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Research Paper

Studies on the Diagnosis and Management of Corneal Ulcers in Dogs

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Abstract

Twenty-four dogs of either sex affected with corneal ulcers were randomly divided into three groups viz. group I treated with medicinal therapy, group II treated with membranoplasty and medicinal therapy and group III, treated by application of contact lens along with tarsorrhaphy and medicinal therapy. Detailed ophthalmoscopic examination, vision reflex tests, Schirmer's tear test, fluorescein dye test, microbiological examination, tonometry, haematological (Hb, TEC, PCV, TLC and DLC) and biochemical (glucose, total protein, albumin and globulin) parameters were studied for diagnosis. Conjunctival infection with chemosis, corneal edema, decreased tear production, fluorescein dye uptake, pupillary and blink reflexes and neo-vascularization were observed in corneal wounds of different groups, and the parameters concerned were recorded before and after the treatment at different time intervals. Results suggested that early corneal healing with maximum reduction in conjunctival infection, edema, neo-vascularization was observed in the animals of group III, followed by groups II and I. It was concluded that medicinal treatment alone was found to be effective in uncomplicated, superficial ulcers. Application of contact lenses along with tarsorrhaphy and medicinal treatment was found to be most efficacious for the management of complicated corneal ulcers as minimal post-operative complications were observed along with faster recovery and earlier restoration of vision.

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1. INTRODUCTION

The cornea is the anterior-most part of the outer fibrous core of the eye, comprising one-sixth of the total ocular surface. The cornea provides a transparent path for the transmission of light and contributes 70% of the refractive power of the eye (KARRING *et al.,* 2004) [11]. Corneal ulcer or ulcerative keratitis is the most common ocular affection in canines (LEDBETTER AND GILGER, 2013) [13]. They are classified according to the depth of corneal involvement as superficial, stromal ulcers and descemetoceles. Superficial ulcers are the most common form which involve only the loss of corneal epithelium and are expected to heal quickly. Stromal ulcers are deep ulcers that extend into or through the stroma. Descemetoceles occur when the ulcer extends through the stroma and involves the Descemet's membrane. A study on breed prevalence of ulcerative keratitis in dogs concluded that brachycephalic breeds were more likely to develop deep corneal ulcers as compared to non-brachycephalic ones often affected with superficial ulcers (IWASHITA *et al.,* 2020) [10]. In a retrospective study of corneal ulcers in dogs, PATEL *et al.,* (2020) [18] reported superficial

ulcers as the most frequent type (62.2%), with the greatest proportion of ulcers occurring among dogs aged 0-3 years (45.5%). The most common organisms found in isolates from severe corneal ulcers of dogs were *Staphylococcus* spp. (45.8%) and *Pseudomonas aeruginosa* (20.8%), fungi were also present in notable numbers (EKAPOPPHAN *et al.,* 2018)[6]. Common clinical manifestations of corneal ulcers include venous congestion, intense corneal oedema, lacrimation, blepharospasm, ocular discharge, corneal opacity, chemosis, discomfort and rupture of different layers of the cornea (ARANTES-TSUZUKI *et al.,* 2019) [1]. The present study was done to diagnose various types of canine corneal ulcers using different tools, to assess the efficacy of various treatment protocols and their comparative evaluation.

2. MATERIALS AND METHODS

The present study was conducted on 24 dogs, clinically affected with corneal ulcers presented to the Teaching Veterinary Clinical Complex, Pantnagar from November 2020 to April 2021. Approval for conducting the study was obtained vide letter no. IAEC/C.V.A.Sc./VSR/431 dated 12/12/2020 from the Institutional Animal Ethics Committee of College of Veterinary and Animal Sciences, GBPUAT, Pantnagar.

Animals were divided into three groups having 8 animals in each. A detail of the treatment protocol applied in each group is given in Table 1.

