HAEMATOLOGICAL AND SERUM BIOCHEMICAL PROFILE OF INTESTINAL IMPACTION IN ELEPHANTS

(Elephas maximus indicus)

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree

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DECLARATION

I hereby declare that the thesis entitled **"HAEMATOLOGICAL AND SERUM BIOCHEMICAL PROFILE OF INTESTINAL IMPACTION IN ELEPHANTS (*Elephas maximus indicus*)"** is a bonafide record of research work done by me during the course of research and that this 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 the thesis entitled **"HAEMATOLOGICAL AND SERUM BIOCHEMICAL PROFILE OF INTESTINAL IMPACTION IN ELEPHANTS (*Elephas maximus indicus)* "** is a record of research work done independently by **Sri. Jayakrishnan. T.N.,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship, fellowship to him.

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DEDICATED
TO
MY MOTHER AND BROTHER

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INTRODUCTION

1. INTRODUCTION

Elephants have been a source of profound astonishment and curiosity to man ever since he evolved the power of reflective thought. From time immemorial, elephants have been a source of man's fascinations. It always aroused his passions of love, affection and the innate urge to conquer the beast by reason of its size, strength and unusual appearance.

Modern day elephants belong to the family Elephantidae under the order Proboscidia as classified by Osborn. The two living representatives of this order are now distributed in two continents, *viz*, Asia and Africa. Formerly there were representatives of Proboscidia in every continent of the world except Australia and Antartica. This unveils the sickening truth that elephants are a dying race. By the end of this century the truly wild elephant will probably have ceased to exist and the elephant population of the world will be restricted to a number of semi-domestic herds in the natural parks.

The Asian elephants, in spite of its close relationship with human race through its association in the day to day life of man, is likely to be the first large mammal to be found only in small numbers and as a domesticated animal by the end of the 21st century. It faces severe pressures on its habitat by virtue of encroachment of forest land by man and poaching than its

African counterpart and its survival is very closely linked to the increasing human population and its demand on natural resources.

The population of Asian elephants in the whole continent ranges from 29,000 to 54,000. Although their number is fewer than compared to their African counterpart, which counts to around 70,000, Asian elephants enjoy a better conservative potential than African elephant. This can be attributed to their close interrelationship to almost all human cultures of South-East Asia where they are associated with religious ethos and so are divinely protected. In fact India boasts the historical evidence of first domesticating this animal as early as second millennium BC. According to a survey conducted in 1984-85 by Asian Elephant Study Group, the estimated population of elephants in whole of India is between 17,000 and 21,000, of which above 6500 are in Kerala. One tenth of the elephant population in Kerala is under captivity, that is about 600 and most of them are tuskers. The highest population of domesticated elephants in Kerala is centered in the three districts of Thrissur, Palakkad and Ernakulam. In Kerala these elephants are used for timber logging and for temple festivities. The role of elephants in religious functions is so indispensable that, such functions are considered complete only with the participation of caparisoned elephants in central Kerala.

Though the elephants enjoy more affection and respect than any other animals domesticated by mankind, they also are often been preys to the selfish human interests. Poor managemental practices and mere negligence of animal welfare from the parts of mahouts as well as from the elephant owners lead to various ill effects in domesticated elephants.

One such condition is the impaction of the colon which is a common digestive tract disease condition of the domesticated elephants in Kerala. This condition often turns fatal, unless attended promptly.

However, there is distinct lack of knowledge about the actual pathogenesis of this condition and its effect upon the homeostasis of the animal especially with respect to its implications on the haematology and serum biochemistry of the affected elephants. It warrants studies in this line to estimate the ill effect of the condition on the circulatory system of the animal. Such a study will help to adopt better therapeutic and control measures against the condition. Available literature did not throw any light in many of these aspects. Hence this study was planned with the following objectives.

1. To study the symptomatology, haematology and serum biochemistry of intestinal impaction in elephants.
2. To understand the pathogenesis of intestinal impaction
3. To suggest better therapeutic and control measures.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Impaction of gastro-intestinal tract (G.I. tract) is a very common non-specific disease of elephants, especially impaction of colon. Any part of the long colon might get impacted with fibrous food materials and a single mass might weigh up to 100 Kg. (Chandrasekharan *et al.*, 1995). The duration of the disease was usually twenty to thirty days, although conditions lasting up to 75 days have been reported (Chandrasekharan, 1997).

2.1 Occurrence

Radhakrishnan (1992) reported that during the last one decade more than 115 cases of gastro-intestinal tract impaction were noticed among the domesticated elephants in Kerala. He described impaction of the G.I tract as a condition affecting elephants of all age groups and sex irrespective of the purpose for which they were maintained.

The incidence of impaction of colon was more in hot and humid summer season. i.e. the season of festivals in Kerala (Chandrasekharan *et al.*, 1995). They suggested that this could be due to the tendency of mahouts to feed and water the elephants immediately after long strenuous walks.

Namboothiri (1996) observed a high incidence of gastro-intestinal tract impaction in Kerala during the periods of treatment and care for elephants (sukha chikilsa) for improving their health.

According to Chandrasekharan (1997) the incidence of gastro-intestinal tract impaction was about three percent among the domesticated elephants of Kerala.

2.2 Etiology

Radhakrishnan (1992) pointed out managemental errors as the common predisposing reason for impaction other than high fibre and low water contents of the palm leaves (the main diet of elephants in Kerala) .

Chandrasekharan (1979) attributed foreign bodies or collection of hard, fibrous food materials, intussusception or invagination, volvulus, malignant growth or healed ulcers on the intestinal wall, irregular peristaltic movement of the intestinal wall as the common causes of impaction of small intestine, colon or caecum.

Radhakrishnan (1992) reported watering and feeding immediately after a period of heavy work and prolonged walking during hot time of the day as the exciting causes of the condition.

Low water consumption and diseases of teeth or shedding of teeth, poor muscular support of the intestine, voracious eating after a period of fasting, over consumption of grains and feeds and indigestion were the other predisposing factors (Radhakrishnan, 1992; Chandrasekharan *et al.*, 1995: Namboothiri, 1996)

Namboothiri (1996) opined ingestion of mud as a cause of impaction.

Warren *et al.* (1996) recorded a case of gastro-intestinal tract impaction in a two year old Asian elephant due to ingestion of sand.

Chandrasekharan (1997) pointed out lack of scrub bath as a predisposing cause of impaction in elephants.

2.3.Symptoms

Radhakrishnan (1992) and Chandrasekharan *et al.* (1995) recorded constipation, passing of small quantities of fibrous and dry faeces, reduced feed and water intake, colic, tympany and vomiting of gastric fluid (in anterior obstruction) as the symptoms of impaction of G.I. tract. They reported death in G. I tract impaction due to rupture of colon and consequent peritonitis.

Dullness, varying degrees of straining and passing smaller sized faecal boluses, bloated abdomen in protracted cases were the other symptoms reported by Chandrasekharan (1997). He also reported the passing of easily digestible materials like banana fruits past the site of impaction in a rare case of partial obstruction where the impacted mass was an elongated faecal material.

The duration of symptoms varied. Uncomplicated cases lasted for two to ten days. Complicated cases with exudation from the intestinal mucosa as evidenced by perrectal seepage of a watery discharge took a course of more than 20 days to get relieved inspite of intensive treatment. One of the complications of gastro-intestinal impaction in elephants was the development of intestinal oedema in animals that were subjected to walking even after the development of the clinical symptoms. The loose intestinal tract under the weight of the impacted bolus produced swinging motion leading to intestinal oedema in these elephants necessitating treatment with antibiotics. Discharge of a thick viscous catarrhal exudate was a good prognostic sign as it indicated posterior movement of the impacted bolus (Chandrasekharan, 1997).

2.4 Treatment

Radhakrishnan (1992) reported a recovery rate of 80 percent in cases of impaction of the G.I. tract. His line of treatment included fluids, nutrients and

calcium borogluconate on alternate days along with parasympathomimetics to stimulate intestinal motility and secretions.

Chandrasekharan *et al.* (1995) reported the treatment of 169 cases of impaction of colon with analgesics and antispasmodics, antihistamines, drugs acting on smooth muscles, antibiotics, parasympathomimetics, electrolytes and dextrose saline parenterally.

2.5. Haematology

2.5.1. Total erythrocyte count.

Simon (1961) reported that adult elephants had a total erythrocyte count of 2.81 millions per cmm

Schmitt (1964) observed that the mean total erythrocyte count of one African and three Indian elephants was 4.64 millions per cmm

Nirmalan *et al.* (1967) reported that baby elephants had an erythrocyte count of 2.42 millions per cmm The erythrocyte count reported by them for tuskers, non-pregnant non-lactating females and pregnant elephants were 2.47, 2.40 and 1.84 millions per cmm respectively.

Adult African bull elephants had a mean erythrocyte count of 5.02 millions per cmm (Young and Lomband, 1967)

Lewis (1974) observed that elephant erythrocytes were large, discoid in shape but fewer in number than in human blood.

Schalm *et al.* (1975) reported that erythrocytes of elephants were biconcave disc in shape. They reported the erythrocyte count in female and male Indian elephants as 3.08 millions and 4.08 millions per cmm respectively.

Allen *et al.* (1985) observed that total erythrocyte count for young African elephants ranged from 2.1 to 4.2 millions per cmm with a mean value of 3.0 millions per cmm. They also confirmed the report that reticulocytes were absent in the peripheral blood of elephants.

Yathiraj *et al.* (1992) reported that total erythrocyte count of elephants was lower when compared to other mammals. They reported the size of the erythrocytes to range from 7.56 to 9.72 microns in diameter. The mean value of total erythrocyte count reported by them was 3.07 ± 0.06 millions per cmm.

The total erythrocyte count of free ranging Asian elephants (*Elephas maximus ceylonicus*) in Sri Lanka was 2.8 to 5.4 millions per cmm. (lower than other species) (Silva and Kuruwita, 1993a).

