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CASE REPORT

Apheresis in three dogs weighing <14 kg

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Abstract

History CaridianBCT apheresis machines require a ~285 mL priming volume (extracorporeal blood) that is withdrawn from the patient in ~10 minutes. Therefore, apheresis in dogs has generally been limited to dogs > ~20 kg to assure <20% of the blood volume is removed in the priming phase.

Animals/physical examination Three dogs weighing <14 kg (13.6, 10.5, and 9.9 kg) with lymphoma that underwent apheresis.

Management The dogs were premedicated for placement of apheresis catheters with hydromorphone (0.1 mg kg^{-1}) IM. Anesthesia was induced with propofol, to effect, intravenously and general anesthesia was maintained with isoflurane in oxygen. Following catheter placement, dogs were allowed to recover from isoflurane but were kept sedated with either a dexmedetomidine constant rate infusion (CRI) or a propofol CRI. Real time autologous blood priming was not performed in any of the dogs. Instead, priming solutions were composed of a combination of hetastarch, lactated Ringer's solution, and/or autologous blood that was harvested 4 days before the procedure. During apheresis, dogs received anticoagulant citrate-dextrose, solution-A (ACD-A) to prevent clotting and 10% calcium gluconate as needed to maintain normal ionized calcium concentrations. Dogs were monitored for cardiovascular and cardiopulmonary stability, anemia and lactic acidosis.

Follow-up All of the dogs had cardiovascular and cardiopulmonary values within clinically acceptable ranges. Immediately following apheresis all of the dogs were mildly to moderately anemic (PCV; 17–35%) although none of the dogs required a transfusion or had an increased lactate concentration.

Conclusions Dogs as small as 9.9 kg can successfully undergo apheresis with a variety of priming solutions. Dexmedetomidine or propofol given as a CRI provides sufficient sedation for this procedure.

Keywords apheresis, dog, fluid therapy, chemical restraint.

Introduction

In human medicine, peripheral blood progenitor cells (PBPC) harvested using sophisticated apheresis machines have replaced bone marrow as the primary source of hematopoietic cell transplantation (HCT) in the treatment of a wide variety of hematological, oncological, and autoimmune disorders. These machines can be used to treat adults and children, although apheresis of young and small patients presents many technical challenges that include metabolic and hemodynamic fragility, citrate toxicity, volume shifts due to relatively large extracorporeal volumes, hypothermia, the need for adequate vascular access, and the patient's tolerance and cooperation throughout the procedure. In people, most apheresis donation centers routinely require patients to weigh >50 kg (Crocco et al. 2009).

When using the recommended white blood cell tubing kit for peripheral blood mononuclear cell apheresis, the extracorporeal volume of the CaridianBCT machine is ~285 mL. Therefore, a variety of priming protocols are recommended by the

manufacturer for pediatric and adolescent patients where the extracorporeal volume of the machine is >10–15% of the patient's total blood volume (TBV). Strategies developed include priming the machine with saline, 20% human albumin solution, irradiated, leukocyte-depleted packed red blood cells, or whole blood.

Dogs have been a valuable preclinical model for human HCT, therefore, aphereses have been reported in dogs since 1967 (Storb et al. 1967; Buckner et al. 1968; Lupu et al. 2008). One of the major challenges for apheresis in veterinary patients is the small size of many dog breeds, since ~285 mL of blood is removed from the patient to prime the machine within the first 10 minutes of the procedure. Due to limitations in banking blood for priming of the apheresis machine, canine candidates for HCT generally have been limited to patients > ~20 kg to assure that the priming volume does not approach ~20% of the patient's total blood volume, assuming canine total blood volume is ~90 mL kg^{-1} (Finsterer et al. 1973). However, since many canine breeds weigh <20 kg, apheresis protocols to manage the rapid loss of a significant blood volume and oxygen carrying capacity are essential. Although apheresis of small dogs <10 kg using a CaridianBCT cell separator has previously been reported in research animals (Lupu et al. 2008) there was no mention of the priming strategies involved, nor were cardiovascular, electrolyte, or anesthetic parameters documented. The objective of this manuscript is to document the hematologic and physiologic consequences of peripheral blood mononuclear cell (PBMC) apheresis using a CaridianBCT apheresis machine in three dogs weighing <14 kg in preparation for an autologous HCT.

Case histories

Dog 1

The first dog was an 8 year old, 13.6 kg (~1,224 mL TBV), MC Beagle who presented for HCT for treatment of T-cell lymphoma. At the time of the admission the dog had received standard multi-agent chemotherapy and was in clinical remission with no comorbidities. The dog met the criteria for HCT (no significant cardiac abnormalities seen on echocardiogram, blood and bone marrow PARR [PCR for antigen receptor rearrangements (Burnett et al. 2003)] negative) and was scheduled for PBMC apheresis followed by total body radiation (TBI) and HCT. Standard machine priming with this patient would have removed ~23% of TBV.

Dog 2

The second dog, a 7 year old, 10.5 kg (<945 mL TBV) MC Shih Tzu, presented for HCT for treatment of B-cell lymphoma. This dog had received standard multi-agent chemotherapy and achieved a clinical remission. However, upon presentation, the dog had multiple mildly enlarged peripheral lymph nodes and fine needle aspirates from one of these nodes was consistent with residual lymphoma. Endocardiosis was diagnosed by echocardiography and as the dog was clinically obese with a body condition score of 9/9. The dog's bone marrow and blood were PARR negative and the endocardiosis was not severe enough to exclude him from HCT, therefore he was scheduled for PBMC apheresis followed by TBI and HCT. Standard machine priming with this patient would have removed >30% of TBV.

Dog 3

The third dog, an 8 year old, 9.9 kg (891 mL TBV) MC Jack Russell Terrier, presented for HCT for treatment of T-cell lymphoma (Dog 3). This dog also had received standard multi-agent chemotherapy and was in clinical remission, however he was mildly anemic (PCV_{CBC} = 26%). The dog met the criteria for HCT and was scheduled for PBMC apheresis followed by TBI and HCT. Standard machine priming with this patient would have removed ~32% of TBV.

Anesthesia and chemical restraint

Anesthesia

All of the dogs were fasted and water deprived for at least 9 hours. Premedication consisted of 0.1 mg kg^{-1} hydromorphone IM (hydromorphone HCL; Baxter Healthcare Corporation, IL, USA) and general anesthesia was induced with propofol (MA Holder; Fresnius Kabi Ltd, UK) administered to effect (~3–4 mg kg^{-1} IV). The dogs were intubated under direct visualization with a cuffed Murphy endotracheal tube (Medline; One Medline Place, IL, USA) which was secured in place with gauze (6 mm OD in the smallest dog and 7 mm OD in the larger 2 dogs). The endotracheal cuff was inflated to prevent air leaks at peak inspiratory pressure of 20 cmH_2O. The endotracheal tube was attached to a small animal