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Effects of lactated Ringer`s and 5% dextrose infusion on haematology in midazolam sedated West African Dwarf goats

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Abstract

This study compared the acute haematological responses of midazolam-sedated West African Dwarf (WAD) bucks to intravenous (IV) administration of lactated Ringer`s and 5% dextrose solution. Changes in white blood cells (WBC $\times 10^{-3}$ /µl), red blood cells (RBC $\times 10^{-6}$ /µl), haemoglobin (Hb g/dl), packed cell volume (PCV %), Platelet (/µl), total protein (TP g/100ml) and albumin (g/100ml) were recorded. Infusion (IV) of lactated Ringer's solution exerted a significant difference ($p<0.05$) on the mean value of the WBC at 90 mins intervals while 5% dextrose solution exerted a significant ($p<0.05$) effect at 60 mins and 90 mins, though all parameters were within the normal recommended range. Changes in RBC for both infusions were not significant ($p>0.05$). The concentrations of Hb obtained for both fluids were significantly lower than previously reported values. The effect of the lactated Ringer solution on PCV value recorded was significant ($p<0.05$) at 60 mins and above and that of 5% dextrose had no significant ($p>0.05$) effect until 90 mins. Lactated Ringer infusion increased the platelet value at 60 mins up to 90 mins but 5% dextrose solution continuously increased platelet value at different time intervals. Other haematological parameters measured were not significantly different ($p<0.05$). This study concluded that the administration of lactated Ringer solution and 5% dextrose saline to WAD bucks exerted some effects on the haematological parameters at different time intervals. This may be of clinical concern in patients with health problems. Haematological parameters must be checked before fluid therapy in goats.

Keywords: Fluid therapy, Haematology, Intravenous fluids, Sedation, WAD goats

Introduction

The earliest domesticated ruminant after the wolf is goat (Zeder & Hasse, 2000). They constitute the largest group of small ruminant livestock in Nigeria, with up to 85% of rural dwellers, poor farmers and small-scale business owners keeping them (FAOSTAT, 2011; Chiejina *et al*., 2015). Their dominance in the rural region is because of their ability to graze and utilize poor quality forage, walk long distances, short generation intervals, high fertility rate and have low risk on investments (Lebbie, 2004). West Africa Dwarf (WAD) is the commonest breed of goat in Nigeria, making up about 45% of the total goat population (Okpeku *et al*., 2011). This breed of goat makes for a strong economic backbone, especially in the rural communities where they are mostly reared. It has been reported that small ruminants generally including sheep and goats are capable of having a lasting effect in improving the standard of living of the populace (Ajala *et al*., 2008; Abu *et al*., 2013). Despite being tolerant to most diseases, they are commonly affected by some morbidities such as coccidiosis, helminthiasis, diarrhoea, gastroenteritis and ruminal

pathologies, which are accompanied by dehydration, electrolyte or water loss, and acid-base imbalances (Fubini & Ducharme, 2004). These imbalances can be fatal in critically ill ruminants unless appropriate medical interventions including fluid therapy are instituted promptly to provide immediate and short-term metabolic needs (Constable, 2003). In addition, goats are presented in veterinary facilities for surgical procedures which necessitate sedation or anaesthesia for easy handling and restraint along with administration of fluid. Oftentimes, fluid therapy is required especially in patients undergoing major procedures such as abdominal surgeries (Constable, 2003; Oyeyemi & Akusu, 2005). Fluids are grouped based on their constituent into crystalloids and colloids. Crystalloids are substances which form a true solution and are capable of being crystallized e.g., Ringer's solution, lactated Ringer's solution, acetated Ringer's solution, 0.9% sodium chloride solution etc. (Constable, 2003). Lactated Ringer's solution is one of the commonly administered fluids during surgery, anaesthesia or sedation as it is a balanced, polyionic, alkalinizing, iso-osmotic fluid which contains physiologic concentrations of sodium, chloride, potassium, calcium, and lactate ions (Constable, 2003; Roussel, 2014; Ness, 2017). Fluid therapy is mostly indicated for dehydration, metabolic acidaemia, chronic anorexia and shock in small ruminants; failure to administer intravenous fluids may be fatal (Riebold, 2007). Aside from this, administration of fluid is important during prolonged sedation or anaesthesia to ensure correction of any pre-existing dehydration, increase cardiac output, fluid loss during surgery, correct hypotension and promote effective tissue perfusion (Ivany & Muir, 2004). Other commonly administered fluids include sodium bicarbonate or any other balanced electrolyte solution infused at a rate of 5 to 10 mL/kg/hour intravenously (IV), more rapid administration may be required during emergencies (Ivany & Muir, 2004; Riebold, 2007). Small ruminants less than 3 months old usually require 5% dextrose solution at 2 to 5 mL/kg/hour to prevent hypoglycemia and in cases where blood loss occurs, colloids (10–20 mL/kg BW) or haemoglobin (20 mL/kg BW) are preferable to be administered to meet physiological demand (Thurmon & Benson, 1993; Posner *et al*., 2003). Fluid therapy in goats can be administered via enteral (i.e., Per Os) or parenteral routes including intravenous, intraperitoneal, subcutaneous, or intraosseous but isotonic solutions must be administered only intravenously (Riebold, 2007).

