



Clinicophysiological, haematobiochemical and electrocardiographic effects of homogenous and heterogenous blood transfusion in traumatized dogs

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ABSTRACT

Twenty four clinical cases of dogs having the history of the accidents irrespective of their age and sex were included in this study. The definite diagnosis was made on the basis of haematobiochemical, radiographic, ultrasonographic and laparoscopic findings. The animals were divided randomly into 3 groups, viz. A, B and C comprising equal number of animals. After the definite diagnosis, patients were subjected to surgical intervention i.e. splenectomy. The animals of groups A, B, and C were subjected to the administration of anaesthetic combination of atropine sulphate, diazepam and thiopental sodium just to pass endotracheal tube followed by either isoflurane (2–2.5%) or sevoflurane (3–3.5%) and also subjected to whole blood transfusion of cattle, buffalo and dogs in groups A, B & C respectively either during the operation or just after the operation. The efficacy of blood transfusion was judged on the basis of effects on various clinicophysiological and haematobiochemical parameters recorded before and after the administration of blood. Electrocardiographic studies were also made. It was concluded that in case of the trauma of spleen, homogenous transfusion of the blood in traumatized patient is most beneficial however in case of the emergency condition, heterogenous blood transfusion from cattle and buffaloes may also be made to save the life of the patients.

Key words: Blood transfusion, Dogs, Electrocardiography, Heterogenous, Splenectomy, Trauma

Transfusion of blood has long been recognized as an important therapeutic modality in human medicine (Diamond 1980 and Myhre 1990). Much of the knowledge of Veterinary transfusion medicine, equipments and techniques have been borrowed from human medicine (Tangner 1982, Authment *et al.* 1987, Hosgood 1990). Transfusion medicine may be a life saving modality in case of emergency or critically ill animals. Blood products are becoming readily available and transfusions can be performed in many Veterinary clinics (Kumar 2017). For administration of whole blood in a normovolemic patient, the recommended infusion rate is 22 ml/kg/24 h. In the hypovolemic animal, the rate should not exceed 22 ml/kg/h. The rate of infusion should not exceed 4 ml/kg/h in cardiac compromised patients (Bernard 2000). Factors pertaining to transfusion of blood to be considered are volume of blood loss, rapidity of loss, nature of ongoing losses, and patient condition. Veterinary patients with acute massive haemorrhage resulting in a haematocrit value lower than 20% and an albumin concentration less than 2 g/dl should undergo transfusion to maintain erythrocyte mass

for adequate tissue perfusion and oxygenation (Kirby and Rudloff 2000).

Transfusion therapy is basically an attempt to replace blood or its components when the life is threatened (Kumar *et al.* 2007). Massive transfusion of blood components containing sodium citrate can lead to transiently decreased level of ionized calcium. Hypocalcemia can cause hypotension and reduced pulse pressure, electrocardiographic abnormalities such as prolonged QT interval (Denlinger *et al.* 1976).

MATERIALS AND METHODS

Twenty four clinical cases of dogs having the history of the accidents irrespective of their age and sex were included in this study. With the history of trauma, dogs were hospitalized and were subjected to physical examination. The definite diagnosis was made on the basis of haematobiochemical, radiographic, ultrasonographic and laparoscopic findings. The clinical examination of the animals were done. Internal bleeding was diagnosed using ultrasonography and laparoscopy and the animals were divided randomly into 3 groups, viz. A, B and C comprising equal number of animals.

To know the pathophysiological alterations due to trauma and loss of the blood, various clinicophysiological and haematobiochemical parameters were also determined. Clinicophysiological parameters included general

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appearance, heart rate, respiration rate, body temperature, capillary refill time, electrocardiogram, respiratory minute-volume and tidal-volume. The haematobiochemical parameters included haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), total leukocyte count (TLC), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), platelets count, differential leucocyte count (neutrophils, lymphocytes and monocytes), plasma total protein, albumin, glucose, plasma urea nitrogen, creatinine, sodium, potassium, calcium, and plasma enzymes including alanine aminotransferase (ALT), aspartate aminotransferase (AST) and gamma glutamyltransferase (GGT).