Table 1: Detail of treatment protocol applied in different groups of animals

Groups	No. of Animals	Treatment Protocol
I	n=8	Medicinal treatment
II	n=8	Membranoplasty along with medicinal treatment
III	n=8	Collagen contact lens + tarsorrhaphy + medicinal treatment

Medicinal therapy consisted of eye ointment (Neosporin: neomycin, bacitracin and polymyxin B), anti-inflammatory agent (Carprofen), systemic broad-spectrum antibiotic (Doxycycline) and carboxymethyl cellulose eye drops.

The diagnosis was done by recording complete signalment, history and clinical examination (colour of the mucus membrane, rectal temperature, heart rate, and respiration). Complete ophthalmological examination (gross examination, vision reflex tests such as menace reflex, pupillary light reflex, Palpebral reflex, Dazzle reflex, Schirmer's tear test, microbiological examination, Fluorescein dye test, ophthalmoscopic examination, tonometry), and haemato-biochemical parameters (haemoglobin, total erythrocyte count, packed cell volume, total leucocyte count, differential leucocyte count, serum glucose, total protein, serum albumin and serum globulin) were recorded for all animals of each group for diagnosis as well as for assessing treatment efficacy. Values and scores of different parameters were statistically analyzed to compare the efficacy of different treatment protocols.

3. RESULTS

The study observed a higher incidence of corneal ulcers among dogs aged 1 to 2 years (50%) and those under 1 year (33.33%), with a majority of cases occurring in male dogs (62.50%) than females (37.50%). Pugs exhibited the highest occurrence (54.17%) of corneal ulcers due to their head conformation, leading to increased vulnerability to trauma, followed by Pomeranians (25%) and Spitz (20.83%). Traumatic corneal injury was the primary cause (62.5%) followed by infection (37.5%). **(Table 2).**

Table 2: Age, sex, breed and causative factor-wise distribution of cases of corneal ulcers

	Categories	No. of cases	Percentage (%)
Age-wise distribution	< 1 year	8	33.33%
	1-2 years	12	50.00%
	2-3 years	4	16.67%
Sex-wise distribution	Male	15	62.50%
	Female	9	37.50%
Breed-wise distribution	Pug	13	54.17%
	Pomeranian	6	25.00%
	Spitz	5	20.83%
Causative factor	Traumatic injury	15	62.50%
	Infection	9	37.50%

Complete ophthalmological examination was performed which included Conjunctival infection and chemosis that showed no significant ($P>0.05$) difference between different treatment groups on the day of presentation, however, it decreased significantly ($P<0.05$) after ^{4th} week in the animals of group III (0.20±0.08*) when compared to the animals of group I (1.09±0.05).

Mean ± S.E. values of scores for corneal edema and transparency showed a significant ($P<0.05$) difference in group III animals. The extent of corneal edema was comparatively lower in animals of group III (0.12±0.05*) as compared to the animals of group I (1.00±0.03) and II (0.17±0.08*) at respective time intervals. The degree of corneal transparency increased significantly ($P<0.05$) on the ^{4th} week as compared to week 0 in the animals of groups II (0.57±0.18*) and III (0.32±0.05*). Maximum corneal transparency was observed in the animals of group III across successive weeks.

Various vision reflex tests such as menace reflex, pupillary light reflex, palpebral reflex and dazzle reflex were performed. The degree of menace reflex (2.05±0.14*) and pupillary reflex (2.15±0.11*) was significantly ($P<0.05$) higher in group III in the ^{4th} week. Palpebral reflex was present in all the animals of all treatment groups which fluctuated non-significantly. The degree of dazzle reflex was significantly ($P<0.05$) higher in the animals of group III (2.04±0.11*) on the ^{4th} week time interval.