Excess administration of crystalloid fluid is known to result in haemo-dilution, relative hypo-proteinaemia and a resultant decrease in plasma colloid osmotic pressure (Evans, 2011). Haemo-dilution is known to result in a drop in haematocrit, blood viscosity, blood oxygen content, increased cardiac output, venous return, heart rate, and blood flow to organs (Messmer, 1975). Ruminants have dilute body fluids, so moles are expressed as millimoles (mmol = mol/1000) for clarity and readability. (Constable, 2003) Ruminant patients are commonly sedated when presented for various clinical and surgical procedures as this makes handling of intractable animals safer and easier (Riebold, 2007; Valverde & Doherty, 2008). Commonly used sedative classes include benzodiazepines, alpha2 agonists, and phenothiazines (Riebold, 2007). Benzodiazepines such as midazolam, diazepam and zolazepam have been reported to have minimal and transient cardiopulmonary effects, aside from having anxiolytic, muscle relaxant, sedative and anticonvulsant properties (Hall *et al.,* 2001). Therefore, this class is safe to use in animals with pre-existing cardiopulmonary compromise or disease (Valverde & Doherty, 2008). The commonly used benzodiazepines in ruminants are diazepam and midazolam. Diazepam may be unpredictable in its absorption and also cause tissue irritation whereas midazolam is water soluble, non-irritant, more potent and therefore preferable for both intravenous and intramuscular administration in ruminants (Hall *et al.*, 2001; Valverde & Doherty, 2008; Dzikiti *et al*., 2011).

In caprine practice, intravenous administration of fluids is indicated for immediate resuscitation of goats presented with acute fluid deficits, electrolyte/acid-base imbalances and clinical dehydration, including nutrient deficit from prolonged anorexia (Jones & Navarre, 2014). These often involve the infusion of large volumes of a variety of fluids within a short period. The direct effect of such fluid administration on haematological values in the goat is scarcely reported. This study aimed to compare the acute haematological effect of lactated Ringer`s and 5% dextrose in midazolam-sedated West African Dwarf bucks.

Materials and Methods

Study animals

The study was approved by the Ethical Committee on Animal Research of the University of Ibadan. Five clinically healthy male West African Dwarf bucks aged between 1 year and 1.5-year-old and weighing an average of 9 ± 2kg were purchased from a local goat market in Ibadan, Oyo state, Nigeria. The bucks were kept in communal pens at the animal house of the Faculty of Veterinary Medicine, Teaching and

Research Farm, University of Ibadan, Nigeria. The goats were fed with forage, dry cassava peelings, and supplemented with cereal-based concentrate. Fresh clean water was provided free choice (*ad libitum*) in the pen. The goats were allowed to acclimatize for three weeks, during which each goat was dewormed with Levamisole subcutaneously at 7.5mg/kg and Toltrazuril at an oral dose rate of 25mg/kg. Before the commencement of the study, the goats were judged to be in general healthy condition based on normal haemograms and complete physical examination findings.

Study design

This study was conducted as a prospective randomized crossover clinical trial, a week washout period was allowed between treatments. Blood sample (5 mls) was collected from the jugular veins of all the five goats to establish baseline data 24 hours before the commencement of the experiment. Blood samples were later collected into sterile Lithium-heparin bottles at 0, 30, 60 and 90 mins during infusion with lactated Ringer's solution or 5% Dextrose saline as appropriate. Blood samples collected were taken to the laboratory for haematological evaluation. Each trial was conducted for a week interval as a buck went through the experiment per day, there was a week rest in between trials to allow washout of each fluid type administered.

