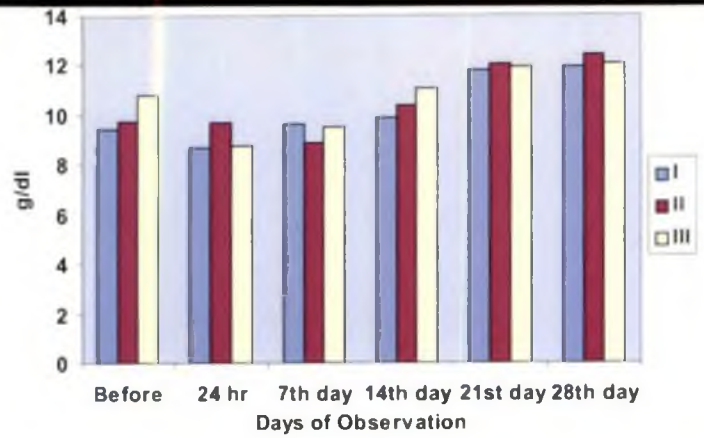


Fig. 9. Haemoglobin concentration in Group I, II and III during the period of observation

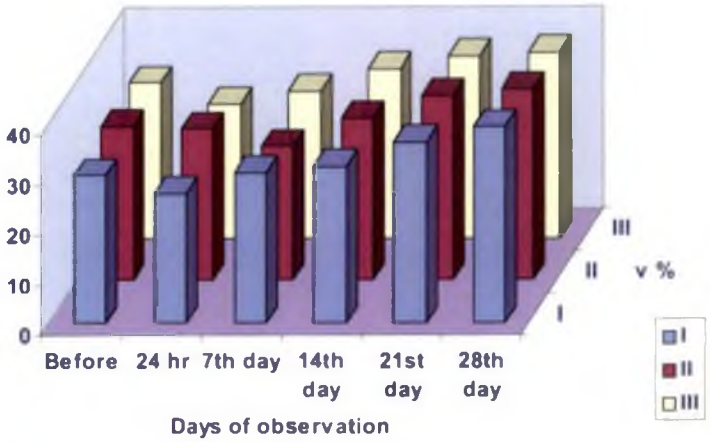


Fig. 10. Volume of packed red cells (VPRC) in Group I, II and III during the period of observation

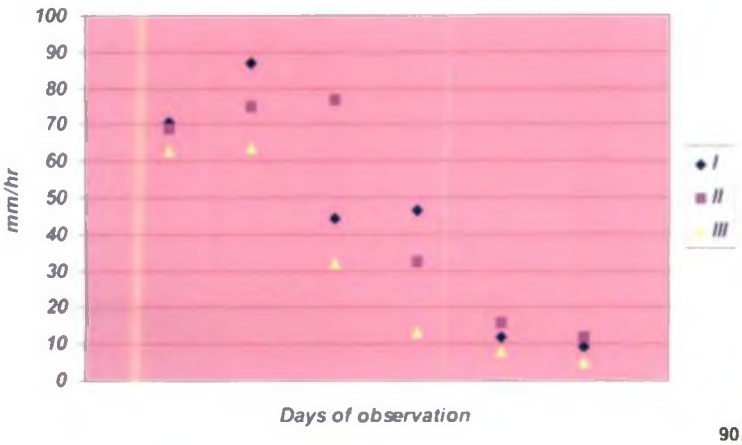


Fig. 11. Erythrocyte sedimentation rate (ESR) in Group I, II and III during the period of observation

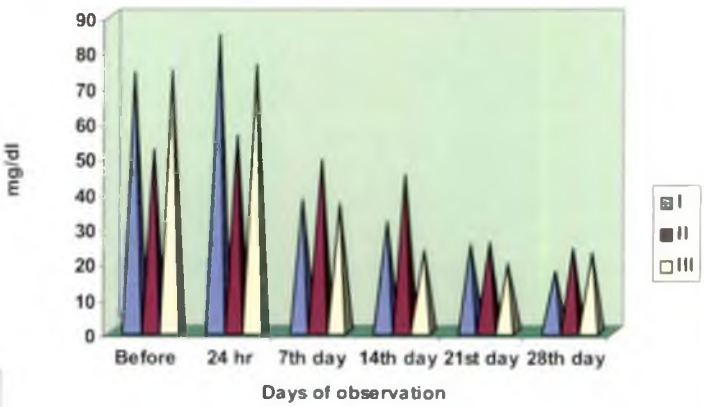


Fig. 12. Blood urea nitrogen (BUN) in Group I, II and III during the period of observation