The estimated STT values of the present study were lower than the normal tear production range. The value of STT increased after 4 weeks of treatment in all groups of animals. During the fluorescein dye test, all the eyes took the stain except in 4 cases where descemetocele was present. In the present study, corneal swab samples were processed for bacterial isolation. Twenty-one

swab samples (87.5%) were found positive for bacterial growth on the blood agar plate or MacConkey agar plate and the main isolated microflora included Staphylococcus spp. (80%), Bacillus spp. (9%) and Streptococcus spp. (9%). They were further subjected to antibiotic sensitivity testing which was found sensitive to neomycin, tobramycin, gatifloxacin and gentamicin antibiotics. Intraocular pressure was relatively constant and within the normal physiological ranges, with a mean IOP of 16.7± 4.0 mmHg. Details of Mean ± S.E. values of various haematobiochemical parameters are given in **Table 3.**

Table 3: Mean ± S.E. value of various haematobiochemical parameters.

Parameters	Groups	Week 0	Week 1	Week 2	Week 3	Week 4
Haemoglobin (gm/dl)	I	11.00±0.23	10.86±0.47	10.22±0.55*	10.00±0.46**	10.24±0.45*
	II	12.18±0.48	11.84±0.39	10.90±0.81*	10.70±0.69*	10.09±0.48*
	III	10.24±0.45	10.45±0.23	10.95±0.32	11.12±0.43*	11.18±0.43*
TEC (10^6/cu mm)	I	5.68±0.25	5.87±0.16	5.82±0.30	5.89±0.25	5.72±0.17
	II	5.62±0.28	5.69±0.17	5.78±0.11	5.90±0.11	5.88±0.05
	III	5.59±0.02	5.62±0.02	5.74±0.03	5.89±0.02	5.90±0.01
PCV (%)	I	43.78±3.17	42.25±2.15	42.60±2.45	41.85±2.98	42.85±1.67
	II	44.75±1.58	44.50±1.83	43.75±1.78	43.60±1.98	42.35±1.30
	III	43.25±2.56	42.30±2.62	42.50±1.26	42.75±1.58	42.65±1.28
TLC (10^3/cu mm)	I	8.68±0.49	8.90±0.59	8.85±0.56	8.52±0.54	8.78±0.58
	II	8.20±0.44	9.83±0.55	8.98±0.52	8.10±0.52	9.15±0.43
	III	9.20±0.35	9.11±0.33	8.95±0.28	8.85±0.31	8.62±0.25
Neutrophil (%)	I	74.50±3.27	70.46±1.75	68.00±2.22*	69.00±2.22*	69.00±1.81
	II	69.75±2.99	66.50±3.89*	64.25±1.85*	65.25±2.42*	66.50±0.81
	III	69.50±1.79	61.35±4.87*	57.75±2.70**	56.25±1.83*	57.80±2.16
Lymphocyte (%)	I	27.50±2.74	31.75±0.44*	35.15±2.73*	37.28±1.28	37.45±1.55
	II	31.65±2.43	32.36±3.75	34.50±2.65	33.75±2.69	34.25±1.58
	III	32.50±1.58	34.25±2.26	36.50±1.70*	38.50±1.39*	38.70±1.22*
Monocyte (%)	I	2.25±0.45	3.00±0.35	3.10±0.57*	3.00±0.58*	2.10±0.36
	II	2.60±0.65	2.90±0.55	2.50±0.38	2.75±0.48	3.10±0.35*
	III	2.60±0.38	2.90±0.85	3.95±0.91*	3.90±0.62*	3.40±0.68
Eosinophil (%)	I	1.55±0.69	1.45±0.56	1.65±0.64	1.70±0.85	1.65±0.57
	II	1.35±0.79	1.10±0.61	1.60±0.65	1.00±0.62	1.60±0.53
	III	1.35±0.58	1.40±0.39	1.20±0.68	1.40±0.37	1.55±0.45
Basophil (%)	I	1.32±0.65	1.03±0.55	1.02±0.33	1.6±0.6	1.03±0.54
	II	1.30±0.79	1.30±0.21	1.32±0.54	1.15±0.16	1.5±0.22
	III	1.43±0.11	1.50±0.34	1.66±0.67	1.40±0.37	1.33±0.22
Glucose (mg/dL)	I	74.40±2.85	69.75±2.46	61.50±3.58	70.65±2.28	75.25±3.18
	II	81.85±4.85	83.40±6.94	84.25±5.76	90.40±4.75	90.85±3.06
	III	81.40±6.32	89.50±8.25	85.80±4.89	83.60 ±6.24	85.60±6.16
Total protein (gm/dL)	I	5.98±1.51	5.53±1.46	5.48±1.40	5.28±0.28	5.27±0.88
	II	5.83±1.72	5.69±1.71	5.60±1.50	5.55±1.52	5.48±1.49
	III	6.85±0.11	6.75±0.34	6.55±1.71	6.51±1.32	6.45±1.22
Albumin (gm/dL)	I	3.10±0.40	3.18±0.46	3.20±0.50	3.32±0.61*	3.35±0.44*
	II	2.19±0.28	2.21±0.44	2.21±0.61	2.21±0.73*	2.33±0.71*
	III	2.24±0.57	2.33±0.62	2.55±0.71*	2.60±0.44*	2.63±0.76*
Globulin (gm/dL)	I	0.51±0.41	0.80±0.39	1.04±0.50	1.29±0.25	1.64±0.27
	II	0.23±0.29	0.72±0.27	1.35±0.13	2.11±0.06	2.10±0.19
	III	2.25±0.15	0.96±0.1	1.64±0.07	2.30±0.09	2.57±0.17