Silva and Kuruwita (1993b) reported that the total erythrocyte count of domesticated Asian elephants (*Elephas maximus ceylonicus*) in Sri Lanka ranged between 1.7 to 5.0 millions per cmm with a mean value of 3.6 millions per cmm.

2.5.2. Total leukocyte count

Simon (1961) reported that adult elephants had a total leukocyte count of 10.16 thousands per cmm

Schmitt (1964) reported that the mean total leukocyte count of one African and three Indian elephants was 14.4 thousands per cmm.

The total leukocyte count (thousands per cmm) in baby elephants, tuskers, non pregnant non-lactating elephants and pregnant elephants were 11.9, 8.78, 9.81 and 12.4 respectively (Nirmalan *et al.*, 1967).

Young and Lomband (1967) reported that the mean leukocyte count of adult African bull elephants was 10.36 thousands per cmm.

Lewis (1974) reported that leukocytes were present in great numbers in elephant blood than in human blood and showed some morphological differences.

The total leukocyte count per cmm in the blood of male and female Indian elephants were 20,800 and 12,700 respectively (Schalm *et al.*, 1975).

Allen *et al.* (1985) observed that the blood of young African elephants had a total leukocyte count ranging from 7.2 to 22.4 thousands per cmm with a mean value of 13.6 thousands per cmm.

Yathiraj *et al.* (1992) reported the mean total leukocyte count of two male and two female Asian elephants as 14.10 ± 0.63 thousands per cmm.

Leukocyte counts in the blood of free ranging Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 8 to 26 thousands per cmm. Elephant leukocytes differed in their morphological characters with the leukocytes of bovine, equine, canine and feline species (Silva and Kuruwita, 1993a). They attributed the high value of leukocytes to the excitement during immobilization.

Silva and Kuruwita (1993b) reported that the total leukocyte count in the blood of domesticated elephants (*E. maximus ceylonicus*) in Sri Lanka ranged between 11.3 to 11.9 thousands per cmm with a mean value of 11.6 thousands per cmm.

2.5.3. Haemoglobin

Simon (1961) observed the haemoglobin content in the blood of adult elephants as 13.4 g / dl.

Schmitt (1964) through his studies on one African and three Indian elephants reported the mean value of haemoglobin as 13. 8 g / dl of blood.

Baby elephants had 11.12 g of haemoglobin / dl of blood. The haemoglobin concentration in the blood of tuskers, non-lactating non-pregnant females and pregnant female elephants in g / dl of blood were 10.24, 10.72 and 9.78 respectively (Nirmalan *et al.*, 1967).

Young and Lomband (1967) reported that mean haemoglobin concentration in the blood of adult bull African elephants was 14.5 g / dl of blood.

Schalm *et al.* (1975) reported the haemoglobin level of male and female elephants as 15.2 and 12.3 g / dl of blood respectively.

According to Allen *et al.* (1985) haemoglobin values in young African elephants ranged from 9.1 to 16.9 g / dl with a mean value of 11.8 g / dl. There was no difference in the haemoglobin level with respect to sex and age.

Yathiraj *et al.* (1992) reported the mean haemoglobin concentration in the blood of Indian elephants as 11.65 ± 0.49 g / dl.

Silva and Kuruwita (1993a) reported that the haemoglobin concentration in the blood of free- ranging Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 9.8 to 15.8 g / dl with a mean value of 12.8 g / dl and was similar to that of the other species of elephants.

The concentration of haemoglobin in the blood of domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 7.4 to 15.4 g / dl with a mean value of 11.7 g / dl (Silva and Kuruwita. 1993b).

2.5.4. Packed cell volume

Simon (1961) reported the packed cell volume of adult elephants as 48.3 percent.

Nirmalan *et al.* (1967) reported a PCV of 34.7 percent for baby elephants. The values of PCV reported by them for tuskers, non-lactating non-

pregnant and pregnant females were 34.8 percent, 34.8 percent and 29.8 percent respectively.

Adult African bull elephant had a packed cell volume of 48 percent (Young and Lomband, 1967)

Schalm *et al.* (1975) reported that male elephants had a PCV of 48 percent and female elephants had 34 percent.

Allen *et al.* (1985) reported that the packed cell volume in young African elephants ranged from 26.8 to 47.0 percent with a mean value of 34.7 percent.

Yathiraj *et al.* (1992) reported that the mean packed cell volume in Indian elephants was 33.25 ± 0.46 percent.

Free ranging Asian elephants (*E. maximus ceylonicus*) in Sri Lanka had a packed cell volume ranging from 31.6 to 44 percent with a mean value of 37 percent (Silva and Kuruwita, 1993a).

Silva and Kuruwita (1993b) reported that the packed cell volume in domesticated elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 25.0 to 45.0 percent with a mean value of 36.0 percent

2.5.5. Differential leukocyte count

Simon (1961) observed that the differential leukocyte count in adult elephant was 36.53 percent neutrophils, 9.40 percent eosinophils, 0.47 percent basophils, 57.73 percent lymphocytes and 2.13 percent monocytes.

Schmitt (1964) reported the mean differential leukocyte count in African and Indian elephants as 41 percent neutrophils, three percent eosinophils, 52 percent lymphocytes and four percent monocytes.

The percentage-wise distribution of neutrophils, eosinophils, basophils, lymphocytes and monocytes were 32.1, 3.8., 0.6, 59.0 and 4.50 in baby elephants, 34.2, 6.2, 0.7, 52.8 and 6.07 in tuskers, 32.3, 6.6, 0.9, 56.2 and 3.90 in non-pregnant non-lactating female elephants and 4.4, 1.9, 0.5, 50.6 and 2.90 in pregnant elephants (Nirmalan *et al.*, 1967).

Young and Lomband (1967) described the percentage-wise distribution of different white blood cells in adult African elephants as 24.7 percent segmented neutrophils, 13.2 percent non-segmented neutrophils, 2.4 percent eosinophils, 58.2 percent lymphocytes and 1.4 percent monocytes.

Schalm *et al.* (1975) classified the bilobed leukocytes in the blood smear of Indian elephants as monocytes. According to them the percentage-wise

distribution of different white blood cells in the blood of male and female Indian elephants were 34.5 and 18.0 neutrophils, 18.5 and 29.5 lymphocytes. 47.0 and 51.5 monocytes. 0.0 eosinophils and 0 basophils.

Allen *et al.* (1985) reported the mean percentage-wise values of white blood cells in the blood of young African elephants as 21.32 neutrophils, 42.65 lymphocytes. 20.59 monocytes, 11.76 bilobed monocytes, 0.37 eosinophils and 0.74 basophils.

The differential leukocyte percentage in Indian elephants were 41.5 ± 0.56 neutrophils, 53.75 ± 0.89 lymphocytes, 1.75 ± 0.21 monocyte and 3.0 ± 0.35 eosinophils (Yathiraj *et al.*, 1992).

Silva and Kuruwita (1993a) classified the neutrophils in the blood of free ranging Asian elephants (*E. maximus ceylonicus*) in Sri Lanka as heterophils. According to them the percentage-wise distribution of various white blood cells were 23 heterophils, 44 lymphocytes, 27 monocytes, 5 eosinophils and 0.03 basophils.

The percentage wise distribution pattern of differential white blood cells in the blood of domesticated Asian elephants (*E. maximus ceylonicus*) in

Sri Lanka were 27 heterophils, 38 lymphocytes, 29 monocytes, 5 eosinophils and 0.31 basophils (Silva and Kuruwita, 1993b).

2.5.6. Erythrocyte Sedimentation Rate

Simon (1961) reported the erythrocyte sedimentation rate in adult elephants as 49mm per 30 min.

The erythrocyte sedimentation rate (millimeter per hour) in baby elephants, tuskers, non-pregnant non-lactating females and pregnant females were 61.3, 63.4, 61.3 and 67.4 mm respectively (Nirmalan *et al.*, 1967).

Young and Lomband (1967) reported an erythrocyte sedimentation rate of 29 mm per hour in adult African bull elephants.

Sreekumar (1986) reported erythrocyte sedimentation rate at 15 min for adult males, adult females and baby elephants as 30.33±2.9, 33.92±3.2 and 20.6±4.5 millimetres respectively. He also reported that age or sex had no influence on ESR.

Silva and Kuruwita (1993b) observed the erythrocyte sedimentation rate in domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka in the range of 64 to 148 mm per hour with a mean ESR of 120 mm per hour.

2.5.7. Haematology in impaction of intestine.

Auer (1992) noted that clinico-pathological changes were minimal but for a mild increase in packed cell volume indicating mild dehydration in the case of impaction of ventral large colon in horses.

Merritt and Calahan (1992) observed mild to moderate increase in packed cell volume in large colon impaction in horses.

Dabareiner and White (1995) reported a lower leukocyte count in venous blood samples from non-survivor horses affected with large colon impaction.

Warren *et al.* (1996) reported that the haematologic values were normal in the case of gastro-intestinal tract impaction of a two year old Asian elephant (*E. maximus*).

Mottelib and Misk (1976) reported haemoconcentration and leukocytosis in experimental obstruction of duodenum and ileum in dogs, manifested by increased RBC count, haemoglobin, haematocrit, MCHC and WBC count. They also reported marked neutrophilia with reduction in the number of other leukocytes.

Avery *et al.* (1986) observed increase in the packed cell volume in cattle with metabolic alkalosis induced by duodenal obstruction.

Haemograms showed non-specific changes such as stress response with a degenerative left shift in severely affected cases of intestinal obstruction in dogs (Strombeck and Guilford, 1991).

2.6. Serum Biochemistry

2.6.1. Blood Urea Nitrogen.

Simon (1961) reported that blood of adult elephants had a urea nitrogen level of 16.19 mg per dl.

Adult African bull elephants had a blood urea nitrogen concentration of 26.5 mg per dl (Young and Lomband, 1964).

Nirmalan and Nair (1971) reported that the blood level of urea nitrogen in baby elephants, tuskers, adult non-lactating elephants and lactating elephants were 12.99, 12.04, 15.20 and 11.47 mg per dl respectively.

Lewis (1974) reported the blood urea nitrogen in the blood of Asian elephants to range from 8 to 12 with a mean value of 10 mg / dl.