After the definite diagnosis, patients were subjected to surgical intervention, i.e. splenectomy immediately. The animals of group A, B, and C were subjected to the administration of anaesthetic combination of atropine sulphate @ 0.04 mg/kg body weight, diazepam @ 1 mg/kg body weight, IM and thiopental sodium @ 10–12 mg/kg body weight IV just to pass endotracheal tube followed by either isoflurane (2–2.5%) or sevoflurane (3–3.5%) and also subjected to whole blood transfusion either during the operation or just after the operation as per the details given in Table 1.

Volume of blood to be transfused was calculated on the basis of PCV: ml of blood (D) with anticoagulant

$$= \text{weight in kg (R)} \times 90 \times \frac{\text{PCV (desired)} - \text{PCV(R)}}{\text{PCV(D) with anticoagulant}}$$

where D, Donar; R, Recipient; PCV, Packed cell volume.

Collection of blood was done by gravity method in citrate phosphate dextrose adenine solution containing blood collecting bags under sterilized conditions and in the mean time the weight of blood withdrawn from the animal was measured by weighing machine. The animals found positive for the haemoprotozoan and bacterial diseases were not used as blood donor in this study.

The efficacy of blood transfusion was judged on the basis of extent of various above mentioned clinicophysiological and haematobiochemical parameters before and after the administration of blood at 6, 12, 48, 72, 96, 168 and 360 h time intervals. Electrocardiographic studies was also made before and after blood transfusion. Arcus Hematology Auto analyzer, NEXCT™ fully auto analyzer and flame photometer were used for estimation of haematobiochemical parameters.

For post-operative care, the antibiotic Amoxycillin +

Cloxacillin were given @10 mg/kg body weight IM bid for 5 days. Antihistaminic drug Pheniramine maleate (0.5–1.0 ml) and dexamethasone sodium phosphate (1–2 ml) were also given IM during and after blood transfusion. The patients were kept on digestible nutritive diet. Skin sutures were generally removed 8 to 10 days after completion of healing of operated region.

Statistical analysis: Data were analyzed using analysis of variance as per the standard procedure outlined by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Clinical examination revealed the signs of hypovolemic shock, i.e. tachycardia, impaired peripheral perfusion, increased capillary refill time, increased respiratory rate and effort. After transfusion of blood, in 50% of animals subjected to the transfusion of buffalo blood, the presence of hemoglobinuria within 4 h of the transfusion of blood was observed and thereafter the urine becomes normal by 12 h of the transfusion of the blood. Despite of hemoglobinuria, no casualty was observed. In one or two cases, the urticaria was observed in the patients subjected to the transfusion of the blood from the cattle and buffaloes. In one case subjected to the transfusion of blood from buffalo, tremors were observed. In some cases, a significant increase in body temperature was observed in the animals subjected to the transfusion of the buffalo blood. The temperature subsided within 24 h.

In ECG parameters, there was no significant difference in the QRS complex of all the traumatized patients as compared to normal healthy dogs. Suppressed T wave, slightly decreased Q-T interval and increased R-R interval were also found in traumatized animals as compared to the normal healthy animals.

The requirement of blood transfusion in traumatized dogs after splenectomy was in agreement of findings of Hanson *et al.* (2017), who reported that dogs undergoing liver lobectomy had a high requirement for transfusion.

