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Nebulization as an adjunct to therapy in the management of boas

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Abstract

The present investigation was carried out at VCC, NTR College of Veterinary Science, Gannavaram from March to November 2023. The dogs were categorised into two groups randomly and dogs included in group I (N=6) were treated with treatment regimen i.e., antibiotic, steroid and proton pump inhibitor whereas dogs under group II (N=6) were subjected to nebulization using 0.9% normal saline in adjunct to treatment protocol.

Keywords: BOAS, brachycephalic, nebulization, respiratory

Introduction

The growing popularity among the brachycephalic breeds has led to an increase in BOAS cases, which had let us to know how major health and wellbeing problems have increased in these breeds (Bagardi *et al.*, 2023) [4]. Although not all brachycephalic dogs show clinical signs, the incidence and severity of the respiratory disorders has increased. The respiratory disease related to brachycephalic conformation is called Brachycephalic Obstructive Airway Syndrome (BOAS). (University of Cambridge 2016 Cambridge BOAS Research group). Although standard therapeutic regimen was useful in the management of BOAS, nebulization as an adjunct improved lung ventilation by causing liquidation of mucus and its evacuation from the bronchial tree as stated by Artur *et al.* (2019) [2].

Materials and Methods

12 brachycephalic dogs with BOAS were categorised into two groups, Group I and Group II. Group I dogs were stabilized with Amoxicillin @ 15 mg/kg body weight (12.5-25mg) and prednisolone @ 0.5 mg/kg body weight and pantoprazole @ 1 mg/kg body weight which were administered parenterally on the first day and was continues orally for a period of one week. Dogs included in Group II (N=6) were subjected to nebulization using normal saline in adjunct to treatment protocol adopted in Group I. (Filho *et al.*, 2017) [5].

Post therapeutically disinfection of nebulizer was done by the procedure recommended by Cystic Fibrosis Foundation viz., cleaning with warm water and mild soap, disinfect, rinse and air dry. The efficacy to therapy was assessed based on clinical response exhibited by the dogs.

Results

Clinical signs

In Group I brachycephalic dogs (N=6) were taken of which all the dogs exhibited response to the therapy (Antibiotic, Steroid & pantoprazole).

All the dogs in Group I exhibited inspiratory dyspnoea on 0th day which were evaluated for remission of clinical signs on day 3, day 5 and day 7 after the initiation of the therapy. On 3rd day after initiation of therapy two dogs exhibited moderate relief from dyspnoea while the remaining four dogs had dyspnoea. On day 5 after initiation of therapy two dogs out of the four dogs which had dyspnoea on day 3 showed relief from dyspnoea. On day 7 after initiation of therapy, the remaining two dogs which had dyspnoea on day 5 showed relief from dyspnoea.

Four dogs in Group I exhibited snoring on 0th day, by 3rd day post treatment one dog showed improvement by reduction of snoring and by 5th day after initiation of therapy, one dog out of the three dogs which had snoring on day 3 showed improvement. On 7th day after initiation of therapy the remaining two dogs which exhibited snoring on day 5 showed improvement as snoring reduced.

Cough was present in three dogs out of six in this group which showed progressive decline after the initiation of treatment. On 5th day after the initiation of treatment two dogs showed reduction in cough while one dog did not show any improvement. On day 7 after initiation of therapy the one dog which had cough on day 5 showed improvement as the intensity of cough reduced.

Vital parameters

The mean $\pm$ SE values of temperature ($^{\circ}$ F), respiratory rate (breaths/min) and heart rate (bpm) in healthy control, Group I dogs before therapy and after therapy were (102.03 $\pm$ 0.34, 29.67 $\pm$ 3.55 and 103.67 $\pm$ 7.64), (102.24 $\pm$ 0.32, 38.6 $\pm$ 2.626 and 114.3 $\pm$ 5.43) and (102.19 $\pm$ 0.44, 37 $\pm$ 2.73 and 110.7 $\pm$ 6.10), respectively. A significant ($p < 0.05$) increase in respiratory rate was observed in brachycephalic dogs when compared to healthy control. The pre therapeutic values of temperature and heart rate showed non-significant ($p > 0.05$) increase compared to that of healthy control group and post therapeutic values of temperature, respiratory rate and heart rate showed no significant variation compared to that of pre therapeutic values (Table 1, Figure 1).