Normal range of urea nitrogen in the serum of elephants ranged from 1-12 mg / dl (Fowler, 1978).

Allen *et al.* (1985) observed the serum level of urea nitrogen in young African elephants to range from 5-13 mg / dl with a mean value of 7.9 mg / dl. They also observed that age specific variation existed for BUN.

Hill and Smith (1990) also reported age specific variation for blood urea. Urea values were the highest in the youngest group of elephants.

Silva and Kuruwita (1993a) reported that the urea nitrogen in the plasma of free ranging Asian elephants (*E. maximus ceylonicus*) in Sri Lanka varied from 3.0 - 18.0 mg / dl with a mean value of 10.0 mg / dl which was wider than those reported for domesticated elephants.

Domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka had a urea nitrogen level of 5.7 - 19.7 / dl with a mean level of 11.4 mg / dl in the plasma (Silva and Kuruwita, 1993b).

2.6.2. Glucose

Simon (1961) observed that the mean glucose content in the serum of adult elephants ranged from 28.0 to 56.0 mg with a mean value of 42.73 mg / dl.

Blood glucose levels in elephants resembled those of ruminants indicating a greater orientation of their metabolism towards volatile fatty acid utilization than glucose. The blood glucose values of baby elephants, tuskers, adult non lactating females and lactating females in mg/ dl of blood or serum were 67.47, 59.54, 52.56 and 64.0 respectively. (Nirmalan and Nair, 1969).

Lewis (1974) reported that the serum glucose level in African elephants varied from 82 - 173 mg / dl with a mean value of 110 mg / dl.

The normal range of glucose in the serum of elephants was 75 - 200 mg/ dl (Fowler, 1978)

Allen *et al.* (1985) reported the serum glucose level in young African elephants as ranging from 71-116 mg /dl with a mean value of 93.5 mg / dl.

2.6.3.Sodium

Lewis (1974) reported the sodium level in the serum of Asian elephants to vary from 124-130 mmol / l with a mean value of 126 mmol/ l.

Fowler (1978) reported that the normal sodium level in the serum of elephants ranged from 129 - 136 mmol / l.

The mean value of sodium in the serum of more than 100 African elephants was 136.5 mmol / l (Brown and White, 1979)

Allen *et al.* (1985) observed 119 - 143 mEq./ l. of sodium in the serum of young African elephants with a mean value of 127.5 mEq / l.

Serum level of sodium was found to vary from 118.24 $\pm$ 4.3 to 126.99 $\pm$ 4.6 mmol/l. (Sreekumar, 1986).

Sreekumar and Nirmalan (1989) reported the sodium levels in the sera of baby, tusker and adult female Indian elephants as 125.36 $\pm$ 6.7, 118.24 $\pm$ 4.3 and 126.99 $\pm$ 4.6 mmol / l respectively.

Silva and Kuruwita (1993b) reported that the serum level of sodium in domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 100 - 140 mEq / l with a mean value of 110 mEq/l. They attributed the wider range to the difference in the nutritional status.

2.6.4. Chloride

Simon (1961) reported the level of chloride in the blood of Asian elephants as 431.38 mg / dl.

Nirmalan and Nair (1969) reported the chloride level in mg / dl of serum in baby elephants as 473.6. Corresponding values were 488.0, 496.90 and 433.0 respectively in tuskers, adult non-lactating females and lactating females.

Lewis (1974) reported that the serum level of chloride in Asian elephants ranged between 81 and 83 mg / dl with a mean value of 82 mg / dl.

Allen *et al.* (1985) observed the serum level of chloride in young African elephants in the range of 74 to 106 mEq / l averaging 86.9 mEq / l.

The level of chloride in the serum of domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 100 - 115 mEq/l. with a mean value of 109 mEq / l. (Silva and Kuruwita , 1993b)

2.6.5. Potassium

Lewis (1974) reported that serum of Asian elephants contained 4.5 - 5.0 mmol/l of potassium with an average level of 4.7 mmol / l.

Brown and White (1979) studied potassium level in the serum of more than 100 African elephants and reported the level of potassium in serum as 6.24 mmol / l. It was higher during wet season and low in dry season.

The normal level of potassium in the serum of elephants was 4.2. - 5.5 mmol / l (Fowler, 1978).

Allen *et al.* (1985) reported that, the concentration of potassium in the sera of young African elephants were in the range of 4.6 - 6.9 mEq / l with a mean value of 5.3 mEq/ l.

Sreekumar (1986) noted the serum level of potassium in Indian elephants as 4.77 ± 0.11 mmol / l.

Level of potassium in the sera of baby, tusker and adult female Indian elephants were 4.97 ± 10.17, 4.77 ± 0.11 and 4.85 ± 0.18 mmol/l respectively (Sreekumar and Nirmalan, 1989)

Potassium level in the serum of domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka was in the range of 4-16 mEq / l. with an average value of 11 mEq./l (Silva and Kuruwita, 1993b)

2.6.6. Total Protein

Adult Asian elephants had a plasma protein concentration of 10.70g / dl (Simon, 1961)

The levels of total protein in baby elephants, tuskers, adult non-lactating females and lactating females were 8.25, 8.49, 9.25 and 9.28 g / dl. respectively (Nirmalan and Nair, 1971).

Lewis (1974) reported that the level of total protein in the serum of Asian elephants ranged from 7.8 to 8.9 g/dl. with a mean value of 8.4 g / dl.

The level of total protein in the serum of normal elephants ranged from 8.0 to 9.2 g/dl (Fowler, 1978)

Allen *et al.* (1985) reported the mean total protein level in the serum of young African elephants as 7.0 g / dl

Sreekumar (1986) reported that the level of total protein in the different age groups of Indian elephants including baby elephants, adult males and females were 6.17±0.26 to 6.92±0.43 g/dl.

Sreekumar and Nirmalan (1989) reported a range of 5.40 - 9.09 g / dl total protein in the serum of Indian elephants. They also reported that age and sex did not exert any influence on the total protein content of the serum.

Total protein level in the serum of African elephants was not affected by age or sex (Hill and Smith, 1990).

The level of total protein in g / dl. was found to be 8.08 in the blood of captive Indian elephants (Nath *et al.*, 1993).

Silva and Kuruwita (1993) reported the total protein level in the serum of free ranging Asian elephants *(E. maximus ceylonicus*) in Sri Lanka as ranging from 6-11 g / dl with a mean value of 8.4 g/dl.

Total protein level in the serum of domesticated Asian elephants (*E. maximus ceylonicus*) in Sri Lanka ranged from 6-13 g/dl with an average level of 9 g / dl (Silva and Kuruwita, 1993)

2.6.7. Creatinine

Simon (1961) reported that adult Asian elephants had a blood creatinine level of 1.6 mg/ dl.

Nirmalan and Nair (1971) reported that the levels of creatinine in the blood of baby elephants, tuskers, adult non-lactating females and lactating females were 1.77, 1.93, 1.88 and 1.91 mg / dl. respectively.

Lewis (1974) noted that the blood creatinine level in Asian elephants ranged from 1.3. - 1.7 mg / dl with a mean level of 1.5 mg / dl blood.

Fowler (1978) reported the normal value of creatinine in elephant blood as 1.3- 1.8 mg /dl.

2.6.8. Aspartate amino transferase (AST, SGOT)

Adult Indian elephants (*E. maximus*) had 13.61 Reitman- Frankel (RF) units of glutamic oxaloacetic transaminase activity per ml of serum (Nirmalan and Nair, 1969).

Lewis (1974) reported that Asian elephants had a SGOT level of 13-20 units / ml with a mean value of 17.

The SGOT level in normal elephants was 7-30 units/ml (Fowler, 1978).

Allen *et al.*(1985) noted the level of SGOT in young African elephants as ranging from 15 to 54 iu / dl with a mean level of 28.6 iu / dl

Level of SGOT in the different age groups of Indian elephants including baby elephants, adult males and females were 10.18±3.8, 18.46±2.4, iu/dl. There was no influence of age or sex on the level of SGOT (Sreekumar, 1986).

2.6.9. Bicarbonate

References regarding the normal level of bicarbonate in the blood of elephants were not available in the literature consulted.

2.6.10. Lactate

References regarding the normal level of lactate in the blood of elephants were not available in the literature consulted.

2.7. Serum Biochemistry in impaction of intestine

Mottelib and Misk (1976) reported hypoglycemia, elevation of total protein, non-protein nitrogen, blood urea nitrogen and creatinine in the blood of dogs with experimental obstruction of the duodenum and ileum.

Warren *et al.* (1996) noted that the serum bio-chemical profile was normal in an Asian elephant (*E. maximus*) with gastro-intestinal tract impaction.

Avery *et al.* (1986) reported that duodenal obstruction resulted in increased blood pH, bicarbonate concentration and base excess values. They also reported the occurrence of severe hypokalemia and hypochloremia within 48 hours, but only a slight decrease in the serum sodium concentration. They also observed increased serum levels of BUN, creatinine, glucose and inorganic phosphate in these cases.

Kohn (1991) reported that in animals with long standing cases of small colon impaction, there was hypokalemia and metabolic acidosis resulting from loss of alkaline intestinal fluid with excess of potassium.

According to Strombeck and Guilford (1991) hypokalemia was a consistent feature of intestinal obstruction in dogs.

The mean blood values (in comparison with eight healthy controls) were - glucose 131. 21 (72) mg / dl, Sodium 93.61 (126.05) mEq / l. and potassium 4.16 (3.26) mEq / l in 13 horses with colic due to colonic impaction (Mert *et al.* 1991)

Auer (1992) reported that clinicopathologic changes in equines with impaction of ventral large colon were minimal but for an elevated level of total protein in the blood.

Merrit and Calahan (1992) noted a mild to moderate elevation of total protein level in the blood depending on the degree of pain and dehydration in large colon impaction in horses.