Study procedure

The goats were fasted for 12 hours before commencement of the fluid therapy. The region of the neck where the jugular vein is located was aseptically prepared; shaved and subsequently scrubbed with 0.3% chlorhexidine gluconate solution (JOHNSON & JOHNSON LTD, Rattray Road, East London, South Africa) mixed with an equal volume of 95% methylated spirit (APACCO METHIS^{R} Apacco Pharmaceutical Ltd, 15/16 Oyekanmi Street, Akute, Ogun State, Nigeria). This was done to ensure no contaminant was around the catheter during venous access and subsequent fluid therapy. Sedation was achieved through an intramuscular injection of 50mg/ml solution of Midazolam hydrochloride at 0.3mg/kg body weight after which an 18-SWG catheter was introduced into the right jugular vein for administration of intravenous fluids as appropriate at a flow rate of 10ml/kg/hour to simulate emergency condition (Chalmeh *et al*., 2014).

Sample collection

Five millilitres of blood samples were taken at 0, 30, 60 and 90 mins for haematological assessment of sedated goats. The rectal temperature in °C was determined using a mercury thermometer inserted into the rectum of the goats. Blood samples were collected into Lithium Heparin bottles and stored at 4^{o}C pending analysis for haematological parameters.

Statistical analysis

Where applicable, all the data were expressed as mean ± standard error mean (SEM). Analysis was carried out statistically using the PRISM software package (version 5.0, GraphPad Software Inc, San Diego CA, USA). The blood parameters were compared using analysis of variance (ANOVA) and Turkey's test was used for post-test. Values of probability less than 5% were considered significant for all data.

Results

Table 1: The results reveal that white blood cells found in the West African Dwarf goats fell after the administration of Lactate Ringer's solution and tested at different time intervals; (0 mins, 30 mins, 60 mins and 90 mins). At the initial time, the white blood cell (WBC) count was within the normal value but continued to decrease and fell below the normal range from 30 mins, a slight increase at an hour and a decrease at 90 mins of administration; there was no significant difference in the mean from initial time till an hour but a significant difference was recorded at 90 mins ($P< 0.05$). The red blood cell (RBC) count recorded was within the range of ($9.33 – 10.45\times10^{6}$ µl) which was within the normal range from 0 min to 90 mins. Initially, the RBC decreased at 30 mins and increased again at 60 mins but was later found to decrease at 90 mins with no significant difference ($P> 0.05$). The haemoglobin (Hb) level recorded was within the range of (5.32 – 8.26 g/dl). At the initial time (0 min) and 30 mins, the HB was found to be below the normal value but increased at an hour and fell again at 24 hours. The packed cell volume (PCV) recorded was within the range of (18.80 – 23.80 %). At 0 min and 30 mins, the PCV recorded fell below the normal reference value. This later increased at 60 mins but later fell below the normal value at 90 mins. The total protein (TP) recorded ranged between 6.76 and 6.90 g/100ml. The platelet count recorded was within the range of (104800 - 122400). This decreased at 30 mins but later increased at 1 hour and decreased at 90 mins. There was a significant difference between 30 mins and 1 hour.

Table 1: Haematological Values (Mean ± SEM) of midazolam sedated West African Dwarf (WAD) bucks administered with lactated Ringer`s solutions at different time intervals

	Normal Range	Pre (0 mins)	30 mins	60 mins	90 mins
WBC (×10^3 /µl)	6.8 – 20.1	7.68 ± 1.02^a	6.09 ± 0.61^a	6.37 ± 0.83^a	5.47 ± 0.70^b
RBC (×10^6 /µl)	9.2 – 13.5	10.45 ± 1.33^a	9.33 ± 1.40^a	10.32 ± 1.53^a	9.37 ± 1.25^a
Hb (g/dl)	7 – 15	6.64 ± 1.50^a	6.34 ± 1.40^a	8.26 ± 2.65^b	5.32 ± 1.02^c
PCV (%)	21 – 35	20.80 ± 4.82^a	19.80 ±3.39^a	23.80 ± 6.70^b	18.80 ± 5.50^a
TP (g/100ml)	6.3 – 8.5	6.90 ± 0.80^a	6.78 ± 0.54^a	6.76 ± 0.50^a	6.78 ± 0.71^a
Platelet (/µl)	N/A	104800 ± 5711.84^a	119600 ± 20687.04^b	122400 ± 19760.71^c	111200 ± 20679.33^a
Albumin (g/100ml)	2.8 – 4.3	2.94 ± 0.23^a	2.92 ± 0.19^a	2.82 ± 0.21^a	2.92 ± 0.16^a