* Significant at P<0.05 difference compared with 0-week time interval
** Significant at P<0.01 difference compared with 0-week time interval

A significant (P<0.05) increase in haemoglobin level was observed in the animals of group III. The haemoglobin value was at a peak level at the fourth week (11.18±0.43) time interval from its base value (10.24±0.45).

Total erythrocyte count (TEC) values in the animals of groups I and II were highest at the third week (5.89±0.25 and 5.90±0.11) time interval and lowest at 0-week time intervals (5.68±0.25 and 5.62±0.28). In group III animals, a non-significant (P>0.05) increase in the mean TEC value was observed throughout the study period. Packed cell volume (PCV) showed a non-significant (P>0.05) decrease in the animals of groups I and II as compared to the animals of group III.

No significant (P>0.05) changes were observed in total leucocyte count in three groups. Neutrophil count was slightly higher in the animals suffering from corneal ulcers as compared to its normal values (58-85%). In the animals of group III, the mean neutrophil values were lowest at 3 weeks (56.25±1.83) and maximum at 0 weeks (69.50±1.79).

A significant (P<0.05) change in mean lymphocyte value was observed throughout the study in the animals of groups I and II. In the animals of group III, the lowest (32.50±1.58) and highest (38.70±1.22) mean lymphocyte levels were also observed at 0 and fourth-week time intervals, respectively. Monocyte count was significantly (P<0.05) higher in the animals of group III at the ^{4th} week time interval as compared to other groups. Non-significant (P>0.05) changes in eosinophil and basophil count were observed at different time intervals in animals of different treatment groups.

Glucose level in animals affected with corneal ulcers was within the normal physiological range (76-119 mg/dL). In the animals of group, I, a non-significant (P>0.05) decrease in mean glucose level was observed up to the second week (61.50±3.58) whereas, in group III, a slight increase in glucose level was observed in the first week (89.50±8.25) as compared to its base value followed by a decrease in its level.

The serum protein level in the animals of groups I and II showed a non-significant (P>0.05) decrease throughout the study. Statistical analysis revealed that serum protein in the fourth week was non-significantly (P>0.05) different from its base value in the animals of group III.

The level of serum albumin was slightly lower in the animals suffering from corneal ulcers as compared to its normal values (2.7-4.4gm/dl). However, its level was comparatively higher in the animals of group I as compared to the animals of groups II and III at respective time intervals.