Dabareiner and White (1995) reported that in equines with large colon impaction, the concentration of serum sodium, potassium and chloride were within the reference ranges. Their study revealed mean blood lactate level of

15.71 mg/ml and mean BUN level of 27.5 mg/dl in horses with large colon impaction.

Spier *et al.* (1996) pointed out that the fluid lost in large colon impaction in horses was isotonic in nature.

MATERIALS AND METHODS

3. MATERIALS AND METHODS.

3.1. Materials

The study was conducted during a period of 17 months from February '98 to June '99. Data on the incidence of gastro-intestinal tract impaction in elephants were collected from the records maintained by the Elephant Welfare Association, Thrissur for a period of two years from 1997 to 1999. Six cases of G.I. tract impaction in and around Thrissur district, which lasted for more than four days were studied. The diseased elephants were subjected to routine clinical examination and observations were recorded. Six healthy control elephants maintained by different owners in and around Thrissur district selected at random were utilized as healthy controls.

3.2. Sampling and Analysis.

Samples of blood and serum from the diseased elephants were collected on the fourth or fifth day after the development of clinical signs *i.e.* the day of report and analysed using standard procedures.

3.2.1. Blood

Samples of five ml of whole blood were collected in clean, dry vials using EDTA (at the rate of 1 mg / ml of blood) as anticoagulant before initiation of any treatment. Ten ml whole blood was also collected from the above

elephants in airtight serum tubes without using any anticoagulants and were allowed to clot. Centrifuged the tubes at 3000 rpm for 20 minutes and serum was separated.

Haematological parameters were determined as per the method of Benjamin (1974) and Schalm *et al.* (1975).

All the biochemical analyses were carried out by using Boehringer 5010 semiautomatic Spectrophotometer under standard conditions of operation as recommended using specific diagnostic kits marketed by Boehringer Manheim.

Serum glucose:- Estimation of serum glucose was made as per oxidase-peroxidase method of Dietzler and Smith (1980) using specific kit under standard conditions as recommended.

Total protein:- Total protein was estimated using the Biuret method of Gornall *et al.* (1949) using the specific kit provided under standard conditions of operation as recommended.

Blood Urea Nitrogen (BUN):- Estimation of blood urea was made as per the Berthelot's reaction of Mc Neely (1980) using the specific kits under standard conditions as recommended. Urea nitrogen was calculated from the value of blood urea by dividing it with 2.14.

Lactate:- Estimation of the level of lactate in the serum was made as per the method of Noll (1974) using the specific kit under standard conditions as recommended.

Creatinine:- Estimation of creatinine level in the serum was made as per the Jaffe method of Mc Neely (1980) using the specific kit under standard conditions recommended.

AST:- Estimation of AST level in the serum was made as per the method of Bergmeyer and Bernt (1965) using the specific kit under standard conditions as recommended.

Bicarbonate:- Estimation of bicarbonate level in the serum was made by titration method of Oser (1965) using the specific kit under standard conditions as recommended.

Chloride:- Estimation of serum chloride was made using colorimetric method of Henry (1996) using specific kit under standard conditions as recommended.

Sodium and Potassium:- Estimation of serum level of sodium and potassium was made by using flame photometer as per the method of Oser (1965) under standard conditions of operation.

Statistical Analysis

Statistical analyses were conducted according to the methods described by Snedecor and Cochran (1967).

RESULTS

4. RESULTS

Results of analyses of different parameters studied in healthy controls and animals with gastro-intestinal tract impaction are presented in Table 1 and 2 along with their 't' values.

Epidemiology

All the animals affected were tuskers which were used for temple festivals. Incidence was found to be more during summer season. Analysis indicated that age had no influence on the occurrence of the disease. Estimates indicated an annual occurrence rate of three percent for gastro-intestinal tract impaction among domesticated elephants in Kerala.

All the animals affected were subjected to strenuous walking during the hot hours of the day as part of the festivities, immediately prior to the onset of the condition. The ambient temperature during the hot periods of the day in central Kerala where the study was mostly concentrated reached up to 36.5°C with a mean relative humidity of 74.38 percent. There was no previous history of gastro-intestinal tract impaction in any of the animals studied except one, which had a past history of gastro-intestinal tract impaction in the previous year also. Analysis showed that duration of the disease ranged from four to 33 days with no mortality.

4.1. Clinical signs.

Fecal boluses were not voided by the affected animals for a minimum period of 24 hours. All the animals were dull and depressed (Plate 1). Varying degrees of systemic involvement depending on the severity and duration of the condition was noticed. The respiratory rate was slightly lower (five to eight per minute). The conjunctival and oral mucous membranes were pale roseate. The animals exhibited varying degrees of inappetence and were reluctant to drink water. On palpation of the chest region, the body temperature was found to be subnormal in the initial stages of the condition. The animals showed varying degrees of straining (depending upon the location of the impacted bolus). Protrusion of the penis suggesting pain was noticed during straining. Mucoid discharge was seen through the anus in all cases (Plate 2) except the one in which the disease had taken a prolonged course where in the discharge was abundant and watery. The volume of the discharge ranged from five to 10 litre per day. Depending on the severity of the condition, there was varying degrees of dehydration. The skin was dry and the number of foldings of the skin had increased in one of the elephants that had a prolonged course of the disease. Urination was not markedly affected in the diseased animals. The animals became dull and debilitated with marked dehydration as the condition progressed (Plate 3). The posterior movement of the bolus was ascertained by manual per-rectal examination. When the bolus was within the hands reach, it was removed manually (Plate 4).

Plate 1. Dull and depressed appearance of an elephant with gastro-intestinal impaction

Plate 2. Mucoid discharge from the anus of an elephant with gastro-intestinal tract impaction

4.2. Haematological parameters

4.2.1. Total erythrocyte count (TEC).

Mean value of TEC in the healthy control group was 3.01± 0.17x10^6/ cmm (Table 1).

The mean value of TEC of the diseased group of animals was 3.08± 0.11x10^6/ cmm (Table 1). Analysis of the data did not reveal any significant difference between the values of the two groups.

4.2.2. Total leukocyte count (TLC).

Mean value of TLC was 12.46± 0.75x10^3/ cmm in the healthy control animals (Table 1).

The mean value of TLC in the diseased group of animals was 14.48± 1.58x10^3/ cmm (Table 1). Analysis of the data indicated no significant difference between the values of the animals in the healthy control and diseased groups.

4.2.3. Haemoglobin (Hb)

Mean value of haemoglobin level in the healthy control was 13.30± 0.9 g /dl (Table 1).

Fig. 1. Mean ESR level in control and diseased elephants (mm/h)

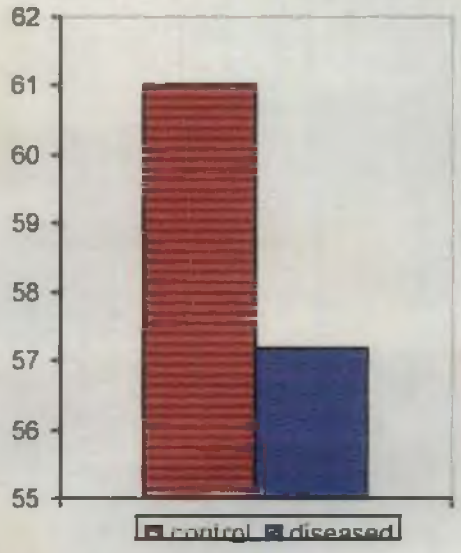
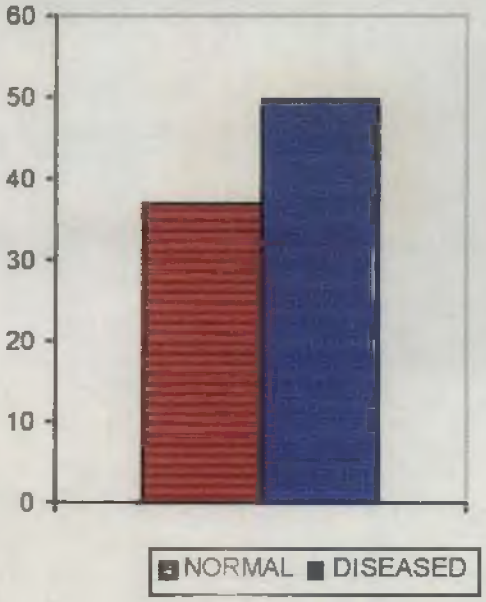


Fig. 2. Mean PCV level in control and diseased elephants (percent)



The mean value of haemoglobin in diseased animals was 13.93± 0.83 g / dl (Table 1). Analysis of the data showed that the difference noticed between the healthy control and diseased group was not significant.

4.2.4. Haematocrit. (PCV)

The mean haematocrit value of the animals of the healthy control group was 36.83± 1.99 percent (Table 1).

The mean haematocrit value of the diseased group of animals was found to be 49.67± 2.21 percent (Table 1). The difference in the values of PCV between the animals of the healthy and diseased groups was highly significant ($p \leq 0.01$).

4.2.5. Differential Leukocyte Count (DLC)

4.2.5.1. Neutrophils.

Mean value of neutrophils for the healthy control animals was 30.17± 1.19 percent (Table 1).

The mean value of neutrophils for the diseased group of elephants was 29.0± 1.13 percent (Table 1). Analysis of the data did not reveal any significant difference between the animals of the healthy control and diseased groups.

