Clinical Control of Packed RBC Transfusion in Acute Surgical Pathology such as Gastric Dilation and Volvulus in Dogs

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ABSTRACTION

The main goal of the present work was the analysis of peripheral blood in case of surgical pathology in dogs with gastric dilation and volvulus as well as correction of post-operative state by RBC transfusion. Scientific supplies of domestic and foreign authors that influenced the use of blood transfusion and control of various types of correction in life-threatening conditions served as methodological basis of the scientific study. The studies used methods of clinical examination characterizing the pathogenetic aspects of the problem being studied. During the period of post-op observation of the animals anemia was detected on Day 1-7, thrombocytopenia on Day 1-3, as well as severe immunosuppression caused by the development of anesthesia and splenectomy, which was confirmed by lymphopenia and thrombocytopenia on Day 1-3. The study has shown that the use of packed red blood cells in the early post-op period reduces the severity of anemia, and the severity of the inflammatory process. Administration of donor red blood cells reduces immunosuppressive effect of splenectomy and effects of general anesthesia, triggers the production of platelets, reticulocytes, thereby stimulating cell proliferation to the reparative processes. The use of packed red blood cells in case of severe abdominal pathology in dogs in the post-op period is a promising direction for the development of hemotransfusion in the veterinary surgery.

Key words: Dogs, Gastric dilation and volvulus, Hemogram, Infusion therapy, Packed red blood cells, Correction, Post-op period.

INTRODUCTION

Surgical abdominal pathology associated with the gastric dilation and volvulus in dogs is a complex multidirectional difficult-to-treat patho logical process. Its analysis including death of dogs at various time points after the surgery (Nedobezhkova and Vatnikov, 2013; Bozhenova, 2013) showed that in case of gastric dilation and volvulus lasting for 4-6 hours 75% of cases were associated with serious complications, while in 25% of cases an animal deceased. If gastric dilation and volvulus lasts for 6-8 hours, in 100% we can see some kind of complications, and the death rate is 50%. These complications are an issue of the great interest in the veterinary practice (Fossum and Hetlund, 2002; Vatnikov, 2009; Hall et al., 2010; Pozyabin 2013; Nedobezhkova et al., 2013; Goleva and Vatnikov 2014; Mooney et al., 2014), because today there is not enough data on the activities guaranteeing clinical control of pathological processes in the post-op period in case of gastric dilation and volvulus.

Aim of the study

Analysis of peripheral blood in the surgical pathology caused by gastric dilation and volvulus

and correction of the post-op state by packed RBC transfusion.

MATERIALS AND METHODS

We used results of peripheral blood studies of large and giant dog breeds (n = 28) admitted for the treatment with a diagnosis of gastric dilation and volvulus in time intervals from 4 to 8 hours from the onset of the disease. Surgical operation in all animals was combined with splenectomy.

Dogs were divided into two groups: Group 1 (n = 12) of animals underwent a standard therapy: Locke-Ringer solution was administered parenterally in the dose of 50 - 90 ml per kg of body weight per day, Polyglucinum in the dose of 10 ml per kg body weight per day for high blood loss, Reopolyglucinum in the dose of 10 ml per kg body weight per day, 10% glucose solution in the dose of 10 ml per kg of body weight per day, 5% ascorbic acid solution in the dose of 2 ml per animal, b.i.d., Gamavit 4 ml per animal q.d., Cocarboxylase in the dose of 0.05 g per animal per day q.d., 10% Sulfocamphocaini solution 0.2 g per animal per day q.d., Zantac 50 mg per animal b.i.d.; per os: Almagelum A - 5 ml per animal t.i.d. for 5 days.

Animals of Group 2 received a standard therapy (described above) with the addition of packed red blood cells in the dose of 1.0 ml per 1 kg of body weight.

The study of the functional state of peripheral blood was performed on Days 1, 3, 7 and 14. The methodology of blood analysis and complete blood count were carried out using the method of Bazhibina E.B., Korobov A.V. et al. (2004). Statistical processing of the results was performed using MedCalc software for Windows.

RESULTS AND DISCUSSION

When assessing red blood cells parameters of the test samples in comparison with physiological parameters (FP), we have established the reduction in the number of red blood cells down by 27.4% ($5.3 \pm 0.3 \times 10^6/\mu l$), hemoglobin – by 43.21%, hematocrit - by 43.21%, as well as many changes in erythrocyte characteristics. At the time of initial admission, MCV index was decreased by 5.12% which is typical for posthemorrhagic anemia and possible hemolysis (Table 1).