There was a significant ($P < 0.05$) increase in the values of heart rate upto 6 h of heterogenous blood transfusion in the animals of groups A (Fig. 1). Thereafter it's level gradually reduced and reached near normal level by 48 to 72 h. No significant ($P > 0.05$) change in the levels of heart rate were observed in the animals of group C subjected to canine blood transfusion. These observations were in the agreement with the findings of Saleem *et al.* (2003). There was no significant ($P > 0.05$) difference in the values of

Table 1. Experimental design

Group	Subgroup	Anaesthesia	Blood transfusion
A (8 animals)	A1 (4 animals)	Atropine + diazepam + thiopental sodium + sevoflurane	Transfusion of whole blood of cattle
	AII (4 animals)	Atropine + diazepam + thiopental sodium + isoflurane	
B (8 animals)	BI (4 animals)	Atropine + diazepam + thiopental sodium + sevoflurane	Transfusion of whole blood of buffalo
	BII (4 animals)	Atropine + diazepam + thiopental sodium + isoflurane	
C (8 animals)	CI (4 animals)	Atropine + diazepam + thiopental sodium + sevoflurane	Transfusion of whole blood of dog
	CII (4 animals)	Atropine + diazepam + thiopental sodium + isoflurane	

respiration rate after trauma and transfusion of the blood in the animals of groups A, B and C at respective time intervals (Fig. 1). However, Saleem *et al.* (2003) reported a significant decrease in respiratory rate after blood transfusion in experimentally induced anaemic dogs. An increase in the rectal temperature upto 12 h after the administration of the blood in all the groups of the animals irrespective of the nature of the blood transfusion was observed in this study. It was in agreement with the findings of Godinho-Cunha *et al.* (2011) who reported a significant increase in body temperature of the animals that suffered from hypothermia before the transfusion. However, Saleem *et al.* (2003) reported non-significant changes in body temperature. There was no significant ($P>0.05$) difference in the values of respiratory minute volume after trauma and transfusion of the blood in the animals of all the groups A, B and C which was contradictory to the findings of Schonhofer *et al.* (1998) who reported a reduction in mean minute ventilation or mean minute respiratory volume. A significantly ($P<0.05$) lower level of tidal volume at 48 h to 360 h intervals in the animals of group A observed in this study may be due to increased respiration rate and this was contradictory to the findings of Rane *et al.* (2003) who reported decreased respiration rate and increased tidal volume after plasma transfusion in anaemic dogs. However no significant ($P>0.05$) difference in tidal volume was observed in the animals of groups B and C subjected to the transfusion of buffalo blood and canine blood respectively. The reduction in the capillary refill time after blood transfusion observed in this study might be due to increased plasma volume and circulatory flow. Gupta *et al.* (1999) reported similar observations.

A significant ($P<0.05$) increase in the level of haemoglobin, PCV and TEC observed in this study after transfusion of homogenous blood (Fig. 2) may be due to increased amount of blood and blood compatibility. The decreased level of haemoglobin, packed cell volume and total erythrocyte count initially in the animals of groups A and B could be due to haemolysis of blood cells as the cattle and buffalo blood is incompatible to dog blood. An increased level of haemoglobin, packed cell volume and total erythrocyte count observed after 7 days in the animals of group A and B subjected to the transfusion of cattle and buffalo blood respectively, might be due to increased erythropoietic activity. Delayed haemolysis is the most common haemolytic reaction observed in the dogs that have received multiple transfusion (Cotter 1998). The increase in haemoglobin, packed cell volume and total erythrocyte count observed in this study was in accordance with the study of Saini *et al.* (2005). A significant ($P<0.05$) increase in mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration level after homogenous blood transfusion was in accordance with the findings of Saini *et al.* (2005) and Gupta *et al.* (1999).

A significantly ($P<0.05$) increased level of total leucocyte count in the animals of groups A and C after blood

transfusion as compared to pre-transfusion value observed in this study was in agreement with the findings of McMichael *et al.* (2010) who reported that transfusion of packed Red blood cells (pRBC) is associated with a significant inflammatory response in normal dogs, indicated by the marked increase in total leucocyte counts. In present study, the platelets count decreased significantly ($P<0.05$) at 6 h interval in the animals of group B subjected to buffalo blood transfusion and group C subjected to canine blood transfusion. Thereafter it increased gradually and significantly ($P<0.05$) at 48 h upto 360 h interval of this study. In trauma patients who receive one and two blood volume replacement, dilutional thrombocytopaenia often occurs (Murray 1988).