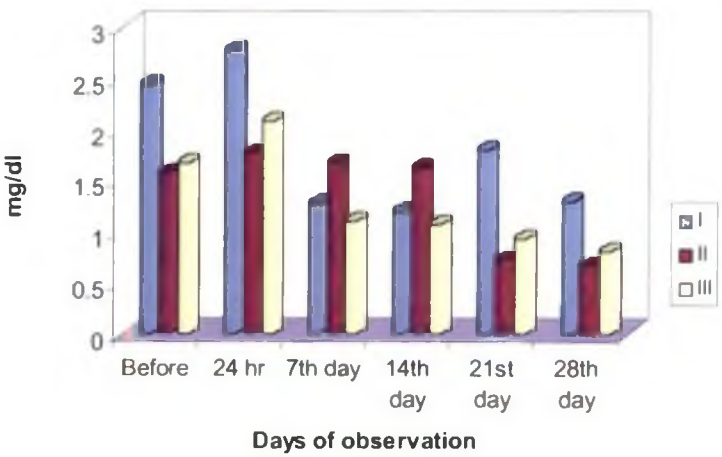


Fig. 13. Serum creatinine in Group I, II and III during the period of observation

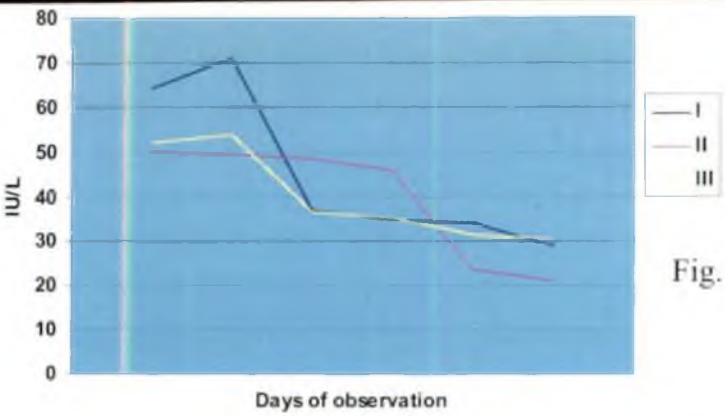


Fig. 14. Serum alanine aminotransferase (ALT) in Group I, II and III during the period of observation

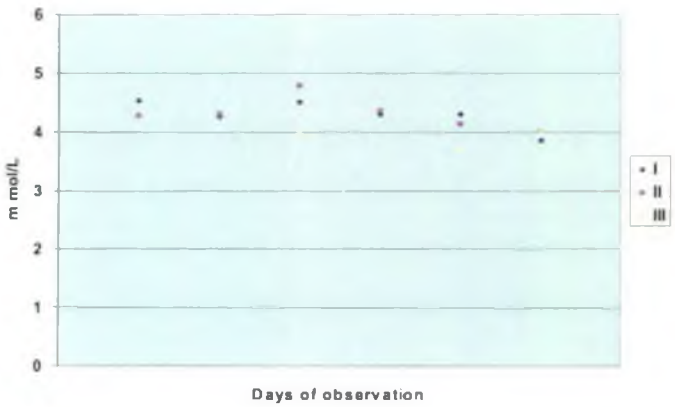


Fig. 15. Serum potassium in Group I, II and III during the period of observation

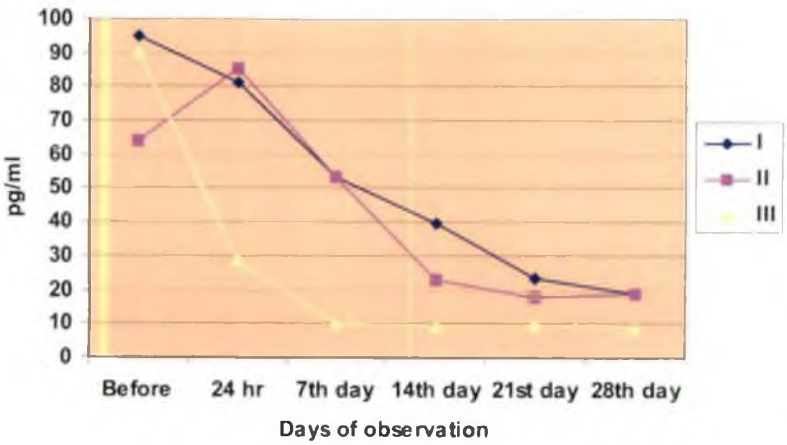


Fig. 16. Plasma oestradiol in Group I, II and III during the period of observation