At the same time MCH parameters, which characterize normochromic anemia, were within the physiological range. Mean corpuscular hemoglobin concentration (MCHC) at the time of admission was within physiological range and comparable with values of the control group. MCHC reflects the degree of RBC saturation with hemoglobin and characterizes the ratio of hemoglobin to the volume of the cell. It is a sensitive indicator of violation of the processes of hemoglobin formation. RDW parameter was increased 2.6 times at the time of admission of the animal. This characterizes dilation of the boundaries of RBC diversity in the bloodstream.

The number of red blood cells in the 1st day after the surgery tended to decline and decreased 2.21 times as compared with the physiological norm and 1.77 times as compared with the number of red blood cells at the time of admission of the animals to the clinic. Since Day 3, the dynamics of red blood cells begins to rise steadily by 13.16%; 27.27%; 75.76% on Days 3, 7 and 14, respectively. However, on Day 14 this value is less than the physiological norm by 20.5%. Hemoglobin and hematocrit on Days 1-3 remain to be at critically low levels. It evidences about severe anemia, which requires immediate replenishment of erythrocyte pool.

In studies on Days 7 and 14 we traced a tendency towards normalization of hemoglobin and hematocrit. These parameters rise 1.13, 1.37 and 0.8, 1.05 times, respectively, as compared to the background values   at the time of initial admission. However, in the test period these parameters did not reach the values   of the control group. Despite restoration of circulating blood volume, it is known that anemia in case of blood loss often increases, since a decrease in the number of red blood cells is caused not only by blood loss, but also by their increased consumption due to hyperaggregation and destruction (Takahashi et al., 1983; Kucera et al., 1984; Higgs et al., 2005; Goleva et al. 2014; Pasupuleti et al., 2014).

**Table 1: Changes in hemograms in dogs on the background
of using the standard postoperative therapy**

Blood parameters	Physiological index	Condition at the time of admission	Surgery in 4 - 8 hours after gastric dilation and volvulus			
			1 day	3 hours	7 hours	14 hours
RBC ˣ 10⁶/µl	7.3 ± 0.3	5.3 ± 0.3	3.3 ± 0.2	3.8 ± 0.2	4.2 ± 0.3	5.8 ± 0.3
HGB, g/dl	16.2 ± 0.6	9.2 ± 1.8	7.9 ± 1.3	8.5 ± 1.5	10.4 ± 1.5	12.6 ± 1.8
HCT, %	48.6 ± 2.2	27.6 ± 2.2	18.5 ± 1.6	19.9 ± 1.5	22.1 ± 2.3	28.9 ± 1.6
MCV, fl	66.4 ± 3.4	63.0 ± 3.3	67.6 ± 3.1	72.1 ± 2.4	69.4 ± 2.4	67.5 ± 2.6
MCH, pg	22.2 ± 1.7	17.3 ± 3.1	23.9 ± 2.1	22.4 ± 1.9	24.7 ± 2.1	22.7 ± 1.9
MCHC, g/dL	33.3 ± 2.2	33.3 ± 3.1	42.7 ± 2.0	42.7 ± 1.8	47.05 ± 1.9	43.5 ± 2.3
RDW, %	12.7 ± 0.3	22.8 ± 3.1	30.9 ± 2.3	18.7 ± 1.9	15.7 ± 1.5	13.5 ± 0.5
Reticulocytes, %	2.0 ± 0.03	4.3 ± 0.2	3.2 ± 1.5	1.5 ± 0.5	2.1 ± 1.0	3.5 ± 1.0
PLT, 10³/µl	210.6 ± 6.7	336.3 ± 8.2	139.6 ± 15.8	202.4 ± 18.2	223.6 ± 15.2	301.5 ± 15.5
WBC	7.2 ± 2.4	9.5 ± 1.2	11.1 ± 2.4	17.3 ± 7.6	15.6 ± 6.1	9.1 ± 2.2
Metamyelocytes	0	0	1.5 ± 0.5	0.5 ± 0.1	0.5 ± 0.1	0
Bands	5.6 ± 1.2	6.1 ± 1.2	7.7 ± 0.8	11.8 ± 3.5	10.6 ± 2.1	7.4 ± 1.5
Segs	67.5 ± 4.8	66.3 ± 5.6	67.9 ± 6.1	66.8 ± 5.1	66.4 ± 4.7	70.7 ± 6.8
Eosinophils	3.1 ± 1.9	0.3 ± 0.1	0.5 ± 0.1	1.2 ± 0.1	1.5 ± 0.5	2.5 ± 0.5
Basophils	1.0 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	1.0 ± 0.5	0.5 ± 0.1	0.5 ± 0.1
Lymphocytes	5 17.5 ± 2	19.2 ± 3.5	11.6 ± 2.7	10.2 ± 2.1	12.9 ± 1.5	13.1 ± 1.5
Monocytes	3.2 ± 1.5	7.8 ± 1.7	9.8 ± 1.5	8.9 ± 1.5	7.1 ± 1.1	5.7 ± 0.5