Haematology

There was a non-significant ($p > 0.05$) variation in pre therapeutic mean $\pm$ SE values of Hb (gm/dl), TEC ($\times 10^6$ / μ L) and TLC ($\times 10^3$ / μ L) (12.89 $\pm$ 1.22), (6.26 $\pm$ 0.62), (11.08 $\pm$ 1.83) when compared to that of healthy control group (13.82 $\pm$ 0.50), (38.06 $\pm$ 1.64) and (5.99 $\pm$ 0.42) respectively.

There was a non-significant ($p > 0.05$) difference in post therapeutic mean value of Hb, TEC and TLC when compared to pre therapeutic mean values.

Prior to treatment, the mean $\pm$ SE values of PCV (%) and platelet count (lakhs/ μ L) (46.88 $\pm$ 3.57), (3.50 $\pm$ 0.58) showed significant ($p < 0.05$) variation from mean values healthy control (38.06 $\pm$ 1.64), (1.72 $\pm$ 0.23).

A significant decrease ($p < 0.05$) was observed in the PCV values before (46.88 $\pm$ 3.57) and after initiation of the therapy (39.47 $\pm$ 0.74) (Figure 3).

There was a non-significant ($p > 0.05$) decrease in the pre therapeutic mean value (3.51 $\pm$ 0.58) and post therapeutic mean value (3.17 $\pm$ 0.42) of platelet count (Figure 4)

Prior to treatment, the mean $\pm$ SE values of neutrophil (%), lymphocyte (%), monocyte (%), eosinophil (%) and basophil (%) counts were (61.70 $\pm$ 6.43, 31.60 $\pm$ 7.02, 3.90 $\pm$ 0.45, 2.70 $\pm$ 0.98 and 0.10 $\pm$ 0.10) which showed non-significant ($p > 0.05$) difference when compared to that of healthy control group. The values varied non-significantly ($p > 0.05$) in comparison to that of the post therapeutic dogs (66.60 $\pm$ 4.90, 30.70 $\pm$ 4.95, 2.10 $\pm$ 0.66, 0.60 $\pm$ 0.50, 0).

Group II

Clinical signs

In Group II brachycephalic dogs (N=6) were taken out of which all the dogs responded to the therapy (Antibiotic, steroid, pantoprazole and nebulization).

All the dogs in Group II exhibited inspiratory dyspnoea on 0th day. The dogs were evaluated on day 3, day 5 and day 7 after

the initiation of therapy. Two dogs showed improvement as relief from dyspnoea and reduction of stertor and stridor on day 3 after initiation of the therapy while the remaining 4 dogs had dyspnoea. Three out of the four dogs which had dyspnoea on day 3 showed improvement by day 5 after initiation of therapy. By day 7 after the initiation of the therapy the one dog which had dyspnoea on day 5 showed improvement marked by relief from dyspnoea.

Four dogs in Group II exhibited snoring on 0th day, by 3rd day post treatment one dog showed improvement by reduction of snoring and on day 5 after the initiation of therapy 2 dogs showed reduction in snoring. By 7th day after initiation of therapy all the four dogs exhibited improvement as reduction in snoring sounds.

Cough was present in two dogs out of six in this group which showed progressive decline after 3rd day and 5th day one each after the initiation of treatment.