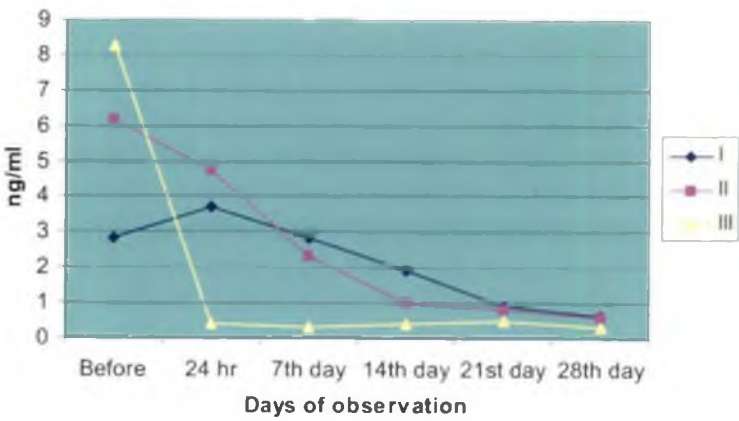


Fig. 17. Plasma progesterone in Group I, II and III during the period of observation

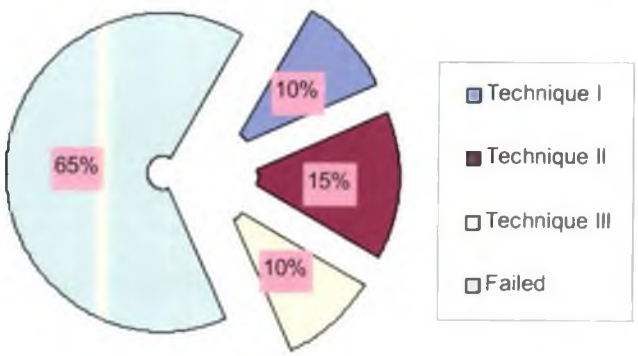


Fig. 18. Success rate in transcervical cannulation using Technique I, II and III

SUMMARY

6. SUMMARY

The study was conducted with the objectives of identifying a radiographic technique for the diagnosis of pyometra in dogs, to compare the efficacy of transcervical drainage with and without prostaglandin $F_2\alpha$ (PG $F_2\alpha$) therapy to ovariohysterectomy as a treatment for pyometra and to assess the efficacy of transcervical drainage in regaining the breedability of the dogs affected with pyometra.

Eighteen female dogs of various age and breeds presented to the College Veterinary Hospitals, Mannuthy and Kokkalai with the history and clinical signs suggestive of pyometra were selected for the study. All the dogs were subjected to physiological, haematological, biochemical and clinical examination and detailed radiographic evaluation to confirm the diagnosis. These dogs were randomly divided into three groups *viz.*, Group I, II and III, consisting of six each and were subjected to different surgical management for pyometra. The evaluation was repeated at 24 hr, and on seventh, 14^{th}, 21^{st} and 28^{th} postoperative days.

The dogs selected for this study belonged to various breeds like Spitz (6), German Shepherd Dog (3), Dachshund (2), Crossbred (2), Cocker Spaniel (1), Dalmatian (1), Labrador retriever (2) and Lhaza Apso (1). The age of the selected dogs ranged from four to 15 years (9.7 ± 3.5 years) with a median of 9.5 years. Body weight of the dogs ranged from six to 37 kg. Of these dogs 62 % of them were nulliparous and 38 % uniparous. Signs of oestrus were exhibited by the dog at an average of 63.4 days before presentation to the clinic and only two of them were mated in that oestrus. Food intake was either reduced (55%) or absent (45%). Vomiting and polydipsia in 56% of the cases, polydipsia alone in 33% and vomiting alone in 11 % were reported. All dogs (83.3%) had purulent or sanguineopurulent vaginal discharge except three (16.6%), which did not show any vaginal discharge.