Fig. 3. Mean Hb level in control and diseased elephants (g %)

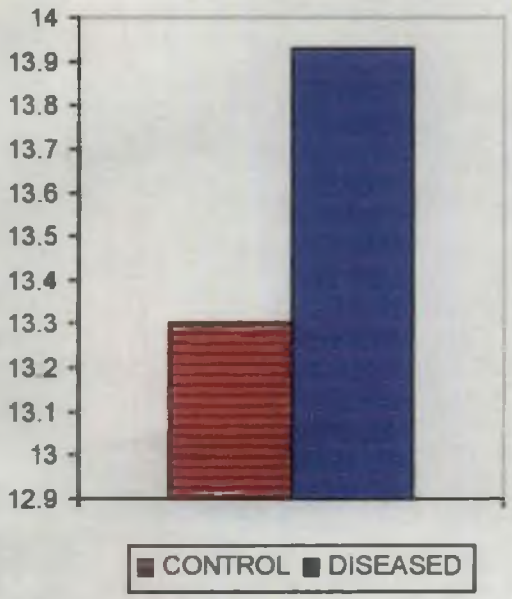
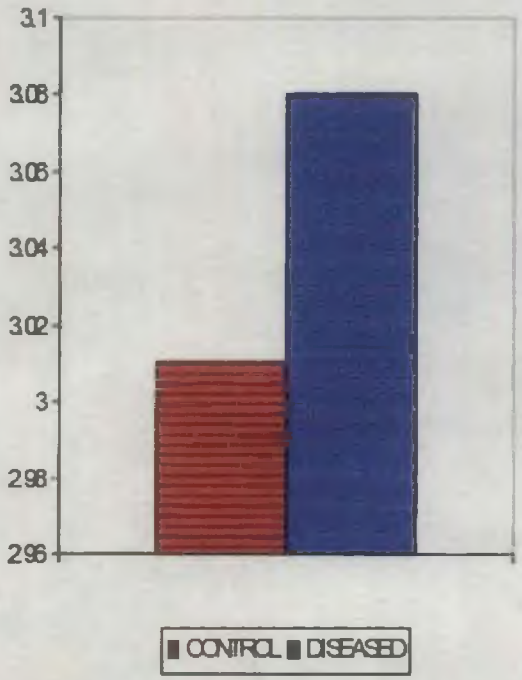


Fig. 4. Mean RBC count in control and diseased elephants (millions / cmm)



4.2.5.2. Lymphocytes.

The mean value of lymphocytes in the healthy control animals was 31.50± 1.19 percent (Table 1).

The mean value of lymphocytes for the diseased group of elephants was 33.77± 1.79 percent (Table 1). Analysis of the data indicated no significant difference between the values of the animals of the healthy control and diseased groups.

4.2.5.3. Monocytes

The mean value of monocytes in the healthy control animals was 36.00± 2.47 percent (Table 1).

The mean value of monocytes of the diseased group was 35.50± 1.63 percent (Table 1). No significant difference was evident between the values of the animals of the healthy and diseased groups.

4.2.5.4. Eosinophils.

Mean value of eosinophils in the healthy control group was 2.33 ± 0.61 percent (Table 1).

Fig. 5. Mean WBC count in control and diseased elephants (thousands / cmm)

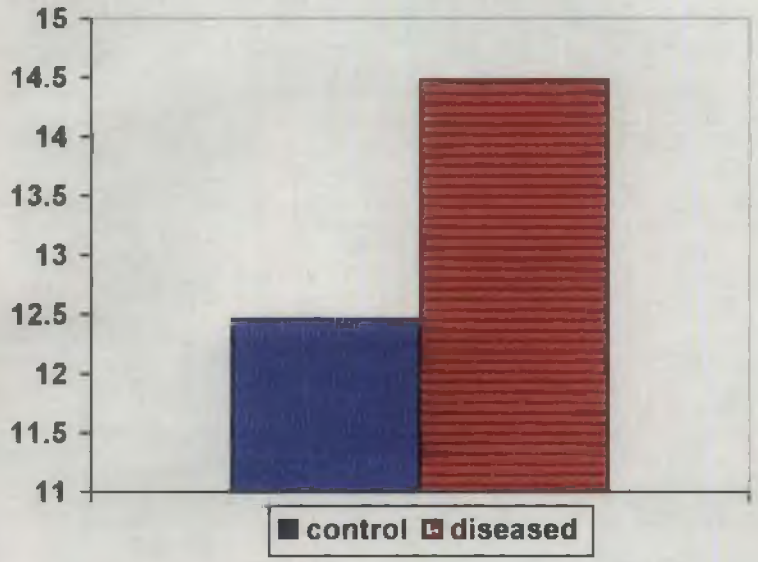
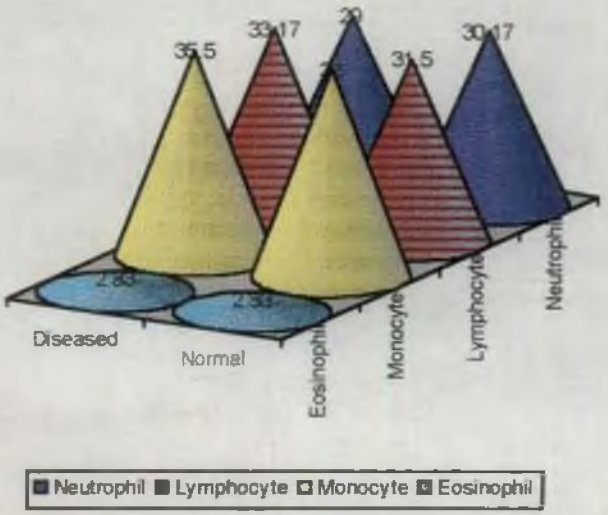


Fig. 6. Mean DLC of control and diseased elephants (percentage)



The mean value of eosinophils in the diseased elephants was 2.33 ± 0.61 percent (Table 1). No significant difference in the values of eosinophils was observed between the healthy and diseased groups of animals.

4.2.6. Erythrocyte Sedimentation Rate (ESR).

The mean value of ESR of the healthy control animals was 61.00± 3.52 mm/hr (Table 1).

The mean value of ESR in animals of the diseased group was 57.17± 3.54 mm/hr (Table 1). The difference in the ESR values between healthy and diseased animals was not significant.

4.3. Biochemical parameters.

4.3.1. Blood Urea Nitrogen (BUN)

The mean value of BUN in the healthy control group was found to be 15.34± 0.76 mg / dl (Table 2).

In the diseased group, the value of BUN was 31.95± 1.89 mg /dl (Table 2). The difference between the healthy control and diseased groups of elephants was highly significant ($p \leq 0.01$).

Fig. 7. Mean BUN level in control and diseased elephants (mg %)

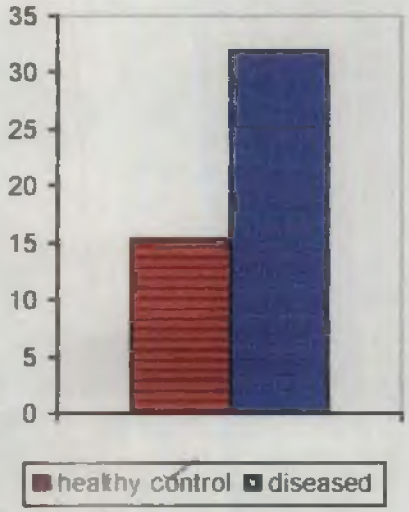
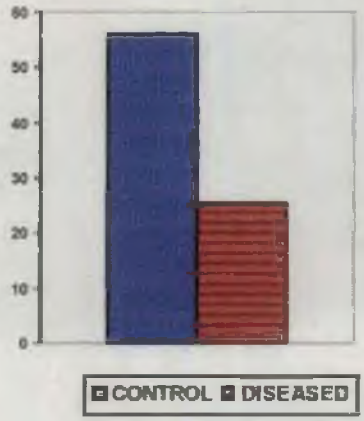


Fig. 8. Mean Serum glucose level in control and diseased elephants (mg %)



4.3.2. Serum glucose.

The mean serum glucose level of healthy control animals was found to be 56.17± 6.3 mg /dl (Table 2).

In the diseased group, the mean blood glucose value was 25.33± 3.41 mg /dl (Table 2). Significant difference was noticed between the healthy control group and the diseased group ($p \leq 0.01$).

4.3.3. Sodium

The mean value of serum sodium in the healthy control group was 133.75± 9.7 mEq / l (Table 2).

In the animals of the diseased group the mean value of the serum sodium level was 133.36± 10.26 mEq / l (Table 2). The difference between the values of the two groups was not significant.

4.3.4. Chloride

The mean value of serum chloride in animals of the healthy control group was 98.78± 2.43 mEq/l (Table 2).

Fig. 9. Mean Serum sodium level in control and diseased elephants (mEq/l)

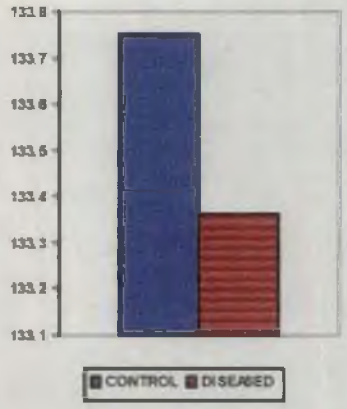
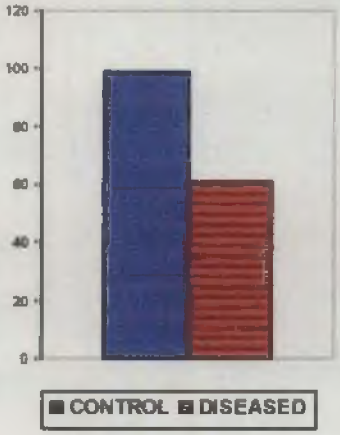


Fig. 10. Mean Serum chloride level in control and diseased elephants (mEq/l)



The mean value of serum chloride in the diseased group was 60.80± 8.79 mEq/l (Table 2). The difference between the values of the two groups was highly significant ($p \leq 0.01$).

4.3.5. Potassium

The mean value of serum potassium in the healthy control animals was 5.65± 0.16 mEq / l (Table 2).

The mean value of serum potassium in the group of animals with gastro-intestinal impaction was 4.43± 0.43 mEq / l (Table 2). The difference between these two groups was significant ($p \leq 0.05$).

4.3.6. Total protein

The mean value of total protein in the serum of healthy control animals was 10.06± 0.49 g /dl (Table 2).

The mean value of total protein in the serum of animals with G.I. impaction was 10.61± 0.65 g /dl (Table 2). Statistical analysis of the data did not reveal any significant difference between the healthy control and diseased groups.