A non-significant (P>0.05) increase in the level of serum globulin was observed throughout the study in the animals of all groups.

Complications noticed post-operatively in the animals of group I (n=8) included epiphora, corneal scar at the ulcer site, corneal edema and keratitis. The corneal scarring was present in all the eyes post-operatively until the last evaluation. In another eye, there was development of mild keratitis by the ^{4th} week of the study, although it did not affect the visual activity of the dog. Membranoplasty along with medicinal treatment was performed in group II(n=8) in which post-operatively there were complications like third eyelid flap dehiscence, corneal edema and scarring, however, the extent of complications observed was less than group I. Contact lens along with tarsorrhaphy and medicinal treatment was applied in group III in which no major complications were observed.

4. DISCUSSION

Corneal ulcer is a most common ocular condition which results from various causes such as trauma, infections, anatomical abnormalities, or underlying systemic diseases. A total of 24 cases were presented, out of which 15 were males and 9 were females. RAMANI *et al.,* (2012) [19] also noted a higher incidence of corneal ulcers in males (67%) than in females (33%). In our study, the highest incidence of corneal ulcers was observed in the age group of 1 to 2 years. The higher incidence of corneal injury and ulcers in this age group and males may be attributed to their high level of activity which would make them more prone to trauma (KIM *et al.,* 2009) [12]. Pugs were reported more which correlates with the findings of KIM *et al.,* (2009) [12] who reported that brachycephalic breeds have characteristic features like lagophthalmos, less blinking frequency and central thinning of the pre-corneal tear film which predispose them to corneal injuries. The most common cause of corneal ulcers in our study was corneal injury followed by infection. KIM *et al.,* (2009) [12] have also reported that keratoconjunctivitis sicca (KCS) is the most common cause of ulcerative keratitis (31%) followed by lagophthalmos (28%), bacterial infection (11%) and trauma (8%).

A comprehensive ophthalmological examination was performed on the day of presentation and up to ^{4th} week. On the day of presentation, there was no significant difference (P>0.05) in conjunctival infection and chemosis between treatment groups. However, after 4 weeks, the animals in group III showed a significant decrease (P<0.05) compared to group I. These results were similar to the findings of BOSSUYT (2016) [4], who reported that soft contact lenses can be used as an adjunct therapy in several conditions varying from superficial corneal ulcers, corneal dystrophies and adnexal diseases to superficial stromal defects.

The scores for corneal edema and transparency showed a significant (P<0.05) difference in group III animals when compared to the other groups. The extent of corneal edema was comparatively lower in animals of group III. The degree of corneal transparency increased significantly (P<0.05) in the ^{4th} week as compared to week 0 in the animals of groups II and III. Throughout consecutive weeks, the animals in group III consistently showed maximal corneal transparency. The result observed in treatment group III was similar to the findings of SINGH *et al.,* (2015) [22].

The examination of different vision reflex tests such as the menace reflex, pupillary light reflex, palpebral reflex, and dazzle response revealed significant differences between treatment groups. RUCKER *et al.,* (2011) [21] have noted that the neuro-ophthalmological examination is one of the most refined and precise components of the clinical examination and allows proper diagnosis and formulation of a treatment plan.

The degree of menace reflex was significantly higher in group III in the 4th week as compared to the animals of groups I and II. The degree of pupillary reflex was also significantly (P<0.05) higher in group III on the 4th week as compared to the animals of groups I and II at respective time intervals. BERANEK AND VIT (2007) [2] have also reported a similar finding in animals under a light source held 2-5 cm from the eye, where they measured the response time of PLR and concluded that in healthy animals, both pupils responded when either eye was stimulated, however, the pupil of the consensual eye was not constricted to the same extent as the pupil of the stimulated eye. Palpebral reflex fluctuated non-significantly which correlates with the findings of MOORE (2001) [15] who stated that a positive palpebral reflex corresponds to a blinking response when the ophthalmic branch of the trigeminal nerve is stimulated by touching the medial or the lateral canthus. The degree of dazzle reflex was significantly (P<0.05) higher in the animals of group III on the 4th week time interval as compared to groups I and II. MARTIN (2001) [14] has described that a positive dazzle reflex elicited by bilateral narrowing of the palpebral fissure could help establish the intactness of the lower visual system when vision could not be evaluated or PLR was altered.