The dogs had shown severe (22.2%), marked (44.4 %), moderate (22.2%) or slight abdominal (11.1%) distension on the day of admission and postoperatively it gradually reduced in recovered dogs of Group I and II. The vulval discharge was

copious and purulent in 22.2%, moderate and purulent in 11.1%, scanty and purulent in 11.1%, moderate and sanguineopurulent in 27.7% and scanty and sanguineopurulent in 11.1%, and absent in 16.6 % of the dogs. . In recovered cases of Group I and II the vulval discharge became scanty by 14th day and was absent on 28th day. It was absent in all dogs of Group III except one from the seventh postoperative day onwards. The vulval lips were oedematous in 77.8% of the dogs and normal in 22.2%. In those recovered cases of Group I, the vulval oedema remained so throughout the period of observation, but it became normal by 14th day in those of Group II and III. Polydipsia and vomiting were disappeared by 14th day in recovered dogs of Group I and II and by seventh day in those of Group III.

Both the respiratory rate and pulse rate were within normal range in the dogs of all the groups throughout the observation period. Slight elevation in mean rectal temperature was recorded before the surgical management in Group II and III, while it was within normal range in Group I. The elevated rectal temperatures reduced to normal range by seventh postoperative days. Three dogs from each group which had shown hypothermia during the observation period, died subsequently. The visible mucous membrane was congested in 17%, pale roseate in 44% and pale in 39% dogs. In recovered cases of the three groups, the visible mucous membrane resumed pale roseate colour towards the end of observation period.

In all the dogs there was marked to extreme leucocytosis and neutrophilia with shift to left before the surgical management. These returned to normal range by 28th day in Group I and II and by 14th day in Group III.

The mean haemoglobin concentration and volume of packed red cells (VPRC) were lower than the normal range in three groups, on the first observation. Following surgical management, the values had shown an increasing tendency towards normalcy by 21st day in Group I and II and by 14th day in Group III.

The dogs of all the groups had shown an extremely high erythrocyte sedimentation rate on the first observation. The ESR reduced to moderate levels by 21st day and to

normal ranges by 28th day in recovered cases of Group I and II and by 14th day in dogs of Group III.

The mean blood urea nitrogen was elevated from normal ranges in all the groups. The recovered dogs of Group I and II had shown gradual reduction in BUN values from seventh day onwards and reached normal ranges by 21st day. Group III had shown an earlier regaining of normal values, by seventh postoperative day. The mean serum creatinine level remained within normal range in Group I, II and III, before as well as after the surgical management. A gradual and progressive reduction in the mean serum creatinine level was evident in the three groups during the observation period.

Slightly elevated levels of serum alanine aminotransferase level was observed before the surgical management in all the groups and in the recovered dogs of the three groups it returned to normal ranges by 21st day.

The mean serum potassium level remained within the normal range in the three groups throughout the observation period.

Formol gel test was positive in 88.8 % of the cases and negative upto 12 hr in 11.1%. The test in the recovered dogs of Group I and II became negative by seventh day and in Group III, three dogs became negative by seventh and two by 14th postoperative days.

The mean plasma oestradiol and progesterone concentrations on the first day of observation varied much between and within the different groups. A gradual reduction in the oestradiol and progesterone concentrations was recorded through the observation period in Group I and II. A sharp reduction in oestradiol and progesterone level was noted in Group III at 24hr observation and it remained so in the subsequent observations.

Survey radiography in all the dogs was found satisfactory in producing a definite image of the distended uterus. The uterus appeared as a distended tubular structure of uniform radiopacity, often with sacculations, occupying the major space of

the abdominal cavity, pushing aside the intestinal loops. In the recovered cases of Group I and II the image of uterus was inappreciable on 28th day.

Hysterography could be performed only in seven (38.8 %) dogs out of the 18 studied, depending upon the feasibility of transcervical cannulation techniques *viz.*, Technique I, II and III. Among those cases, the full extend of the distended uterine lumen could not be outlined by the contrast medium in any of the cases. In three dogs the distribution of the contrast medium was comparatively better; but in others it was partial.