Vital signs

The mean $\pm$ SE values of temperature ($^{\circ}$ F), respiratory rate (breaths/min) and heart rate (bpm) in healthy control, Group II dogs before therapy and after therapy were (102.03 $\pm$ 0.34 $^{\circ}$ F, 29.67 $\pm$ 3.55 breaths/min and 103.67 $\pm$ 7.64 bpm), (102.49 $\pm$ 0.49 $^{\circ}$ F, 39.10 $\pm$ 3.26 breaths/min and 115.70 $\pm$ 7.98 bpm) and (101.91 $\pm$ 0.39 $^{\circ}$ F, 34 $\pm$ 2.59 breaths/min and 115.5 $\pm$ 6.86 bpm), respectively. A significant ($p < 0.05$) increase in respiratory rate was observed in brachycephalic dogs when compared to healthy control. The pre therapeutic values of temperature and heart rate showed non-significant ($P > 0.05$) increase compared to that of healthy control group and post therapeutic values of temperature, heart rate and respiratory rate showed no-significant variation compared to that of pre therapeutic values (Table 2, Figure 2).

Haematology

There was a non-significant ($p > 0.05$) variation in pre therapeutic mean $\pm$ SE values of Hb (gm/dl), TEC ($\times 10^6$ / μ L) and TLC ($\times 10^3$ / μ L), (13.08 $\pm$ 1.37), (6.27 $\pm$ 0.53), (10.96 $\pm$ 0.85) when compared to that of healthy control group (13.82 $\pm$ 0.50), (5.99 $\pm$ 0.42) and (7.85 $\pm$ 1.25) respectively. The pre therapeutic values also varied non-significantly ($p > 0.05$) with post therapeutic mean value (13.28 $\pm$ 1.04), (6.20 $\pm$ 0.34) and (8.98 $\pm$ 0.81) of Hb (gm/dl), TEC ($\times 10^6$ / μ L) and TLC ($\times 10^3$ / μ L). Prior to treatment, the mean $\pm$ SE values of PCV (%) and platelet count (lakhs/ μ L) (48.78 $\pm$ 3.84), (3.54 $\pm$ 0.56) showed significant ($p < 0.05$) variation from mean values of healthy control (13.82 $\pm$ 0.50) and (1.72 $\pm$ 0.23) respectively.

A significant difference ($p < 0.05$) was observed in the PCV values after initiation of the therapy (42.00 $\pm$ 0.87), (Figure 5). Non-significant decrease ($p > 0.05$) in the platelet count was observed after therapy (3.23 $\pm$ 0.22) (Fig. 6).

Prior to treatment, the mean $\pm$ SE values of neutrophil (%), lymphocyte (%), monocyte (%), eosinophil (%) and basophil (%) counts (60.40 $\pm$ 3.59, 36.20 $\pm$ 3.90, 2.80 $\pm$ 0.44, 0.60 $\pm$ 0.53, 0.0 $\pm$ 0.0) showed non-significant ($p > 0.05$) difference when compared to that of healthy control group (60.17 $\pm$ 2.56, 35.00 $\pm$ 2.45, 3.17 $\pm$ 0.48, 1.33 $\pm$ 0.49 and 0.33 $\pm$ 0.21) respectively. The corresponding values after therapy were (61.8 $\pm$ 5.11, 34.9 $\pm$ 4.95, 2.7 $\pm$ 0.8, 0.5 $\pm$ 0.27, 0.1 $\pm$ 0.1) which varied non-significantly ($p > 0.05$) with that of the pre therapeutic values.

4.5.3 Comparison of therapeutic efficacy in Group I and Group II dogs: From above findings it is evident that no significant difference was observed in the vital parameters

before and after therapy in both the groups. The pretherapeutic PCV (%) improved significantly after therapy in both the groups. Based on clinical response exhibited, the efficacy of the therapy was assessed in Group I and Group II dogs which was shown in Table 5.

Out of six dogs that were taken up for therapeutic trial in Group I all the six dogs responded to therapy in which one dog showed recovery by 3rd day (16.67%), two dogs by 5th day (50.00%) and three dogs by 7th day (100%) after

initiation of therapy. The average time taken for recovery in Group I dogs was 5.67±0.67 days.