The level of Schirmer's tear test (STT) was comparatively lower in the animals suffering from corneal ulcers compared to STT of normal eyes. The value of STT increased after 4 weeks of treatment in all groups of animals. The normal range of canine tear production according to GELATT (1991) [7] is 15-25 mm/min. Estimated STT values of the present study were lower than the normal tear production range; this is suggestive of keratoconjunctivitis sicca (KCS) being the inciting cause of corneal ulceration. During the fluorescein dye test, all the eyes took the stain except in 4 cases where descemetocele was present on the day of presentation. In cases of descemetocele, only the margin of ulcers took the stain because the ulcer was so deep that the corneal stroma had abraded, resulting in protrusion of Descemet's membrane. SINGH *et al.,* (2015) [22] have also reported that the fluorescein dye is ideal for the detection of corneal and conjunctival defects. Fluorescein stain helps in defining the margins of corneal ulcers by exposing and staining the corneal stroma green.

Corneal swab samples were processed for bacterial isolation and of a total of 24 cases, only 21 cases were found positive for bacterial growth on the blood agar plate or MacConkey agar plate. The main isolated microflora included Staphylococcus spp. The findings of the present study have also been supported by RAMANI *et al.,* (2013) [20], who have isolated Staphylococcus spp. (54%), Escherichia coli (17%) and Bacillus spp. (8%) from corneal swab cultures of dogs. Twenty-one samples positive for bacterial growth were further subjected to antibiotic sensitivity testing. Most of the isolates were sensitive to neomycin, tobramycin, gatifloxacin and gentamicin antibiotics.

Intraocular pressure was relatively constant and within the normal physiological ranges in all the animals. It was measured in all the dogs except for the cases of descemetocele and cases of collapse of the anterior chamber because of corneal perforation. WILLIAMS AND BURG (2017) have also reported that the mean value of IOP was lower in the ulcerated eye (11.8 ±3.0 mmHg) as compared to the control eye (16.7 ± 2.6 mmHg) which might be related to mild uveitic changes in the ulcerated eye.

Values of various haematobiochemical parameters at different time intervals in various groups of animals were recorded. A significant (P<0.05) increase in haemoglobin level was observed in the animals of group III subjected to contact lenses along with tarsorrhaphy. An increase in haemoglobin level might be due to the improvement in corneal ulcers and their physiological status. NAIR AND VASANTH (2007) [16] have also studied haematological and biochemical changes during ocular disease in dogs and observed that haematological parameters like Hb, PCV, TLC and DLC values remained within their normal physiological range.

Total erythrocyte count (TEC) values in the animals of groups I and II were highest at the third-week time interval and lowest at 0-week time intervals. In group III animals, treated with contact lenses a non-significant (P>0.05) increase in the mean TEC value was observed throughout the study period. CHINCHU (2010) [5] also observed that the mean values of RBC count showed a significant increase in cases of corneal ulcers as the healing progressed, with the values returning to the normal range.

Packed cell volume (PCV) showed a non-significant (P>0.05) decrease in the animals of groups I and II, which may be due to the slow healing of corneal wounds as compared to the animals of group III. According to ISAAC *et al.,* (2013) [9], packed cell volume is involved in the transportation of oxygen and nutrients. Increased packed cell volume shows better transportation, so that following the corneal injury its value increased and reached to normal level during healing. Similar observations have also been reported by CHINCHU (2010) [5].