The three techniques were attempted for transcervical cannulation in each case. Technique II gave comparatively good results (16.6 %). Technique II appeared to be more practicable with least instrumentation and facilities, though it had an incidence of penetration at the vaginal fornix. Technique I and III produced similar results (11.1 % each). But among them, Technique III was felt more satisfactory on application because of the visibility of the anterior vagina with the illumination provided. The major difficulty encountered in Technique I and III was the lack of reachability of vaginal fornix with the instruments used. Alignment of the lumen of cervix and the cannula was found difficult with transabdominal palpation. Locating the *os* of cervix by feeling movement of tip of cannula was also difficult as the size of cervix was too small to hold. Location and gripping of the cervix and uterine body transabdominally was also found difficult, especially in obese dogs.

Ultrasonography was conducted in three dogs of each group preoperatively and in three dogs each from Group I and II on seventh and 28th postoperative days. Distended uterus with hypoechoic or anechoic texture was recorded in all the cases preoperatively and size of the uterus was reduced following transcervical drainage in recovered cases and the walls appeared thick in few cases and inappreciable in others on 28th postoperative day.

The dogs belonging to Group I, II and III were subjected to different surgical procedures *viz.*, transcervical drainage, transcervical drainage with $PGF_{2\alpha}$ and ovariohysterectomy respectively.

In dogs of Group I, surgical management by passage and retention of transcervical catheter was attempted and found successful in two cases (33.3 %) in which the transcervical cannulation was feasible. In those dogs catheter was found displaced by seventh and fifth postoperative days. The cases, in which transcervical drainage failed, were subjected to ovariohysterectomy.

Passage and retention of transcervical catheter was attempted in Group II and found successful in two cases (33.3%) in which the transcervical cannulation was feasible. The catheter was found misplaced on seventh day of observation in both the cases. Drainage of pus through the catheter was not observed beyond two days in the former case and upto its displacement in the latter. In addition these dogs received $PGF_{2\alpha}$, dinoprost tromethamine, at the rate of 30 μg/kg body weight intramuscularly, twice daily for five days. Administration of $PGF_{2\alpha}$ in catheterized dogs did not produce any appreciable difference in uterine drainage. All these dogs developed varying degrees of panting, excitement, salivation, vomiting and nausea within five minutes of the injection, which lasted for a maximum of 20 min and whining at the night. The cases, in which transcervical drainage failed, were subjected to ovariohysterectomy.

In Group III ovariohysterectomy was performed in all the dogs of this group under general anaesthesia following standard surgical procedure. The procedure was uneventful in all the cases.

In Group I and II, two dogs (33.3%), in which transcervical drainage was successful, were discharged as cured. Another dog in Group II, which had unsuccessful transcervical drainage, cured at the end of the observation period with $PGF_{2\alpha}$ and other supportive therapy alone. In Group III all the dogs (83.3 %) recovered uneventfully after ovariohysterectomy except one.

One each among the recovered dogs of the Group I and II had shown oestrus symptoms four months after the discharge. The dog from Group I developed pyometra eight months after the treatment. The dog that recovered by $PGF_{2\alpha}$ therapy alone developed pyometra nine months after discharge.

Three dogs belonging to three different groups died during the period of observation had exceptionally high haematological and biochemical values.

From the results of this study the following conclusions could be drawn.

- Plain lateral abdominal radiography is a practicable tool in diagnosing the uterine distention in pyometra.
- Hysterography cannot be employed a routine diagnostic tool in pyometra owing to the requirement of anaesthesia in otherwise compromised patients, skill and expertise and specialized instrumentation .
- Technique II of transcervical cannulation for hysterography and drainage using Scandinavian AI catheter is comparatively feasible to other techniques.
- In Technique I and III of transcervical cannulation, it is difficult to access the *portio vaginalis* of cervix through the narrow anterior vagina. Even then Technique III was found more suitable due to the illumination and visibility.
- Concurrent use of $PGF_{2\alpha}$ therapy did not have any advantage over transcervical catheterization in treating pyometra.
- Transcervical drainage may be opted as a treatment for pyometra in young bitches with breeding value, provided extra-genital affections are minimum. Failure in introduction and retention of catheter, inadequate drainage and other risk involved must be born in mind while opting to that treatment.
- Ovariohysterectomy was found the most effective treatment for pyometra in salvaging the affected dogs, than transcervical drainage, but at the cost of breeding life of the dogs. It can be recommended as the treatment of choice in old and compromised patients and those which are not intended for breeding.
- Haematological and serum biochemical values are of prognostic importance in assessing the recovery rate in the treatment of pyometra, whatever may be the method of treatment adopted.