Fig. 11. Mean Serum potassium level in control and diseased elephants (mEq/l)

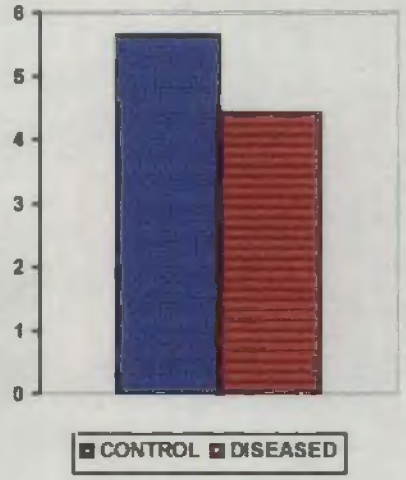
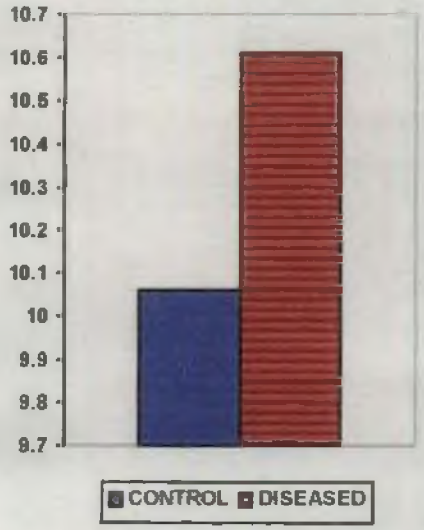


Fig. 12. Mean serum total protein level in control and diseased elephants (g/ dl)



4.3.7. Creatinine

The mean value of creatinine in the serum of healthy control animals was 1.95± 0.20 mg /dl (Table 2).

The mean value of serum creatinine in the diseased group was found to be 2.89± 0.39 mg /dl (Table 2). Analysis of the data did not reveal any significant difference between the animals of the healthy control and diseased groups.

4.3.8. Bicarbonate

The mean value of serum bicarbonate in the healthy control animals was 25.30± 0.58 mEq/l (Table 2).

The mean value of serum bicarbonate level in the diseased group was 27.72± 0.48 mEq/l (Table 2). The difference between the values of the two groups was significant ($p \leq 0.05$).

4.3.9. Lactate

The mean value of lactate in the serum of healthy control animals was 55.82± 3.07 mg/dl (Table 2).

Fig. 13. Mean serum creatinine level in control and diseased elephants (mg/ dl)

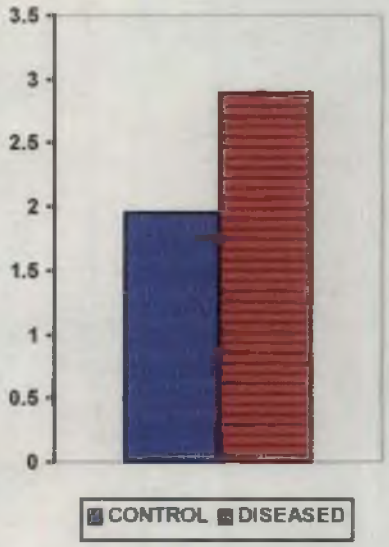


Fig. 14. Mean serum bicarbonate level in control and diseased elephants (mEq/l)

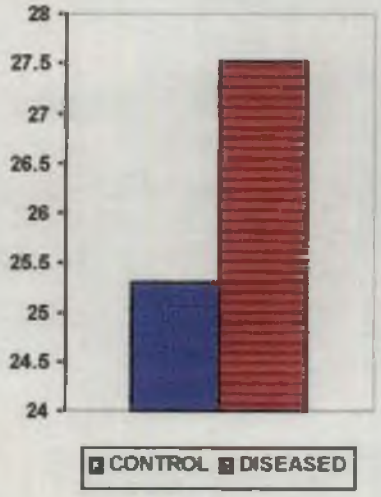


Fig. 15. Mean serum lactate level in control and diseased elephants (mg / dl)

Fig. 16. Mean serum AST level in control and diseased elephants (IU / l)

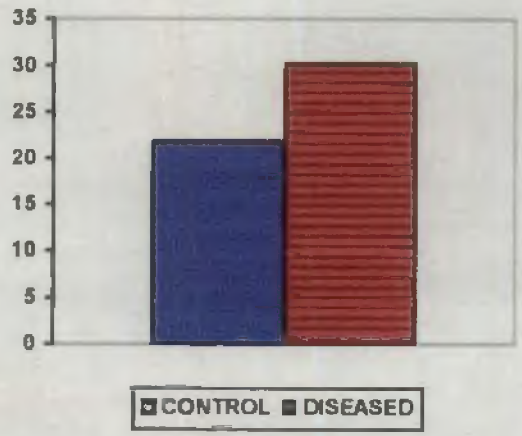


Plate 3. Debilitated and dehydrated appearance of an elephant that had a prolonged course of the disease

Plate 4. A mahout manually removing the impacted faecal bolus from the rectum of an elephant with gastro-intestinal tract impaction.

The mean value of lactate in the serum of animals affected with gastro-intestinal impaction was 154.62± 11.15 mg/dl (Table 2). Highly significant difference ($p \leq 0.01$) was observed between the two groups.

4.4. Serum Enzymology

4.4.1. Aspartate amino transferase (AST)

The mean value of AST in the serum of healthy control animal was 21.83± 2.81 IU/ l (Table 2).

The mean value of AST in the serum of animals affected with gastrointestinal impaction was 30.17± 2.64 IU/l (Table 2). Analysis of the data on serum AST level did not reveal any significant difference between healthy control and diseased groups.

Table 1. Mean haematological values of healthy controls and animals with gastro-intestinal tract impaction.

Parameters		Healthy control Mean ± S.E.	Diseased group Mean ± S.E.	't' value
TEC ($x10^6$/cmm)		3.01±0.17	3.08±0.11	0.332^{NS}
TLC ($x10^3$/cmm)		12.46±0.75	14.48±1.58	1.063^{NS}
Hb (g%)		13.30±0.90	13.93±0.83	0.472^{NS}
PCV (%)		36.83±1.99	49.67±2.21	3.94**
DLC (%)	N	30.17±1.19	29.00±1.13	0.649^{NS}
	L	31.50±1.19	33.77±1.79	-0.4049^{NS}
	M	36.00±2.47	35.50±1.63	0.1542^{NS}
	E	2.33±0.61	2.33±0.61	0.00
	B	-	-	-
ESR (mm/hr)		61.00±3.52	57.17±3.54	0.701^{NS}

NS- non significant ** $p \leq 0.01$

Table 2. Mean biochemical values of healthy control and animals with gastro-intestinal tract impaction

Parameters	Healthy control Mean ± S.E.	Diseased group Mean ± S.E.	't' value
Blood urea nitrogen (mg%)	15.34±0.76	31.95±1.89	7.422^{**}
Glucose (mg/dl)	56.17±6.30	25.33±3.41	3.930^{**}
Sodium (mEq/l)	133.75±9.70	133.36±10.26	0.026^{NS}
Chloride (mEq/l)	98.78±2.43	60.80±8.79	3.803^{**}
Potassium (mEq/l)	5.65±0.16	4.43±0.43	2.242^{*}
Total protein (g/dl)	10.06±0.49	10.61±0.65	0.621^{NS}
Creatinine (mg/dl)	1.95±0.20	2.89±0.39	1.937^{NS}
Bicarbonate (mEq/l)	25.30±0.58	27.72±0.48	2.677^{*}
Lactate (mg/dl)	55.82±3.07	154.62±11.15	7.793^{**}
AST (IU/l)	21.83±2.81	30.17±2.64	1.972^{NS}

NS- non significant *- $p \leq 0.05$ **- $p \leq 0.01$

DISCUSSION

5. DISCUSSION

Gastro-intestinal tract impaction is an important disease condition-affecting elephants of all ages and both sexes irrespective of the work for which they are used. The condition in elephants has no uniform pattern of clinical signs except withholding of faecal boluses for a minimum period of 24 hours. In the present study all the elephants affected were tuskers, used for temple festivities. Generally only male elephants are utilized for the procession connected with social and cultural festivals in Kerala. The incidence rate was high during the summer season. This is in accordance with the observations of Chandrasekharan *et al.* (1995). An incidence rate nearing three percent observed in the present study was also supported by Chandrasekharan (1997).

The dietary habits of the affected elephants revealed that they were all fed with palm (Caryota) leaves. The palm leaves have a high amount of fibre and low water content (Ananthasubramanium, 1979).

History also revealed that all the affected elephants were made to walk long distances as part of the festivities, and they were given water immediately, after strenuous exercise. Pugh and Thomson (1992), Radhakrishnan (1992), Chandrasekharan *et al.* (1995) and Namboothiri (1996) also attributed these factors as the predisposing causes of the condition. The practice of feeding

elephants with raw, uncooked rice grains during the processions may also be contributing to the development of the disease. Dietary abnormalities of minor degree including indigestible roughage and moderate excess of grain may lead to indigestion in animals. Cattle suffering from grain overload will engorge themselves if allowed free access to water (Radostits *et al.* (1994).

The poor muscular support of the intestine may contribute to the cessation of peristaltic movement and lead to the formation of hard fibrous bolus (Radhakrishnan, 1992).

5.1. Clinical signs

The clinical signs exhibited by the affected elephants varied with the duration and location of the obstruction as well as its severity on proper treatment with fluids and electrolytes. The animals affected exhibited different degrees of straining depending upon the location of the impacted bolus. In anterior gut obstruction there was no straining. In mid gut impaction, the affected elephants exhibited straining. This is in accordance with the reports of Chandrasekharan (1997). The duration of the cases studied ranged from four to 33 days, with uncomplicated conditions getting relieved in ten days. This also was in accordance with the observations of Chandrasekharan (1997). In deprivation of water in an otherwise normal animal, the dehydration is minimal as the kidney compensates effectively. In addition water is preserved by reduced faecal out put and increased absorption which results in dry, scant faeces

(Radostits *et al.*, 1994). Conditions which were complicated by intestinal oedema had prolonged duration characterised by intestinal effusion, abnormal discharge through the anus and dehydration of the animal. Similar observations were also made by Chandrasekharan (1997). Symptoms of dehydration were exhibited by animals only after a loss of five percent of their body weight (Radostits *et al.* (1994). In the present study all the animals affected were intensively treated with fluids and electrolytes from the fourth day onwards.