A gradual and significant increase in plasma total protein level after transfusion of blood observed in this study (Fig. 2) confirms the findings of Gupta *et al.* (1999) and Rane *et al.* (2003). A gradual and significant ($P<0.05$) increase in plasma glucose level upto 48 h in all the groups of animals irrespective of the nature of blood transfusion observed in this study could be due to progressive improvement in erythrocytic profile and restoration of oxygen supply (Coles 1967). Similar observations had been reported by Pandey and Misra (1983) and Rane *et al.* (2003). There was no significant ($P>0.05$) difference in the level of the plasma urea nitrogen after the transfusion of blood in all the groups of animals irrespective of the nature of the blood transfusion, however the values of plasma urea nitrogen were comparatively lower after the transfusion of the blood in all the groups of animals. The decrease in the plasma urea nitrogen level after the administration of whole blood could be due to rehydration and diuretic effects of administered blood (Sodhi *et al.* 2003). The level of plasma creatinine was in normal physiological range of all the traumatized patients. A slight decrease in creatinine level observed in all the groups of animals upto 12 h after the transfusion of blood may be due to the reduction in the disintegration process in the tissue due to reduction in the release of histamine. It is also an indication that there was no derangement of kidney function in traumatized canine patients. Similar observation had also been reported by Singh *et al.* (1988) and Singh (2006).

There was no significant ($P>0.05$) change in the level of the plasma sodium after the transfusion of blood in all the groups of animals at different time intervals throughout the period of this study. However it's level was slightly higher in the animals of groups A and B at 168 and 360 h interval. This might be due to increased level of sodium in stored bovine blood (Ganesh and Kamalapur 1983, Patel and Dave 1985). Srivastava and Pandey (1992) and Pandey and Misra (1983) also reported a gradual increase in sodium level. An increase in plasma potassium level after the transfusion of blood in this study could be due to increased level of potassium in stored blood (Jameson *et al.* 1990). The level of the calcium remained unaffected throughout the period of this study in all the groups of animals before and after transfusion of blood could be due to normal level of calcium