In response to therapeutic regimen followed in Group II (nebulization with normal saline), all the six dogs which were taken up for therapeutic trial showed regression of clinical signs by 3rd (33.33%), 5th (83.33%) and 7th (100%) day after initiation of therapy in 2, 3 and 1 dogs respectively. The average time taken for recovery in Group II dogs was 4.66±1.61 days.

Table 1: Vital signs in group I dogs before and after therapy (N=6)

S. No.	Parameter	Apparently healthy control	Group I	
			Before therapy	After therapy
1.	Temperature (°F)	102.03±0.34	102.24±0.32 ^{NS}	102.19±0.44 ^{NS}
2.	Respiratory rate (breaths/min)	29.67±3.55	38.60±2.62*	37.00±2.73 ^{NS}
3.	Heart rate (bpm)	103.67±7.64	114.30±5.43 ^{NS}	110.70±6.10 ^{NS}

*: significant difference ($p<0.05$) between healthy control and before therapy

NS: Non-significant ($p>0.05$)

Table 2: Haematological findings in group I dogs before and after therapy (N=6)

S. No.	Parameter	Control	Group I	
			Before therapy	After therapy
1.	Haemoglobin (g/dL)	13.82±0.50	12.89±1.22 ^{NS}	12.81±1.00 ^{NS}
2.	PCV (%)	38.06±1.64	46.88±3.57*	39.47±0.74 [#]
3.	TEC ($\times 10^6/\mu\text{L}$)	5.99±0.42	6.26±0.62 ^{NS}	6.19±0.40 ^{NS}
4.	TLC ($\times 10^3/\mu\text{L}$)	7.85±1.25	11.08±1.83 ^{NS}	9.670±1.07 ^{NS}
5.	DLC (%)			
	Neutrophils (%)	60.17±2.56	61.70±6.43 ^{NS}	66.60±4.90 ^{NS}
	Lymphocytes (%)	35.00±2.45	31.60±7.02 ^{NS}	30.70±4.95 ^{NS}
	Monocytes (%)	3.17±0.48	3.90±0.45 ^{NS}	2.10±0.66 ^{NS}
	Eosinophils (%)	1.33±0.49	2.70±0.98 ^{NS}	0.60±0.50 ^{NS}
	Basophils (%)	0.33±0.21	0.10±0.1 ^{NS}	0
6.	Platelet count (Lakhs/ μL)	1.72±0.23	3.50±0.58*	3.17±0.42 ^{NS}

*: Means differ significantly ($p<0.05$) in comparing before therapy with healthy control

#: Means differ significantly ($p<0.05$) before and after therapy

NS: Non-significant ($p>0.05$)

Table 3: Vital signs in group II dogs before and after therapy (N=6)

S. No.	Parameter	Apparently healthy control (n=10)	Group II (n=6)	
			Before therapy	After therapy
1.	Temperature (°F)	102.03±0.34	102.49±0.49 ^{NS}	101.91±0.39 ^{NS}
2.	Respiratory rate (breaths/min)	29.67±3.55	39.10±3.26*	34±2.59 ^{NS}
3.	Heart rate (bpm)	103.67±7.64	115.70±7.98 ^{NS}	115.50±6.86 ^{NS}

*: significant difference ($p<0.05$) between healthy control and before therapy

NS: Non-significant ($p>0.05$)

Table 4: Haematological findings in Group II dogs before and after therapy (N=6)

