Plasmapheresis for Comprehensive Treatment of Surgical Sepsis in Dogs

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***Abstract*—The paper dwells upon treatment of surgical sepsis in dogs by extracorporeal detoxification. Data were sampled from 32 dogs of various breeds, aged 4 to 12, weighing 20 to 68 kilogram, treated against surgical sepsis at the Panacea Veterinary Hospital, Chelyabinsk; the dogs were divided into the experimental group (17 dogs) and control group (15 dogs). In control dogs, the infection site was treated surgically by abdominal drainage in peritonitis, ovariohysterectomy in pyometra, etc., supported by infusion antibiotic therapy, vasopressor support, and treatment of comorbidities. Comprehensive treatment of the experimental group included 2 to 4 sessions of plasmapheresis with exfusion of 20% of the circulating plasma volume (CPV) and its replacement with Ringer and Refortan 6% solutions, 2 to 1, using Rosa-type plasma filters and a KMBP-01 machineless plasmapheresis complex. To that end, the experimenters studied such clinical readings as appetite, body temperature, heart rate (HR), respiratory rate (RR), capillary refill time (CRT), and skin turgor, as well as blood morphology and biochemistry. Plasmapheresis did not use perfusion pumps to minimize its effects on total hemodynamics.**

The study identified that combining a commonly accepted sepsis treatment method with 2 to 4 plasmapheresis sessions did reduce the mortality rates in the experimental group and boosted the animals' recovery while also rapidly restoring the normal morphology and biochemistry of their blood. The team noted a significant increase in the total protein content, lower bilirubin, creatinine, and urea in the serum, which indicated recovered hepatic and renal functionality as a result of the comprehensive membrane plasmapheresis-enabled treatment of surgical sepsis in dogs.

Keywords—dogs, sepsis, peritonitis, membrane plasmapheresis, total protein, bilirubin, creatinine

I. INTRODUCTION

Despite the advancements in veterinary medicine and surgery, sepsis in surgically pathologic patients remains the most important, yet least studied problem [1-8]. Lack of a single classification of sepsis, the insufficient understanding of septic pathogenesis, and underestimation of the role endogenous intoxication has to play in septic shock and multiorgan failure on top of the lack of a single antibacterial therapy tactic are the problems both human medicine and veterinary medicine have yet to solve. In surgical sepsis, like in any other sepsis, timely and comprehensive surgical treatment of the primary site, adequate antibacterial treatment, efficient functional correction and sustenance of the affected organs and systems are imperative. Sepsis treatment is a long-term, expensive, and not necessarily successful undertaking, so finding faster, less expensive, and lower-mortality sepsis treatment methods is relevant for veterinary medicine today. Extracorporeal detoxification and hemocorrection are two methods veterinarians have recently borrowed from human medicine [1,9-13]. However, pre-treatment and treatment with various extracorporeal hemocorrection methods, as well as use of membrane plasmapheresis for comprehensive treatment of abdominal sepsis in dogs, are vastly understudied issues [10,12,13].

II. EXPERIMENTAL

The research involved 32 dogs of various breeds, aged 4 to 12, weighing 20 to 68 kg, treated against surgical sepsis at the Panacea Veterinary Hospital, Chelyabinsk; the dogs were divided into the experimental group (17 dogs) and control group (15 dogs).

The patients were grouped into the experimental (n=17) and control (n=15) groups by the principle of approximate analogies. In control dogs, the infection site was treated surgically by abdominal drainage in peritonitis, ovariohysterectomy in pyometra, etc., supported by infusion antibiotic therapy (60 mg/kg of ceftriaxone IV once daily plus 5 mg/kg of metronidazole IV every 8 hours), vasopressor support, and treatment of comorbidities. The experimental group received similar treatment with 2 to 4 plasmapheresis sessions: exfusion of 20% of CPV for replacement with Ringer and Refortan 6% solutions in a 2-to-1 ratio.

Plasmapheresis was done by Rosa plasma filters and a KMBP-01 machineless plasmapheresis complex. Venous approach was provided by puncturing the forelimb vein. Before plasmapheresis, dogs had undergone adequate

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hemodilution and heparinization. The extracorporeal circuit was assembled and prepared following the manufacturer's manual. The plasmapheresis procedure included:

1. Preparing the patient (hemodilution, heparinization, venous approach).

2. Preparing the extracorporeal circuit (assembly and heparinization).

3. Blood collection.

4. Plasmapheresis per se: blood separation, with corpuscles being returned through the "sampling vein" and plasma being redirected to a separate tank. A maximum of 20% of CPV was extracted per session.

5. Restoring the circulating blood volume (CBV) by injecting colloid and crystalloid solutions. During the experiment, control and experimental dogs were tested to assess the general conditions, the duration and degree of peritonitis and abdominal sepsis, the body temperature, heart rate and its patterns, respiratory rate, capillary refill time, skin turgor, survival rates, and the mean life of deceased animals [14].

Blood for morphology and biochemistry tests was sampled from the cephalic vein of the forearm and from the ear in the morning before feeding; blood was collected into heparin-coated tubes (20 to 25 units per ml of blood) as well as non-coated tubes to make serum. Serum was produced by normal blood clotting.

Whole blood was used to count red and white blood cells in a Goryayev chamber; hemoglobin counts were obtained by the hemoglobin-cyanide method; the erythrocyte sedimentation rate (ESR) was counted by Panchenkov's micromethod; leukograms were obtained on smears stained with azur-eosin by Romanovsky-Giemsa's method on 200-cell samples [15].

The following readings were obtained from the serum:

- total protein content by refractometry using an RL-2 refractometer;
- AST/ALT by Reitman-Frankel;
- total bilirubin concentration by Jendrassik-Gróf;
- creatinine concentration by Jaffe;
- urea by reaction with diacetyl monoxime.