5.2. Haematology

5.2.1. Total erythrocyte count

Mean value of total erythrocyte count in healthy control elephants obtained in the present study was comparable to the values reported by Allen *et al.* (1985), Yathiraj *et al.* (1992) and Silva and Kuruwita (1993b).

Slight increase noticed in the RBC count of elephants with gastro-intestinal tract impaction was not statistically significant. Reports by Boles and Kohn (1977) also showed similar results.

5.2.2. Total leukocyte count

Mean value of total leukocyte count in healthy control elephants obtained in the present study was comparable to the values reported by Nirmalan *et al.* (1967) and Silva and Kuruwita (1993b).

The increase in the TLC in the diseased group was non-significant. Normal to moderately high total leukocyte counts were reported in colonic impaction in horses by Boles and Kohn (1977). There was no evidence of any infection in any of the affected elephants on the day of collection of blood.

5.2.3. Haemoglobin

The mean value of the haemoglobin in the healthy control elephants were comparable with the values reported by Simon (1961), Schmitt (1964), Allen *et al.* (1985) and Silva and Kuruwita (1993b).

The increase in the level of haemoglobin in the diseased group of elephants was not statistically significant. The slight increase in the haemoglobin level of the affected animals could be attributed to possible haemoconcentration.

5.2.4. Haematocrit

Mean value of haematocrit for the healthy elephants was comparable to the values reported by Allen *et al.* (1985) and Silva and Kuruwita (1993b).

Highly significant difference ($P \leq 0.01$) was observed in the value of haematocrit between the healthy control and diseased elephants. The affected elephants had higher values which were in agreement with the reports of Boles and Kohn (1977), Auer (1992) and Merrit and Calahan (1992). The high value

of PCV could be due to the effect of dehydration. The initial response to negative water balance is the withdrawal of fluid from the tissues and maintenance of normal blood volume (Radostits *et al.* (1994). The highly increased value of PCV without an appreciable increase in the RBC count suggested that there was only reduced plasma volume rather than an actual increase in the number of erythrocytes.

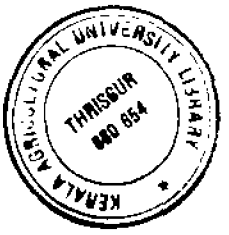
5.2.5. Differential Leukocyte Count (DLC)

Mean value of DLC obtained in case of healthy control elephants was comparable to the values reported by Schalm (1975) and Silva and Kuruwita (1993b).

No difference in the mean value of DLC was observed between healthy and diseased elephants except a non-significant increase in the percentage of neutrophils. This could be due to the stress response in elephants with gastro-intestinal tract impaction. Strombeck and Guilford (1991) reported a degenerative left shift as a stress response in dogs severely affected with intestinal obstruction.

5.2.6. Erythrocyte Sedimentation Rate (ESR)

The mean value of ESR obtained from healthy control elephants in the present study was well within the normal range reported by Nirmalan *et al.* (1967) and Silva and Kuruwita (1993b).



Difference in the ESR values between the healthy animals and the elephants affected with gastro-intestinal tract impaction in the present study was not significant.

5.3. Biochemical parameters

5.3.1. Blood Urea Nitrogen (BUN)

Mean value of BUN (15.34 ± 0.76 mg/dl) obtained for the healthy control elephants in the present study was comparable to the ranges for healthy elephants reported by Simon (1961), Nirmalan and Nair (1971) and Silva and Kuruwita (1993b).

A highly significant ($p \leq 0.01$) increase in the value of BUN (31.95 ± 1.89 mg/dl) in the diseased elephants was similar to the reports of Dabareiner and White (1995) in horses with large colon impaction. The increase in BUN level in the diseased elephants in the present study might be attributed to physiologic response against dehydration and refusal of water intake. Avery *et al.* (1986) also reported a similar increase in serum urea concentration in duodenal obstruction in cattle. Urine formation decreases because of the restriction of blood flow and this together with increased endogenous metabolism, causes a moderate increase in blood levels of non-protein nitrogen (Radostits *et al.* (1994).

5.3.2. Glucose

Mean value of blood glucose (56.17 ± 6.3 mg/dl) in the healthy control elephants in the present study was well in accordance with the values reported by Simon (1961).

A highly significant decrease ($p \leq 0.01$) was observed in the blood glucose level (25.33 ± 3.41 mg/dl) in diseased elephants in the present study. This contradicted the findings of Avery *et al.* (1986) and Mert *et al.* (1991), who reported hyperglycemia and attributed it to the effect of catecholamines released during stress. In the present study, samples were collected from the affected animals on the fourth or fifth day at which stage the animals were anorectic but stressor effects not commenced. This could be the reason for the hypoglycemia. In lactating cows, the effect of a short period of starvation was a significant reduction in blood glucose level (Radostits *et al.* (1994).

5.3.3. Sodium

Mean sodium level obtained in the present study in the healthy control elephants was comparable to the values for apparently healthy elephants reported by Lewis (1974) , Fowler (1978), Brown and White (1979) Allen *et al.* (1985) and Silva and Kuruwita (1993b).

Non-significant difference between healthy control and elephants with gastro-intestinal tract impaction observed in the present study concurred with

the earlier observations of Avery *et al.*(1985) in heifers and Dabareiner and White (1995) in equines. However Mert *et al.*(1991) observed a significantly higher level of serum sodium in thirteen horses with colonic impaction. The relatively unchanged value of serum sodium on the fourth day of the disease condition suggested that not much of extra cellualr fluid has been lost from the body within that period. Determination of sodium concentration does not always indicate with accuracy the total amount of sodium in the body. Sodium deletion or excess may be present when the sodium concentration is normal if water volume has changed to preserve isosmotic conditions (Tasker, 1980).

5.3.4. Chloride

Mean value of serum chloride (98.78 ± 2.43 mEq/l) in healthy control elephants in the present study was comparable to the values reported by Allen *et al.* (1985) and Silva and Kuruwita (1993b).

A highly significant ($p \leq 0.01$) decrease in the serum chloride level (60.80 ± 8.79 mEq/l) was obtained in the elephants with gastro-intestinal tract impaction and this might be due to the exudation of fluid into the intestinal lumen anterior to the impacted mass. Absorption and fermentation functions complement each other in the colon of non-ruminant herbivores and it leads to an interdependence between the two processes, meaning that disturbances in fermentation can result in important abnormalities in absorption and vice versa (Cunningham, 1997). Serum chloride concentration varies directly with sodium

concentration and inversely with bicarbonate level. Hence hypochloremia without equivalent hyponatremia indicated loss of hydrogen chloride (HCl in gastric secretions) from the body, rather than a loss of sodium chloride (Tasker, 1980). If because of an alkalotic condition , the plasma level of bicarbonate ions rises, an equivalent amount of chloride ion is excreted in order that electro-neutrality is maintained in the ECF (Houpt, 1993).

5.3.5. Potassium

Mean serum potassium level obtained from the healthy elephants (5.65 ± 0.16 mEq/l) was comparable to the values reported by Fowler (1978), Brown and White (1979), Allen *et al.* (1985) and Silva and Kuruwita (1993b).

There was a statistically significant decrease ($p \leq 0.05$) in the serum potassium level (4.43 ± 0.43 mEq/l) of the diseased elephants. This is comparable with the reported hypokalemia in dogs with intestinal obstruction (Strombeck and Guilford, 1991). Hypokalemia occurs as a result of decreased dietary intake, increased renal excretion and intestinal obstruction. In abomasal diseases of cattle, potassium becomes sequestrated along with hydrogen chloride resulting in hypokalemia, hypochloremia and metabolic alkalosis (Radostits *et al.* (1994). The hypokalemia may be due to the resulting influx of potassium intracellularly at the place of hydrogen ions which goes extracellularly to correct the alkalosis resulting from the loss of chloride ions. Kohn (1992) reported that in persisting cases of intestinal obstruction, loss of

intestinal fluid containing potassium in excess of concentrations found in unobstructed bowel may result in hypokalemia. Determination of potassium in ECF does not reveal directly the intracellular concentration of potassium. The interpretation of laboratory determination of potassium in serum or plasma must include an evaluation of acid-base balance as well as an estimation of potassium intake and out put from the body (Tasker, 1980).

5.3.6. Total protein

The mean value of total protein in the serum of healthy control elephants was found to be within the reference range reported by Simon (1961) and Silva and Kuruwita (1993b).

Though there was slight increase in the level of total protein in the serum of elephants affected with gastro-intestinal tract impaction, it was not statistically significant. An increase in the level of total protein in intestinal obstruction was reported by Mottelib and Misk (1976), Auer (1992) and Merrit and Calahan (1992). The increase in total protein is an indication of the degree of dehydration. By the routine simultaneous determination of both erythroid value and total solid concentration a correct interpretation can be made regarding the fluid balance of the body (Tasker, 1980). This suggests that the affected elephants were not suffering from severe haemoconcentration on the day of collection of samples, *i.e.*, the fourth or fifth day after the development of impaction.

5.3.7. Creatinine

The mean creatinine in the serum of healthy elephants was well within the reference range reported by Simon (1961), Nirmalan and Nair (1971), Fowler (1978) and Silva and Kuruwita (1993b).

Though there was an increase in the serum creatinine level in the affected group of elephants, the difference was not statistically significant. This is contradictory to the findings of Mottelib and Misk (1976) and Avery *et al.* (1986). The results suggested that glomerular filtration rate and thereby renal function was not impaired in the affected elephants. The fact that the animals were passing urine occasionally also suggested that there was no severe fluid imbalance on the fourth day after the development of clinical signs.