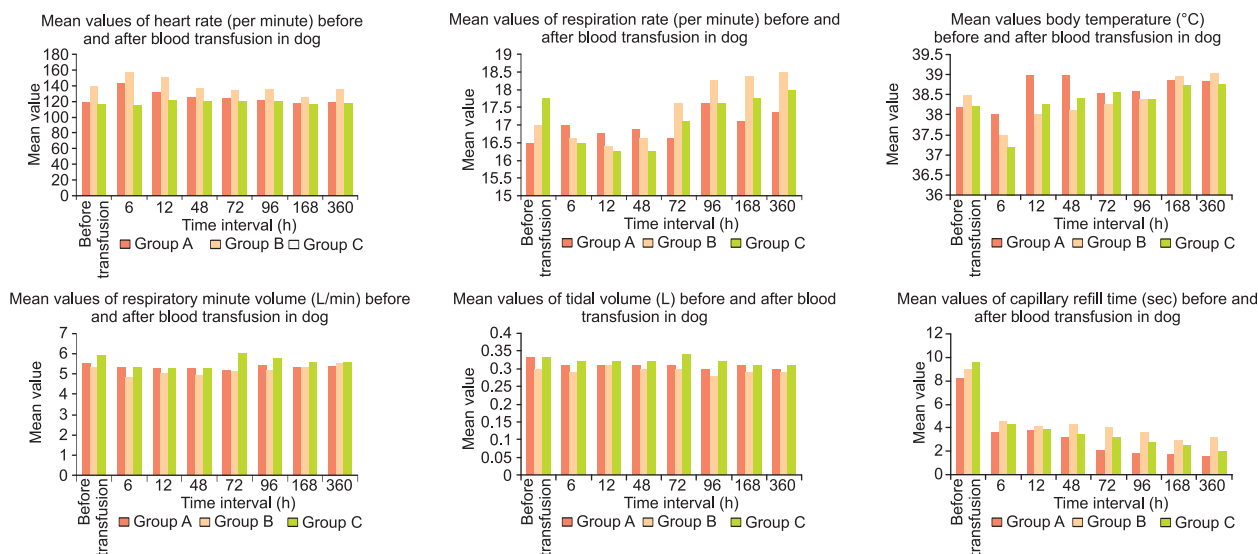
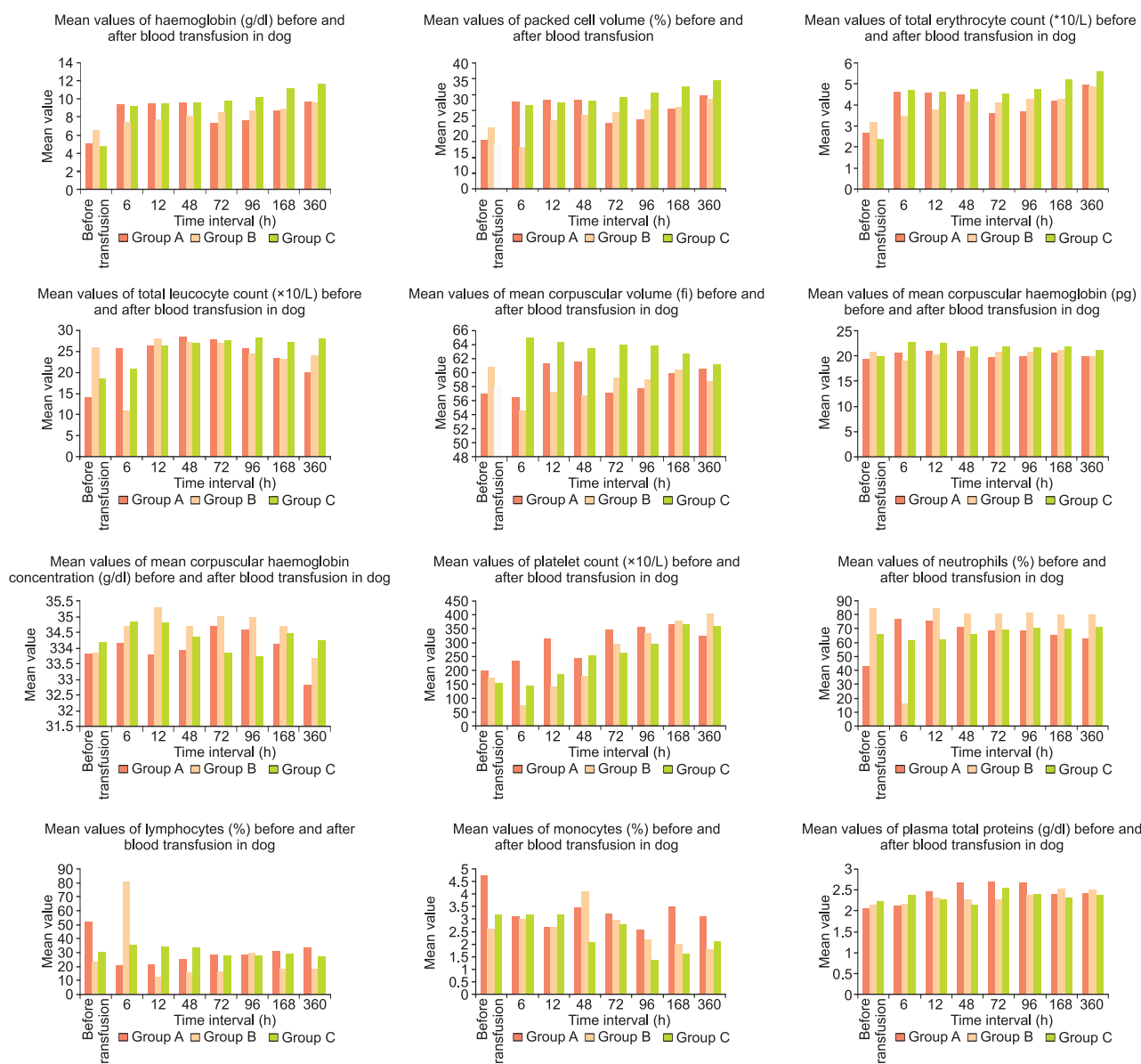


Fig. 1. Different physiological parameters before and after blood transfusion in different groups of dogs at different time intervals.