**Table 2: Changes in hemograms in dogs on the background
of using standard post-operative therapy and RBC transfusion**

Blood parameters	Physiological index	Condition at the time of admission	Surgery in 4-8 hours after the inversion (CE)			
			1 day	3 hours	7 hours	14 hours
RBC x 106/µl	7.3 ± 0.3	5.3 ± 0.3	3.6 ± 0.2	4.3 ± 0.2	5.9 ± 0.3	6.9 ± 0.3
HGB, g/dl	16.2 ± 0.6	9.2 ± 1.8	9.3 ± 1.5	9.9 ± 2.1	12.5 ± 2.4	13.3 ± 2.4
HCT, %	48.6 ± 2.2	27.6 ± 2.2	21.4 ± 2.1	24.4 ± 2.3	26.1 ± 2.3	31.3 ± 2.5
MCV, fl	66.4 ± 3.4	63.0 ± 3.3	54.4 ± 1.8	56.7 ± 2.1	58.1 ± 1.9	65.5 ± 2.6
MCH, pg	22.2 ± 1.7	17.3 ± 3.1	25.8 ± 2.1	23.0 ± 1.4	21.1 ± 2.4	19.2 ± 2.4
MCHC, g/dL	33.3 ± 2.2	33.3 ± 3.1	43.4 ± 2.0	40.5 ± 2.3	47.8 ± 2.1	42.5 ± 3.3
RDW, %	12.7 ± 0.3	22.8 ± 3.1	34.5 ± 3.4	21.8 ± 1.9	17.7 ± 2.1	17.6 ± 1.5
Reticulocytes, %	2.0 ± 0.03	4.3 ± 0.2	6.2 ± 1.5	5.5 ± 0.5	3.2 ± 1.6	3.1 ± 1.0
PLT, 103/µl	210.6 ± 6.7	336.3 ± 8.2	166.8 ± 18.7	198.7 ± 16.4	221.6 ± 17.2	329.9 ± 21.5
WBC	7.2 ± 2.4	9.5 ± 1.2	10.7 ± 1.9	16.8 ± 5.8	14.8 ± 4.1	9.3 ± 1.9
Metamyelocytes	0	0	0.9 ± 0.5	0.3 ± 0.1	0	0
Bands	5.6 ± 1.2	6.1 ± 1.2	8.4 ± 0.9	13.4 ± 3.8	11.9 ± 2.2	6.6 ± 1.5
Segs	67.5 ± 4.8	66.3 ± 5.6	67.7 ± 5.7	64.5 ± 5.4	64.8 ± 4.9	68.4 ± 5.5
Eosinophils	3.1 ± 1.9	0.3 ± 0.1	0.8 ± 0.1	1.2 ± 0.1	2.1 ± 0.5	3.5 ± 0.5
Basophils	1.0 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	1.0 ± 0.5	1.0 ± 0.5	0.5 ± 0.1
Lymphocytes	5 17.5 ± 2	19.2 ± 3.5	12.1 ± 2.4	11.6 ± 2.2	14.2 ± 2.1	15.6 ± 3.1
Monocytes	3.2 ± 1.5	7.8 ± 1.7	8.8 ± 1.7	6.8 ± 1.9	5.5 ± 1.4	4.1 ± 0.6

The analysis of clinical data shows changes in some RBC characteristics: MCV, MCH, MCHC, RDW in the animals of Group 1. This confirms conclusions on the occurrence of increasing heterogeneity of red blood cells in the early post-op period, significant B_{12} and iron-deficiency anemia. The reason is the presence of iron reserves in the spleen that is necessary for formation of red blood cells. Dysfunction of peristalsis and intestinal microflora is followed by violation of vitamin B_{12} production. Herein an increased value of MCHC in the post-op period should be interpreted not by errors of the measuring equipment, but rather by the influence of factors affecting the understatement of hematocrit or overstatement of hemoglobin levels (massive i.v. infusion of crystalloid solutions, intravascular hemolysis, etc.).