S. No.	Parameter	Control	Group II	
			Before therapy	After therapy
1.	Haemoglobin (g/dL)	13.82±0.50	13.08±1.37 ^{NS}	13.28±1.04 ^{NS}
2.	PCV (%)	38.06±1.64	48.78±3.84*	42.00±0.87 [#]
3.	TEC ($\times 10^6/\mu\text{L}$)	5.99±0.42	6.27±0.53 ^{NS}	6.20±0.34 ^{NS}
4.	TLC ($\times 10^3/\mu\text{L}$)	7.85±1.25	10.96±0.85 ^{NS}	8.98±0.81 ^{NS}
5.	DLC (%)			
	Neutrophils (%)	60.17±2.56	60.40±3.59 ^{NS}	61.80±5.11 ^{NS}
	Lymphocytes (%)	35.00±2.45	36.20±3.90 ^{NS}	34.90±4.95 ^{NS}
	Monocytes (%)	3.17±0.48	2.80±0.44 ^{NS}	2.70±0.8 ^{NS}
	Eosinophils (%)	1.33±0.49	0.60±0.53 ^{NS}	0.50±0.27 ^{NS}
	Basophils (%)	0.33±0.21	0	0.10±0.10 ^{NS}
6.	Platelet count (lakhs/ μL)	1.72± 0.23	3.54±0.56*	3.23±0.22 ^{NS}

*: Means differ significantly ($p<0.05$) in comparing before therapy with healthy control

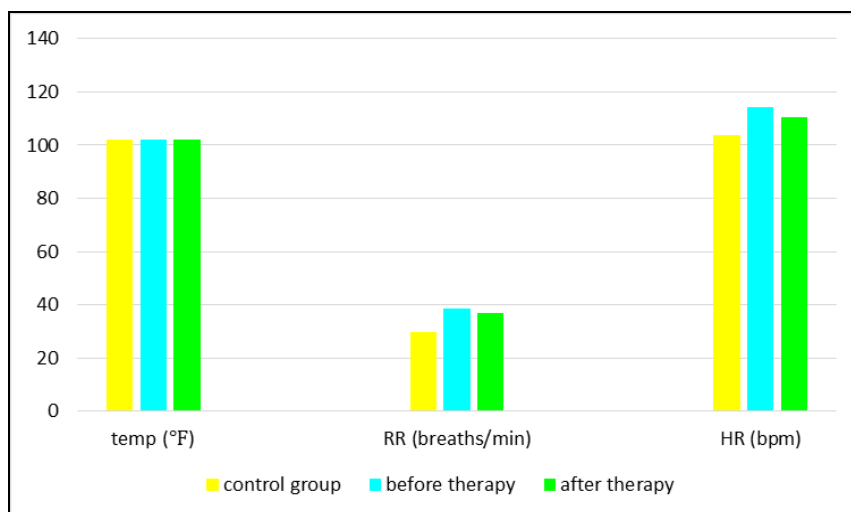
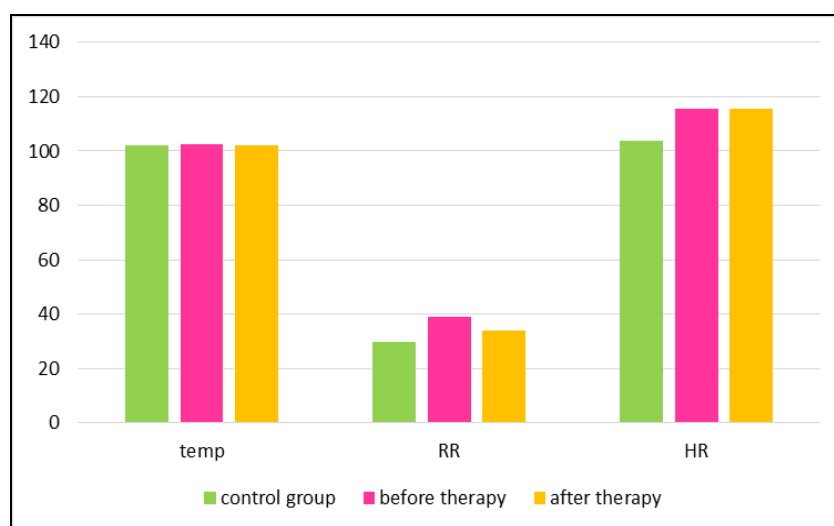
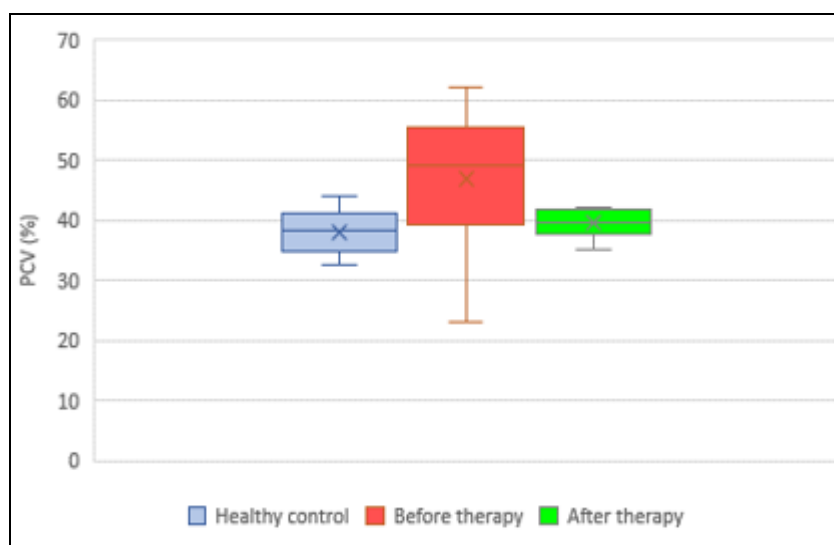
#: Means differ significantly ($p<0.05$) before and after therapy