The resulting digital data was processed by variance statistics on a PC running Microsoft Excel.

III. Results and discussion

Statistical testing of the obtained results showed the dogs in the control group had a mortality rate of 26.6% (4 dogs died within 2 to 3 days since the onset of treatment); the rest showed considerable improvement by Day 5 or 6, recovered fully by Day 14-20. Such a high abdominal sepsis-associated mortality rate was due to multiple pathological changes induced by psychoemotional stress, pain response, disrupted microcirculation, injection of various toxins into bloodstream en masse, including the products of damaged tissue decay; other reasons included septic complications, first indicated by endogenous intoxication signs (EI). EI, like any other toxicosis, is a cascading, staged, progression-capable generalized process caused by the accumulation of toxins in the bloodstream at such concentrations the body's natural neutralization systems cannot process, which results in damaging other organs and systems. Such damage effectively alters the structural and functional status of cellular and subcellular membranes, causing a second intoxication wave and closing the vicious circle of this critical condition. The severity of endogenous intoxication is an indirect metric of the general condition of patients with various pathologies.

The experimental group had a mortality rate of 11.7%, with two dogs dying on Days 2 and 5; other patients showed considerable improvement by Day 2 or 3, recovered fully by Day 10-14.

To assess the animals' general condition, the team ran blood tests for both groups.

Before any treatment was prescribed, most animals' peripheral blood tests indicated reduced hemoglobin (down to 98.7±2.78 g/l), red blood cell counts (down to $5.1\pm0.07\cdot10^{12}$/l), hematocrit (down to 98.7±2.78 g/l), pronounced leukocytosis (up to $36.8\pm0.78\cdot10^{9}$/l), increased percentage of band neutrophils (up to 14.2±0.30%), and a considerably increased percentage of monocytic cells, indicating intense lymphopoiesis and less active cellular immunity; such results are consistent with those obtained by several other researchers [1, 16-18]. Neutrophil leukocytosis is a characteristic feature that reflects the general biological patterns on injuries [9, 12, 13].

The table I summarizes the biochemical readings of the control and experimental groups.

Analysis of animal biochemistry in surgical sepsis, believed to be indicated by reduced or zero appetite, general depression, fever, emesis, an infection site, toxic leukocytosis, and disrupted hemodynamics, indicated that experimental animals and controls did not differ significantly in total protein, aminotransferase, bilirubin, creatinine, and urea, the levels of which indicated a natural body response to intoxication. The authors hereof agree with a popular opinion [14, 17, 18, 21] that such dynamics of biochemical

TABLE I. BIOCHEMICAL INDICATORS OF SERUM IN EXPERIMENTAL AND CONTROL GROUPS (M±M)

Indicator	Experimental group (n-17)		Control group (n-15)	
	Day of treatment			
	Day 1	*Day 14*	*Day 1*	*Day 14*
Total protein (g/l)	56.4±3.02	67.2±4.12*	59.0±4.02	62.4±2.02
ALT (µmol/h.l)	83.2±5.32	18.4±1.12*	78.9±3.24	31.7±2.02
AST (µmol/h.l)	98.8±4.32	27.9±1.26*	107.3±4.26	52.1±2.44
Total bilirubin (µmol/l)	59.2±1.16	4.9±0.08*	52.1±2.32	14.2±0.42
Creatinine (µmol/l)	217.9±4.12*	99.2±2.04*	198.7±3.26	110.3±3.82*
Urea (mmol/l)	14.2±0.92	7.8±0.68*	16.9±1.04	8.2±0.56*

**-P≤0.05 against the controls.*

readings is characteristic of sepsis and severe sepsis.

Notably, the identified metabolic changes induced by abdominal sepsis in dogs depend not only on the functional status of the liver but also on other parenchymatous organs and regulatory systems [6, 11, 16, 22-24].

Membrane plasmapheresis replaced 20% of the circulating plasma volume (CPV) with Ringer and Refortan 6% solutions at a 2-to-1 ratio, which arrested the inflammatory process in most animals, reduced endotoxicosis, improved the general condition, induced appetite, and arrested the DIC syndrome.

Note that aside from the recovered total protein levels, experimental animals showed a significant reduction in protein metabolites on Day 14; thus, urea levels dropped to 7.8±0.68 mmol/l, total bilirubin dropped to 4.9±0.08 μmol/l, and creatinine dropped to 99.2±2.04 μmol/l, which was considerably lower than in the controls. This leads to a suggestion that circulatory renal failure and cardiac failure accompanied by tissue dehydration and reduced hepatic protein production were less expressed in experimental animals than in controls.

Combining the commonly accepted methodology with 2 to 4 sessions of plasmapheresis reduced the mortality rates and sped up the recovery of experimental patients compared to the controls. Plasmapheresis did not induce any severe change in condition, nor was associated with any technical problems such as great vessel thrombosis, etc.; plasmapheresis did not use perfusion pumps to minimize its effects on general hemodynamics. By Day 14, the team noted a significant increase in the total protein content, lower bilirubin, creatinine, and urea in the serum, which indicated recovered hepatic and renal functionality as a result of the comprehensive membrane plasmapheresis-enabled treatment of surgical sepsis in dogs; this was consistent with the clinical course of the disease.

IV. Conclusion

Completing the comprehensive treatment of surgical sepsis in dogs with membrane plasmapheresis reduces mortality rates and speeds up recovery. Persistent normalization of previously disrupted homeostasis in abdominal sepsis-affected dogs proves the treatment method efficient, as it enables animals to attain and maintain such resistance levels that are necessary for a favorable postoperative period. The period is associated with a progressive normalization of general clinical symptoms.

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