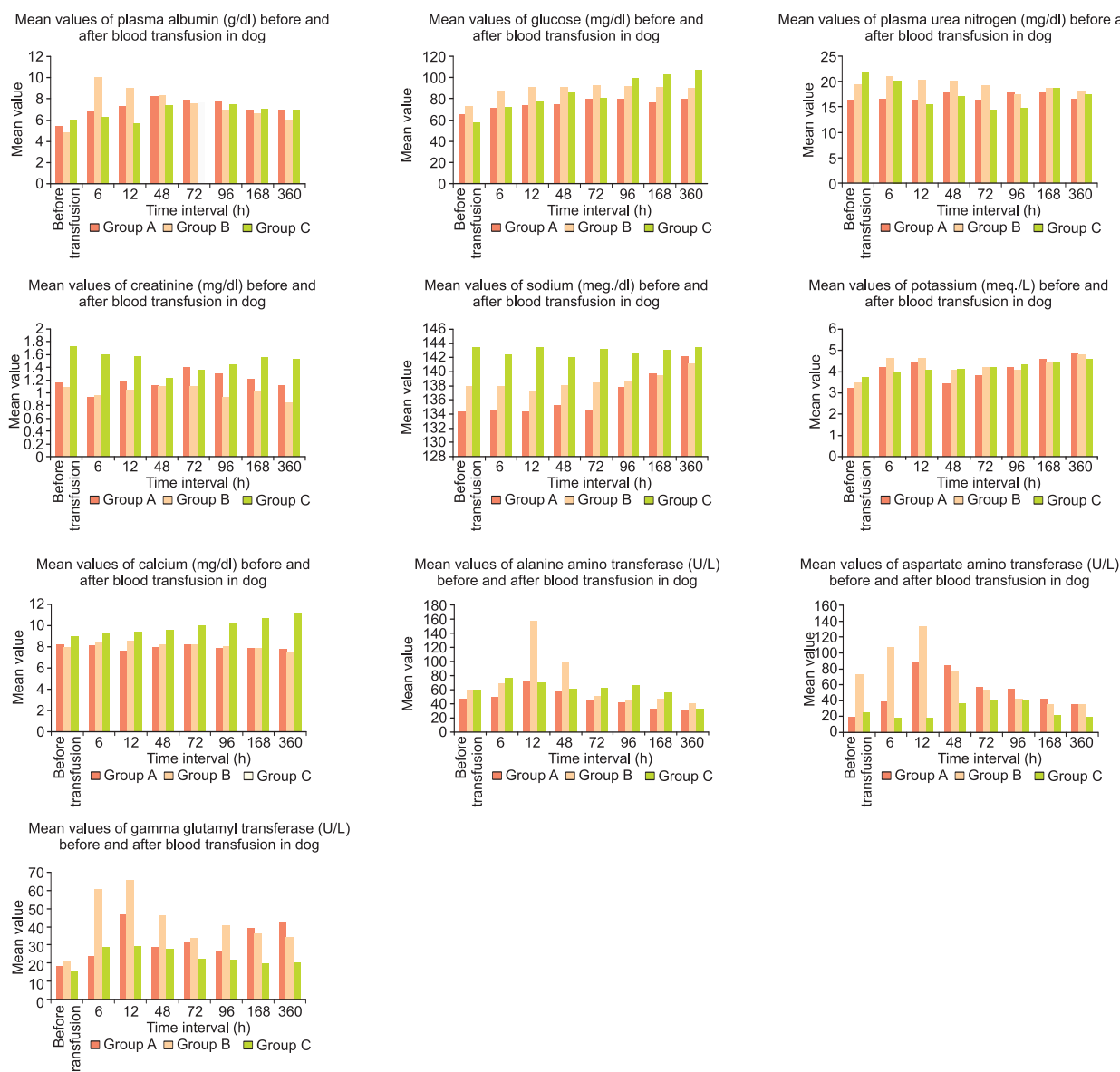


Fig. 2. Haematobiochemical parameters before and after blood transfusion in different group of dogs at different time intervals.