^{a,b} Mean in the same row with different superscripts are significantly different at p< 0.05.
Range adapted from Daramola *et al.* (2013)
WBC – White Blood Cell, RBC – Red Blood Cell, HB – Haemoglobin concentration, PCV – Packed Cell Volume,
NA – Not Available

Table 2: Haematological Values (Mean ± SEM) of midazolam sedated West African Dwarf (WAD) bucks administered with 5% Dextrose solutions at different time intervals

Parameters	Normal Range	(0 mins)	30 mins	60 mins	90 mins
WBC (×10^3 /µl)	6.8 – 20.1	7.68 ± 1.02^a	6.59 ± 1.45^a	5.05 ± 1.24^b	5.45 ± 0.97^b
RBC (×10^6 /µl)	9.2 – 13.5	10.45 ± 1.33^a	9.27 ± 1.28^a	10.51 ± 1.39^a	9.12 ± 1.39^a
HB (g/dl)	7 – 15	6.64 ± 1.50^a	6.32 ± 1.04^a	6.76 ± 1.64^a	5.30 ± 1.03^b
PCV (%)	21 – 35	20.80 ± 4.82^a	19.20 ± 2.85^a	20.20 ± 4.63^a	16.80 ± 3.41^b
Total Protein (g/100ml)	6.3 – 8.5	6.90 ± 0.80^a	6.58 ± 0.54^a	7.08 ± 0.50^a	6.44 ± 0.60^a
Platelet	N/A	104800 ± 5711.84^a	119800 ± 45882.78^a	133000 ± 45687.55^b	150400 ± 48414.97^b
Albumin (g/100ml)	2.8 – 4.3	2.94 ± 0.23^a	2.88 ± 0.16^a	3.0 ± 0.15^a	2.60 ± 0.15^a

Mean ± SEM of five WAD goats
^{a,b} Mean in the same row with different superscripts are significantly different at p< 0.05.
Range adapted: Daramola *et al.* (2013)

The albumin level recorded ranged between 2.82 and 2.94 g/100ml. This decreased at 1 hour and later increased at 90 mins but no significant difference in the goats (P > 0.05).

Discussion

The study evaluated the acute haematological effect of lactated Ringer`s and 5% dextrose in midazolam-sedated West African Dwarf goats. Infusion of 5% dextrose solution exerted a significant (p<0.05) effect on the WBC at 60 mins and 90 mins, though all parameters were within the normal recommended range except at 90 mins where it was lower.

Lactated Ringer's solution exerted a significant difference (p<0.05) in the mean value of the WBC in the WAD goats at 90 mins intervals while 5% dextrose solution exerted a significant difference at 60 mins and 90 mins respectively. This indicates that the lactated Ringer's solution began affecting the white blood cell count of the goats after 90 mins, while the 5% Dextrose solution showed effects starting at 60 mins and thereafter. The WBC count in this study was within the range of 6.8 -20.1 x10^9/µl documented by Hunter (1996) Olotu *et al.* (1998) Ajala *et al*. (2000) and Daramola *et al*. (2003). Although, the WBC count in the WAD goat detected in this study was less than the value detected in the WAD goat by Shittu *et al*. (2016); Daramola *et al*. (2003) and Tambuwal *et al*. (2002), who reported a mean of 19.85 × 10^3/µl, 13.5 x10^3 /µl and 10.6 x 10^3/ µl, respectively. Okonkwo *et al*. (2011) also detected a significantly lower WBC in WAD goats compared to other Nigerian goat breeds, with the detected value being only slightly higher than that found in the current study. West African Dwarf goats seem to possess a protective system, providing a rapid and potent defence against any infectious agent and this is probably the physiological basis for the adaptation of this species to this eco-zone characterized by a high prevalence of disease (Daramola *et al*., 2003). The solutions had the same effect on the RBC of the goats at different time intervals. The highest value of RBC was recorded at 60 mins for both solutions and a drop in the value at 90 mins, while lactated Ringer's solution did not cause a decrease in RBC below the normal range at 90 mins, 5% dextrose solution resulted in a drop below the