5.3.8. Bicarbonate

References regarding the normal level of bicarbonates in the blood of elephants were not available. The significant increase ($p \leq 0.05$) in the level of bicarbonate in the serum of elephants with gastro-intestinal tract impaction (level in control: 25.3 ± 0.58; diseased : 27.72 ± 0.48 mEq/l) indicated that mild metabolic alkalosis existed in these animals. This concurred with the reports of Avery *et al.*(1986), Radostits *et al.* (1994) and Strombeck and Guilford (1991). Radostits *et al.* (1994) reported varying degrees of dehydration and metabolic alkalosis with hypochloremia and hypokalemia in impaction of large bowel in equines. Strombeck and Guilford (1991) also made similar

observations. The bicarbonate level in the blood increases as a compensatory mechanism, when chloride is lost from the body (Benjamin, 1974). The apparent reduction in the rate of respiration during clinical observation could be considered as a compensatory mechanism against metabolic alkalosis. When interpreting changes in bicarbonate concentration without knowledge of the blood pH and PCO_2 values, one must appreciate that bicarbonate increases are expected in metabolic alkalosis and compensated respiratory acidosis. Careful clinical evaluation of the patient is needed to avoid misinterpretation of laboratory results (Tasker, 1980).

5.3.9. Lactate

Reference regarding the normal level of lactate in the plasma of normal elephants were not available. The highly significant ($p \leq 0.01$) increase in the lactate level (level in control 55.82 ± 3.07, diseased 154.62 ± 11.15 mg/dl) in the serum of elephants affected with gastro-intestinal tract impaction corresponds with the observations of Kohn (1991) and Dabareiner and White (1995). Normally blood lactate is derived principally from the breakdown of muscle glycogen (Kaneko, 1980). Glycogen utilization and lactate production are increased during intense exercise (Erickson, 1993). Radostits *et al.* (1994) reported an increase in the blood lactate levels in horses, which developed colic immediately following exercise. The fact that the affected elephants in the present study also were subjected to strenuous exercise immediately prior to the onset of gastro-intestinal tract impaction coincides with this observation.

Threatte and Henry (1996) reported an increase in the blood lactate level up to 70 percent due to delays in the separation of plasma during sampling. This fact should also be considered while interpreting the increased lactate level in the present study.

5.4. Serum enzymology

5.4.1. Aspartate aminotransferase (AST)

The mean AST level in the healthy control elephants in the present study was in the reference ranges reported by Lewis (1974), Fowler (1978), Allen *et al.* (1985) and Sreekumar (1986). No significant difference in the AST level in the blood was observed between the healthy and diseased elephants. It suggested that there was no major involvement of the liver at least in the initial stages of intestinal impaction in elephants.

CONCLUSION

It is concluded from the present study that, gastro-intestinal tract impaction occured mostly in elephants during summer season and periods of high physical activity, due to faulty managemental practices. There was no serious systemic changes due to GI impaction at least on the day of collection of samples *i.e.*, on the fourth day after the development of clinical symptoms. The present study revealed presence of mild metabolic alkalosis with hypokalemia,

hypochloremia, mild dehydration along with hypoglycemia and an elevated blood urea nitrogen.

Feeding and managemental practices are to be closely monitored during the festival season. It is recommended that electrolyte replacement rather than volume replacement is of paramount importance during the initial stages of development of the disease. Hypoglycemia also has to be corrected appropriately. Therefore, it is advised to administer a balanced electrolyte solution / dextrose saline/ gastric replacement solution along with other therapeutic measures. Further investigations are needed in elephants with prolonged duration of GI tract impaction. Cytological and biochemical assays of the fluid escaping from the intestine of the affected elephants are advised

SUMMARY

6. SUMMARY

The present study was undertaken to analyze the haematological and biochemical alterations in elephants affected with gastro-intestinal tract impaction. The epidemiology, clinical findings and observations on blood were the main items of observations.

Six elephants in and around Thrissur district, affected with gastro-intestinal tract impaction, lasting for more than four days were utilized for the study. The animals were subjected to the study on the fourth day after the development of clinical symptoms. Six apparently healthy elephants, in and around Thrissur district were selected at random and utilized as the healthy controls. Detailed history of the animals affected were collected from the mahouts, using a questionnaire (Annexure- I). Samples of whole blood and serum from the healthy control elephants were also collected. The samples were subjected to detailed laboratory examinations. Haematological changes *i.e.*, ESR, PCV, Hb, TEC, TLC and DLC were recorded. Biochemical parameters like urea nitrogen, glucose, sodium, chloride, potassium, total protein, creatinine, bicarbonate, lactate and AST in the serum samples were estimated using standard methods.

Analysis of the data indicated that the disease was more common among male elephants of all ages during summer season. There was history of exhaustive physical activity just prior to the onset of the condition in all the animals. All the animals were fed regularly with palm leaves which has a high fibre and low water content. Some of the elephants affected had the history of ingestion of raw, uncooked rice grains during the processions held as part of the temple festivals. Some of the animals were fed and watered immediately after the physical activity.

The characteristic clinical symptoms were absence of defaecation for more than 24 hours, varying degrees of straining, dullness, exudations from the rectum, indifference to feed and water and mild dehydration. In prolonged cases, the animals had bloated abdomen and dull and debilitated appearance. Clinical data were within the physiological limits on the day of examination, *i.e.* on the fourth day after the development of clinical symptoms.

A highly significant increase in PCV but no significant alterations in Hb, ESR, TEC, TLC and DLC were observed in elephants affected with gastro-intestinal tract impaction. Biochemical changes in blood included a highly significant increase in urea nitrogen and lactate levels. Highly significant decrease in the level of chloride was noticed. Significant increase in the level of bicarbonate was noticed. Decreases in the levels of glucose and potassium in the

affected elephants were significant. Variations in total protein, sodium, creatinine and aspartate amino transferase in the blood were not significant.

The haematological and serum biochemical assay revealed the presence of mild metabolic alkalosis with hypochloremia and hypokalemia in elephants with gastro-intestinal tract impaction. Dehydration was not marked on the day of examination. There was a negative energy balance in the affected elephants as evidenced by the hypoglycemia. Liver function was not affected on the day of examination.

Based on these results, it is recommended to

1. have strict vigil on feeding and management practices of elephants during festival seasons. Strict managemental instructions must be given to the mahouts regarding walking and feeding of the elephants. The following points must be emphasised.
   a) Prevent walking of the elephants during the hot hours of the day.
   b) Prevent bathing, feeding and watering immediately after exercise
   c) Prevent excess ingestion of jaggery, banana fruits and raw, uncooked rice grains during processions.
   d) Prevent eating of tender coconut or palm leaves which may skip the chewing action, leading to impaction.
   e) Prevent eating the base of the palm leaves, which is highly fibrous and undigestable.

f) Prevent eating of dry leaves and give sufficient amount of succulent and fresh leaves.

g) Provide regular and adequate scrub bath to elephants

2. infuse a balanced electrolyte solution / dextrose-saline / gastric replacement solution along with other supportive treatments in elephants during the course of gastro-intestinal tract impaction.

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HAEMATOLOGICAL AND SERUM BIOCHEMICAL PROFILE OF INTESTINAL IMPACTION IN ELEPHANTS

(Elephas maximus indicus)

By

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ABSTRACT OF A THESIS

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ABSTRACT

The present study was undertaken to analyze the haematological and biochemical alterations in elephants affected with gastro-intestinal tract impaction. The epidemiology, clinical findings and haematology were the main items of observations.

Six elephants affected with gastro-intestinal tract impaction lasting for more than four days in and around Thrissur district were utilized for the study. Six apparently healthy elephants in and around Thrissur district were selected at random and utilized as the healthy controls. The detailed history was collected using a questionnaire (Annexure I). Sample of whole blood and serum from the animals of the healthy and diseased groups were collected and analysed. Haematological values consisting of ESR, PCV, Hb, TEC, TLC and DLC were recorded. Urea nitrogen, glucose, sodium, chloride, potassium, total protein, creatinine, bicarbonate, lactate and AST in the serum were estimated using standard methods.

Analysis of the data indicated that the disease was more common in male elephants than in females. The incidence was more in summer season i.e., during the season of festivals. Characteristic clinical symptoms were absence of defaecation for more than 24 hours, varying degrees of straining, exudation from rectum and varying degrees of dehydration. Clinical data were within

physiological limits on the day of collection of blood sample, *i.e.* on the fourth day after the development of clinical symptoms.

A highly significant increase in PCV but without significant alterations in Hb, ESR, TEC, TLC and DLC were observed in elephants affected with gastro-intestinal tract impaction. Biochemical changes in blood included a highly significant increase in urea-nitrogen and lactate levels. Highly significant decrease in the level of chloride was noticed. Significant increase in the level of bicarbonate was noticed. Decrease in the levels of glucose and potassium in the affected elephants was significant. Variations in total protein, sodium, creatinine and aspartate amino transferase in the blood were not significant.

Changes in the parameters observed in elephants with gastro-intestinal tract impaction in the present study indicated that mild metabolic alkalosis with hypochloremia and hypokalemia were associated with this condition. Intensive treatment with a balanced electrolyte solution/ Dextrose saline/ gastric replacement solutions is recommended in the early stages of gastro-intestinal tract impaction.

ANNEXURE

ANNEXURE- I

PROFORMA FOR COLLECTION OF DETAILS FROM THE ELEPHANT OWNERS/ MAHOUTS

1. Serial No. :
2. Name and address of the owner :
3. Species :
4. Age :
5. Sex :
6. Purpose for which the animal is maintained :
7. Present history :
8. Past history :
    a) Previous occurrence of impaction: Yes/ No
    b) Details regarding previous occurrence :
    c) Treatment given :
    d) Other diseases if any :
9. Feeding practices
    a) Type of feed given :
    b) Quantity fed :
    c) Frequency of feeding :
    d) Watering :
10. Management practices
    a) No. of days in work in an year :
    b) Rest period :
    c) Bathing details :
    e) Details regarding environment/ surroundings
11. Duration of the present disease :
12. Predisposing causes, if any :
13. Symptom shown :
14. Treatment done :
15. Details regarding weather viz. Temperature, relative humidity :