NS: Non-significant ($p>0.05$)

Table 5: Comparison of therapeutic efficacy in Group I and Group II dogs

Group	No of dogs stabilized (in terms of remission of signs)			Average number of days taken for recovery
	Day 3	Day 5	Day 7	
Group I (N=6)	1 (16.67)	3 (50.00)	6 (100)	5.67±0.67
Group II (N=6)	2 (33.33)	5 (83.33)	6 (100)	4.67±1.61

Figures in parenthesis indicate percentage

**Fig 1:** Vital signs in Group I BOAS dogs before and after therapy**Fig 2:** Vital signs in Group II BOAS dogs before and after therapy**Fig 3:** PCV in Group I BOAS dogs before and after therapy

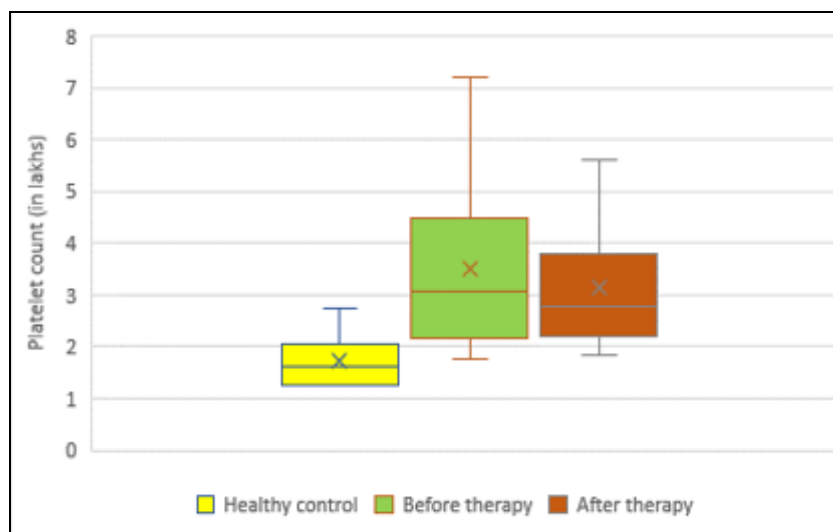


Fig 4: Platelet count in Group I BOAS dogs before and after therapy

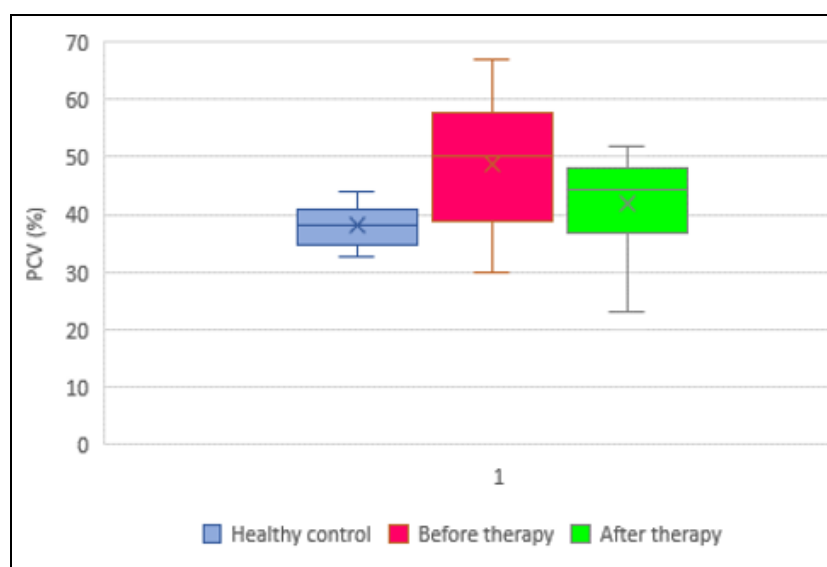