The dynamics of changes in the number of reticulocytes in the animals of Group 1 is not statistically significant. At the same time, signs of the severe anemia observed in these animals should cause reticulocytosis. However, the absence of reticulocytosis during the surgery in this case can be explained by inhibition of hematopoiesis in animals after splenectomy (Pozyabin 2013; Goleva, 2015).

At time of admission to the hospital not all hemogram values in dogs with gastric dilation and volvulus had significant differences compared to the physiological norm. Nevertheless, it is noticeable that there is an increase in the total WBC number by 31.9%; platelets by 59.7%; band neutrophils by 8.9%; lymphocytes by 9.7%; monocytes - 2.4 times; eosinophil reduction - 10.3 times. Such a change in the composition of WBC cells can be explained by the redistribution of blood volume associated with gastric dilation and volvulus and strengthening mechanisms for inducing phagocytic activity of macrophages. On Day 1 after the surgery changes in the total cellular composition and hemogram were more considerable. A total WBC number increased by 16.8% compared with the amount at the time of admission and by 54.2% compared to the physiological norm. The number of band neutrophils increased by 37.5% compared with the physiological norm. At this time in hemogram there were solitary band neutrophils

without a significant shift of hemogram to the left side with a decrease in the number of lymphocytes by 33.7%. This indicates immunosuppressive condition of the body. Possibly, it is caused by splenectomy and the impact of anesthesia - degenerative neutrophil shift. At the same time, we can link these changes with an increase in toxic effects due to the appearance of the dead tissues, accumulation of proteolytic enzymes, exo- and endotoxins. This information is supported by a number of studies (Walshaw and Jonston, 1986; Fernandes et al., 2001; Fossum and Hetlund, 2002 ; Pulnyashenko, 2004; Brockman and Drobajau, 2005; Vatnikov, 2009).

A significant reduction in the number of platelets by 33.7% as compared to physiological norm is an issue of particular attention. The number of platelets in the first day after the surgery was close to critical. On the one hand, it is caused by splenectomy, and on the other hand - by an increased platelet consumption due to massive surgery. We also observed monocytosis that was 3.1 times greater in comparison with the physiological norm. On the third day after the surgery we noted the continuing growth of the total number of WBC by 82.1% as compared to the normal one. It is also typical for acute inflammation in combination with WBC shift to the left**.** On Days 7-14 we noted a gradual normalization of the blood count and the total number of white blood cells and platelets. On Day 14 the content of WBC and platelets did not have any significant differences as compared to the physiological range. However, we noted an increase in the number of band neutrophils by 32.1%, monocytes by 78.1%; a decrease in the number of lymphocytes by 25.1%, and eosinophils - by 19.3%. It can be explained by a long postoperative recovery period after gastric dilation and volvulus.

Analysis of the characteristics of Group 2 (dogs with RBC transfusion) showed that the number of red blood cells in the animals of Group 2 continued to decline on Day 1 after the surgery, as it was in the animals of Group 1. Finally, it fell 1.47 times (3.6 ± 0.2 x10^6/ml). Compared to the animals of Group 1, it had a less significant decrease by 9.1% (Table 2). At the same time, the decrease in the number of red cells may be associated with

hyperplasia of the red pulp and increased consumption of erythrocytes. During this period, the spleen had signs of diffuse blood filling and contains areas of hemorrhagic impregnation (Bozhenova, 2013).

As can be seen from Table 2, starting from Day 3 the number of red blood cells steadily begins to increase by 19.44% and 63.89% on Days 3 and 7. On Day 14 the number of red blood cells exceeded 1.3 times that at the time of initial admission. However, it did not reach the values of the physiological norm. In animals of the 2nd test group hemoglobin and hematocrit levels had a clear tendency to normalize. An increased hemoglobin level compared with the initial values at the admission amounted to 1.09%; 7.61%; 35.87% and 1.43 times, respectively, on Day 1, 3, 7 and 14. Hematocrit levels also were increased: 0.77%; 0.88%; 0.94%; 13.4%, respectively. On Day 3 both parameters reached the values recorded the at time of admission and on Day 14 after the surgery hemoglobin level was within the physiological norm. The lower growth rate of hematocrit level can be explained by the presence of a large volume of crystalloid solutions in the blood stream received by animals during the recovery period.