regulating hormones (Chew *et al.* 1992).

A gradual and significant ($P < 0.05$) increase in the plasma ALT level in the animals of group A subjected to cattle blood transfusion and group B subjected to buffalo blood transfusion upto 48 h after blood transfusion observed in this study could be due to incompatibility of blood. The decreased level of alanine amino transferase, aspartate amino transferase and gamma glutamyltransferase after 48 h of the transfusion of whole blood could be due to decrease in the inflammatory process and enhancement of the repair process of soft tissue and corroborates with findings of Singh (2006).

The adverse reactions including haemoglobinurea, urticaria and increase in body temperature after the transfusion of the blood in the animals of groups A and B subjected to administration of blood from cattle and buffalo respectively observed in this study may be due to anaphylactic (allergic or Type I hypersensitivity) reactions

that occur within one or two hour after the transfusion of blood. Similar observations had been reported by Harrell and Kristensen (1995). The presence of haemoglobinurea after 4 h of the transfusion of the blood in the animals of groups A and B observed in this study could be due to intravascular haemolysis (acute haemolytic reaction) which confirm the findings of Harrell *et al.* (1997). Despite of haemoglobinurea, no casualty was observed in this study which confirms the findings of Kerl and Hohenhaus (1993). The urticaria developed after the blood transfusion may also be caused by antibodies against soluble proteins in the blood administered (Lanevski and Wardrop 2001). No adverse reactions after blood transfusion were observed in the animals of group C subjected to the administration of blood from the dogs. This may be because of the low acute haemolytic reaction due to low prevalence of naturally occurring antierythrocytic antibodies in this species. Similar observation was reported by Hohenhaus (2000) and Harrell

and Kristensen(1995).

There was a significant increase in R-R interval or decrease in heart rate in all the groups of animals just after the transfusion of blood irrespective of the nature of blood which might be due to restoration of circulatory volume. Haideri and Jana (2001) observed bradycardia after infusion of blood in anaesthetized dogs. There was an increase in PQ and QT interval after the transfusion of blood in all the groups of animals and their level remained constant upto 24 h in all the groups of animals. Prolongation in QT interval is due to hypocalcemia which is resulted from massive transfusion of blood components containing citrate phosphate dextrose that can lead to transiently decreased level of ionized calcium. Similar observations had been reported by Denlinger *et al.* (1976). A decrease in P wave amplitude after the transfusion of blood observed in the present study might be due to hyperkalaemia (Beckwith 1982). Haideri and Jana (2001), had also reported this. An increase in T wave amplitude after the transfusion of blood to the 30 min in this study could be due to hyperkalemia as stored blood commonly elevates potassium concentration upto 30 to 40 meq/l by 3 weeks of storage and hyperkalemia is also possible with massive transfusion of blood (Jameson1990). Beckwith (1982) also reported that increased serum potassium at the level of 5.5 to 6 meq/l results in peaked T waves. An increase in R wave amplitude after the transfusion of blood in all the groups of animals observed in this study confirms the finding of Haideri and Jana (2001).

On the basis of the observations made in the present study, it was concluded that in case of the trauma of spleen, homogenous transfusion of the blood in traumatized patient is most beneficial; however, in case of the emergency condition, heterogenous blood transfusion from cattle and buffaloes may also be made to save the life of the patients. In heterogenous transfusion, blood from the cattle had comparatively less adverse effect as compared to the blood from buffalo in canine traumatized patients.

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