Fig 5: PCV in Group II BOAS dogs before and after therapy

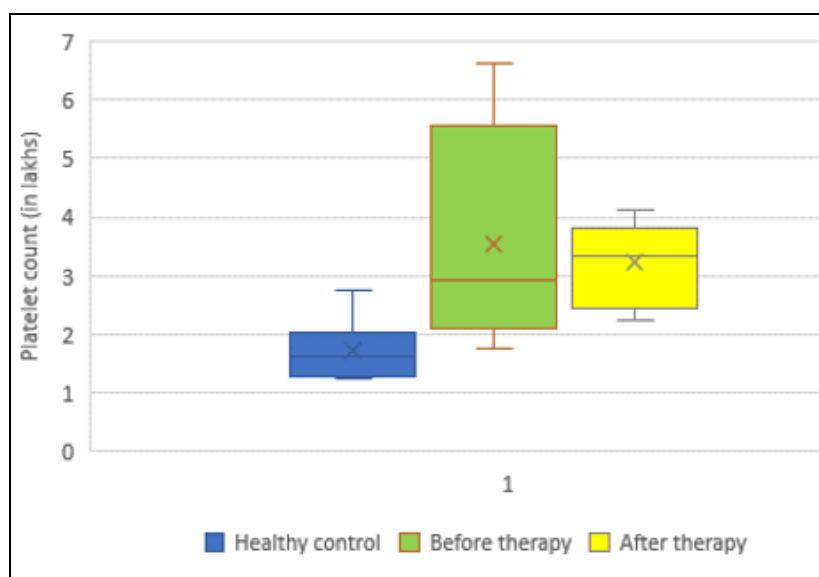


Fig 6: Platelet count in Group II BOAS dogs before and after therapy

Discussion

Group I and II dogs were treated with Amoxicillin @ 15 mg/kg body weight (12.5-25mg) and prednisolone @ 0.5 mg/kg body weight and pantoprazole @ 1 mg/kg body

weight. Group II brachycephalic dogs were therapeutic regimen along with nebulization with 0.9 per cent normal saline. Inspiratory dyspnoea, snoring, exercise intolerance and coughing were the common clinical signs observed in dogs of

both the groups and the resolution of these signs was taken into consideration for evaluation of therapeutic response.