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RADIOGRAPHIC EVALUATION OF PYOMETRA AND ITS SURGICAL MANAGEMENT IN DOGS

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ABSTRACT

Radiographic techniques for diagnosis and comparative efficacy of transcervical drainage with or without prostaglandin $F_2\alpha$ therapy and ovariohysterectomy for the management of pyometra were studied in 18 dogs.

All the dogs were subjected to detailed clinical, physiological, haematological, biochemical and hormonal and detailed radiographic evaluation before and after the treatment. The dogs were divided into three groups, *viz.*, Group I, II and III, of six each and were subjected to different surgical management *viz.*, transcervical drainage, transcervical drainage with $PGF_{2\alpha}$ and ovariohysterectomy respectively.

The dogs selected for the study belonged to various breeds with a high proportion of Spitz (37%) and German Shepherd Dog (19%). The age ranged from four to 15 years (9.7 ± 3.5 years) and body weight from six to 37 kg. Of these dogs, 62% were nulliparous and 38 % uniparous. Symptoms of pyometra were noticed on an average of 63.4 days after the onset of previous oestrus. Commonly observed symptoms were vomiting and polydipsia (56%), polydipsia alone (33%) and vomiting alone (11%) with purulent or sanguineopurulent discharge was present (83%).

All the dogs had slight to severe abdominal distension and oedema of vulval lips, which reduced postoperatively in recovered cases. Vulval discharge reduced by 14^{th} day, and absent by 28^{th} day in Group I and II and by seventh day in Group III. In recovered dogs of Group I and II polydipsia and vomiting disappeared by 14^{th} day and in Group III by seventh day.

Physiological parameters like respiratory and pulse rate were normal throughout the period of observation. Rectal temperature had shown an initial elevation and returned to normal by seventh day postoperatively. Colour of mucous membrane, which was congested or pale in a few, resumed to pale roseate at the end of observation period in recovered dogs.

Extreme leucocytosis and neutrophilia with shift to left, decreased haemoglobin concentration and volume of packed red cells, and severely elevated erythrocyte sedimentation rate were noticed in all the dogs. These values had shown an earlier tendency to return to normal ranges in Group III than Group I and II.

Extreme elevations of blood urea nitrogen and moderate elevation of creatinine and alanine aminotransferase were noticed preoperatively. These were reduced subsequent to the treatments in all the groups. In dogs subjected to ovariohysterectomy an early recovery was noticed. Serum potassium levels remained within normal range throughout the observation period. Formol gel test that was positive 88.8% of the dogs initially became negative by 14^{th} postoperative day.

Plasma oestradiol and progesterone concentrations had shown a vide variation between and within the groups, but shown a gradual decreasing tendency towards the end of observation in Group I and II. But the decrease was sharp following ovariohysterectomy in Group III.

Survey radiography was found satisfactory in diagnosis of pyometra. For hysterography transcervical cannulation was attempted in all dogs before the treatment using techniques *viz.*, I, II and III. Technique II using Scandinavian AI catheter was found feasible, despite the penetration at vaginal fornix in one case. Technique III employing an illuminated proctoscope as vaginal speculum was found more practicable than Technique I. In seven dogs out of 18, only in which hysterography was successful, uterine lumen could not be completely outlined.

Transcervical drainage of uterus through the catheters was successful in two cases each from Group I and II. Concurrent administration of $PGF_{2\alpha}$ did not produce any appreciable difference in uterine drainage, while the dogs received it had shown various degrees of side effects. All the dogs except one subjected to ovariohysterectomy recovered uneventfully. Three dogs died during the period of observation had exceptionally high haematological and biochemical values. One dog each among the recovered in Group I and II had shown oestrus symptoms subsequently and that belonged to Group I developed pyometra after eight months.