Dynamics of changes in the characteristics of erythrocyte indices (MCV, MCH, MCHC, RDW) in the animals of Group 2 in the postoperative period in comparison with these values in the animals of Group 1 indicates a more rapid replenishment of circulating blood volume, restoring the function and morphology of red blood cells. Animals from Group 2 on Days 1, 3 and 7 of observation revealed a mild reticulocytosis 2.15; 3.1; and 2.75 times, respectively. This characterizes an adequate response of the bone marrow to severe anemia caused by pathological process. In the post-op period a mixed anisocytosis develops with a significant reduction in normocytes and discocytes in the group of animals with the time from gastric dilation and volvulus no more than 4 - 6 hours. The number of red blood cells with Howell-Jolly inclusions also increases after splenectomy (Bozhenova, 2013).

Analysis of quantitative composition of white blood cells, platelets and cellular composition of white blood cells of dogs of the 2nd test group with gastric dilation and volvulus in postoperative period receiving conventional infusion therapy and transfusion of packed red cells showed the following changes: less significant increase in the total number of white blood cells, as compared to this parameter in the dogs of Group 1. Dynamics of postoperative changes by days does not have significant differences in the dogs of Groups 1 and 2. In comparison with Group 1, young forms of neutrophils were detected in hemogram only on Days 1 and 3. The number of these cells was by 40% less than in the dogs of Group 1. On Days 7-14 there were no young forms of neutrophils in the hemogram. The number of band neutrophils on Day 1 of observations increased in comparison with the data at the time of admission by 37.7%; on Day 3 – 2.2 times. The further observations revealed a gradual decline of this parameter, and on Day 14 the number of stab neutrophils decreased to the background levels at the time of admission. However, it was higher than the physiological norm by 17.8%. Such dynamics in dogs that received transfusion of packed red cells in the post-op period indicates a more adequate response of the bone marrow to the blood loss.

In the dogs of Group 2 on Day 1 of post-operative period eosinopenia was less pronounced than in the dogs of Group 1; on the 3rd day eosinophil number increased 2.4 times in comparison with their number at the time of admission; on Day 7 eosinophil number increased by 25%; on Day 14 it reached the physiological norm; in the dogs of Group 2 as well as in dogs of Group 1 the quantitative index of lymphocytes decreased, although lymphopenia was less pronounced. The 1st day of post-op observation revealed no critical thrombocytopenia, on Days 3 and 7 a platelet count increased by 44.9% and 60.2%, respectively, relative to the lowest level observed on Day 1. Decrease in the percentage of lymphocytes by the study day was 36.9%; 39.6%; 26.0% and 18.7%, respectively, when compared with the indicator at the time of admission to the clinic.

The dogs of Group 2 revealed less pronounced monocytosis in the post-op period. A similar trend can be explained by an increased immune response (due to changes in infusion

therapy), improved microcirculation in tissues, decreased ischemic processes in tissues, increased lifetime of the own red blood cells, as well as circulation in the peripheral blood stream of the donor cells.

CONCLUSION

Thus, the studies have shown that during the post-op surveillance of animals anemia was detected on Day 1-7, and thrombocytopenia on Day 1-3. Severe immune suppression caused by anesthesia and splenectomy was confirmed by lymphopenia and thrombocytopenia on Day 1-3. Transfusion of packed red blood cells in the early post-op period reduces the severity of anemia (RBC count, hemoglobin concentration and hematocrit), and severeness of the inflammatory process (number of stab and band neutrophils). Transfusion of packed red blood cells reduces the severity of immunosuppressive action caused by splenectomy as well as effects of anesthesia, causing the production of platelets, reticulocytes, and thus improving reparative processes in the post-op period. Transfusion of packed red cells in case of severe abdominal pathology in dogs, study of the methods of clinical and laboratory control in the post-op period are the promising directions for the development of hemotransfusiology in veterinary surgery and can serve as a basis for the further development of this problem.

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