Out of six dogs that were treated in Group I all the dogs responded to therapy in which one dog showed recovery by 3rd day, two dogs by 5th day and three dogs by 7th day after initiation of therapy.

Of the three common clinical signs exhibited by dogs with BOAS of Group I, dyspnoea showed faster response to therapy and were restored to near normalcy by 3rd, 4th and 5th day after initiation of therapy in two, one and three dogs respectively, while cough was reduced in two and one dogs by 5th and 7th day after initiation of therapy respectively and snoring was reduced in one, one and two dogs by 3rd, 5th and 7th day after initiation of therapy respectively.

No significant difference ($p>0.05$) in temperature, respiratory rate and heart rate were observed in Group I dogs after seven days of therapy when compared to pretherapeutic means.

After therapy, Group I dogs showed significant decrease ($p<0.05$) in packed cell volume when compared to healthy control which was in corroboration with Prakash *et al.* (2021)^[13] who also stated that an increased in PCV might be due to increased oxygenation after initiation of therapy.

Amoxicillin was used in the current study which was also used by Statz (2018)^[14] and Lindsay *et al.* (2020)^[10]. In the same line Lodato and Mauterer (2014)^[9] recorded the administration of amoxicillin-clavulanic acid for 5-7 days which was effective against common oral bacteria and anaerobes. Amoxicillin was useful in treatment of secondary bacterial upper respiratory infections (Lappin *et al.* 2017)^[7]. Lodato and Hedlund (2012)^[8] stated the use of glucocorticoids @ 0.5-2 mg/kg reduced the oedema and swelling of airways which facilitate patency of upper airways and thus ventilation. These findings also align with reports of Meola *et al.* (2013)^[11] who opined that prednisolone @ 0.5-1.0 mg/kg IV or PO was used to reduce the pharyngeal oedema which facilitates airway oxygenation in brachycephalic dogs. These findings were in line with Aiken (2021)^[1] and Patel *et al.* (2022)^[12] who also recommended the usage of glucocorticoids.

In response to therapeutic regimen followed in Group II (nebulization with normal saline), all the six dogs which under therapy exhibited regression of clinical signs i.e., dyspnea, snoring and cough by 3rd, 5th and 7th day after initiation of therapy in 2, 3 and 1 dogs respectively.

No significant ($p>0.05$) changes were observed in Group II dogs in the vital parameters like temperature, respiratory rate and heart rate after initiation of the therapy.

A significant decrease ($p<0.05$) in PCV was observed in Group II dogs after initiation of therapy which was due to increased oxygen flow through the nostrils after the initiation of therapy as reported by Prakash *et al.* (2021)^[13].

Nebulization with normal saline was performed in Group II dogs along with the treatment protocol followed in Group I dogs. Nebulization did not cause any unpleasant side effects and relieved breathing difficulties immediately by decongestion of respiratory mucus membranes (Ayodhya *et al.*, 2014)^[3]. In the same line Filho *et al.* (2017)^[5] opined that the particles of 0.9% sterile saline solution reached interior of the airways and caused humidification of the ciliary epithelium and integrated into the associated mucus which resulted in mobilization and expectoration of mucus.

Nebulization improved lung ventilation by causing liquification of mucus and its evacuation from the bronchial tree as stated by Artur *et al.* (2019)^[2]. The findings were also in association with findings of Hulsebosch and Johnson, (2019)^[6] who

reported that nebulization with sterile saline 2 to 3 times per day humidified and cleared airway mucus.

The average number of days taken for recovery in Group I and Group II was 4.66 ± 1.61 days when compared to 5.67 ± 0.67 days respectively. Based on resolution of clinical signs, improvement in haematological changes to near normalcy in Group III, it was considered that having the treatment along with nebulization was showing superior efficacy and could be useful to hasten the recovery time.

Conflict of Interest:

Not available

Financial Support:

Not available

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