No significant (P>0.05) changes were observed in total leucocyte count in animals of groups I, II and III. However, differential leucocyte count showed some significant findings. In the animals of group III, the mean neutrophil values were lowest at 3 weeks and maximum at 0 weeks. The major function of the white blood cells is to fight against infections, strengthen the body's defence system by phagocytosis against invasion by foreign organisms and distribute antibodies in the immune response. Thus, animals which show low white blood cells are more prone to infection, while those with high counts are capable of generating antibodies for phagocytosis and have a high degree of resistance to diseases (SOETAN *et al.,* 2013) [23].

A significant (P<0.05) change in mean lymphocyte value was observed throughout the study in the animals of groups I and II. In the animals of group III, the lowest and highest mean lymphocyte levels were also observed at 0 and fourth-week time intervals, respectively which may be correlated to the role of lymphocytes in the healing of corneal ulcer. Monocyte count was significantly (P<0.05) higher in the animals of group III at the 4th week time interval as compared to other groups. This may be correlated to the role of monocytes in immune stimulation (NELSON AND COUTO 1998) [17]. Non-significant (P>0.05)

changes in eosinophil and basophil count were observed at different time intervals in animals of different treatment groups. In the animals of group, I, a non-significant (P>0.05) decrease in mean glucose level was observed up to the second week whereas, in group III, a slight increase in glucose level was observed in the first week as compared to its base value followed by a decrease in its level. Insignificant (P>0.05) changes in the blood glucose at different time intervals indicated that the animals might have not been in a stressed condition for a sufficient period. However, a significant increase in the mean glucose level was a characteristic feature of corneal ulcers reported by GOOD *et al.,* (2003) [8], who examined corneal sensitivity in dogs with diabetes mellitus.

The serum protein level in the animals of groups I and II showed a non-significant (P>0.05) decrease throughout the study. The decreased concentration of total protein (TP) indicates the possibility of mild interference in the absorption and assimilation of nutrients owing to intestinal disorders in dogs. THRALL AND BAKER (1994) [24] have also observed a significant decrease in the level of plasma total protein in stressed animals.

The level of serum albumin was slightly lower in the animals suffering from corneal ulcers as compared to its normal values (2.7-4.4gm/dl). The levels of serum albumin remained within the normal physiological limit in all the animals of different groups throughout the study. Albumin is synthesized by the liver. Lower levels of albumin indicate liver damage and are also suggestive of a compromised immune system (BLACK, 2005) [3].

A non-significant (P>0.05) increase in the level of serum globulin was observed throughout the study in the animals of all groups. The levels of serum globulin remained within the normal physiological limit in all the animals of various groups at different time intervals throughout the study. Around 38% of the blood plasma is made up of globulin, which is secreted by the immune system. Globulin is synthesized by the white blood cells and is one of the major components that strengthen the immune system. The increase in the level of serum globulin may be attributed to the effect of different therapies (THRALL AND BAKER, 1994) [24].

5. CONCLUSIONS

The results of the present study revealed that the highest number of corneal ulcer cases were observed among dogs in the age group of 1-2 years, mostly in brachycephalic breeds and male dogs. Tests including vision reflex tests, Schirmer's tear test, microbiological examination, fluorescein dye test and other clinical and ophthalmic observations were helpful in the diagnosis of corneal ulcers. Medicinal treatment was found to be effective in uncomplicated, superficial ulcers. However, many complications such as epiphora, keratitis, corneal scarring and edema were also observed. Membranoplasty/third eyelid flap technique with medicinal treatment resulted in effective healing of the corneal ulcer, however, complications including flap dehiscence, edema and scarring were also observed. Application of contact lenses along with tarsorrhaphy and medicinal treatment was found most effective for the management of corneal ulcers, as post-operative complications observed in this group were minimal followed by faster recovery and restoration of vision in all cases.

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