normal range. The baseline RBC detected in this study was higher than the value obtained by Olotu *et al.* (1998), Plumb (1999), Ajala *et al*. (2000) and Tambuwal *et al*. (2002). Okonkwo *et al*. (2011) reported the lowest significant value of RBC in WAD goats in all the previous studies (4.10 x 10^3 /µl). The results revealed that the solutions exerted a not significantly higher value in RBC at the different time intervals. The concentrations of Hb obtained in this study were significantly lower than the value reported by Daramola *et al*. (2003), Okonkwo *et al*. (2011), Plumb (1999), Olotu *et al*. (1998) and Ajala *et al*. (2000). The values obtained in this study were below the normal range presented by Tambuwal *et al*. (2002). The mean Hb values reported by Okonkwo *et al*. (2011) and Daramola *et al*. (2003) for WAD goats fall within a similar range. However, Shittu *et al*. (2016) found a notably higher Hb value in WAD goats (91.71 g/dl). According to Shittu *et al*. (2016), WAD goats have a higher haemoglobin concentration. Hence, WAD goat seems to possess relatively high haemoglobin values which is an advantage in terms of the oxygen-carrying capacity of the blood. Lactated Ringer solution led to a rise in the Hb value at 60 mins and a later decrease at 90 mins below the value obtained at 0 mins. The 5% dextrose solution had the same effect on the Hb value of the goats. The lactated Ringer`s exerted a significant difference on the Hb at 60 mins and 90 mins while the 5% dextrose solution did not until 90 mins. This suggests that it takes approximately an hour before the effects of 5% Dextrose solution on the Hb levels of WAD goats become noticeable. The baseline PCV value was lower than the normal range reported by Daramola *et al*. (2003). The value was found to be lower than the one reported by Olotu *et al*. (1998), and Ajala *et al*. (2000). By 60 mins, the lactated Ringer's solution raised the PCV to levels near those reported by Plumb (1999), Okonkwo *et al*. (2011), and Tambuwal *et al*. (2002) for various goat breeds, falling within the range of 21-35%.

The lactated Ringer's solution only exerted a significant difference at 60 mins and 5% Dextrose solution at 90 mins. The effect of the lactated Ringer`s solution was seen in the PCV at 60 mins above and that of 5% Dextrose has no significant ($p>0.05$) effect until 90 mins. The total protein content remained within the normal range observed by previous researchers. However, the administration of 5% Dextrose solution increased the PCV to 7.08 g/100ml at 60 mins.

Zubcic (2001) reported that the total protein value in goat serum could be increased to 7.5 g/dl in extensively raised animals.

However, significant differences between sexes were also noted. Deangelino *et al*. (1990) demonstrated that total protein concentration in young goats was significantly lower compared to adults. The solutions did not significantly affect the platelet count of WAD goats. The albumin content detected fell within the normal range reported by Daramola *et al*. (2003). There was no significant difference in albumin values observed at different time intervals with the administration of either solution ($P > 0.05$). The albumin values in this study were lower than those reported by Shittu *et al*. (2011).

Lactated Ringer's solution led to an increase in platelet count at 60 mins, which continued to rise until 90 mins. In contrast, the 5% Dextrose solution caused a continuous increase in platelet count at different time intervals. The 5% Dextrose solution exerted a significant effect on WAD goat platelets at 60 and 90 mins, while lactated Ringer's solution showed a significant effect from 30 mins, returning to non-significant levels by 90 mins.

Based on the haematological findings, the study concluded that the administration of lactated Ringer`s solution and 5% Dextrose saline to WAD goats at different time intervals exerted a significant effect on some haematological values. The lactated Ringer's solution had a significant effect ($p<0.05$) on the WBC, RBC at 90 mins; Hb, PCV and Platelet at 60 mins and the solution did not have a significant effect in the value of total protein and albumin at the different time intervals. The infusion of 5% Dextrose solution had a significant effect ($p<0.05$) on the values of WBC, Hb, PCV and platelets at 60 mins and 90 min intervals but did not have a significant difference ($p>0.05$) on the values of RBC, Total Protein and Albumin at a different time interval.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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