



Hematological prediction study of peritonitis following laparotomy in goats

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ABSTRACT. Surgical trauma to the abdominal wall and peritoneum during celiotomy is expected to cause postoperative inflammation. However, complications after abdominal surgery are hardly detected in the early stage. Hematological analysis of blood has been considered beneficial in disease diagnosis and prognosis. This study aimed to evaluate the hematological parameters predicting peritonitis in goats and to determine the post-surgery day that hematology is significant. Six apparently healthy West African Dwarf goats were included in this study. After 2 weeks of acclimatization, blood samples were obtained daily for 3 days for hematological analyses, which served as the baseline data. The right flanks of the animals were aseptically prepared routinely for exploratory laparotomy. Restraint and anesthesia were achieved using xylazine and lignocaine using an inverted "L" block technique. Laparotomy was performed, and the incision was left for 20 min and then closed routinely. Blood samples were collected for hemogram 24 hr postoperatively and daily for 7 days. Based on the post-surgery hematology results, relative neutrophil ($P=0.015$) and lymphocyte ($P=0.006$) counts significantly increased and decreased on day 5 respectively. Significant differences were also observed for red blood cell count, hemoglobin concentration, and packed cell volume on days 5, 6, and 7 respectively. It could therefore be concluded that the diagnostic result for hematology post-laparotomy can be obtained on the fifth and sixth day.

KEY WORDS: goat, hematology, laparotomy, peritonitis, West African Dwarf

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In ruminants, laparotomy is considered the most frequent surgical procedure [1] and is carried out for exploratory purpose in conditions when confirmatory diagnosis is dicey and when the established diagnosis is indicative of this procedure [1, 9]. The indications for laparotomy include but are not limited to abomasopexy, rumenotomy, Cesarean section, and pyloro-omentopexy [9]. Laparotomy could be performed using an appropriate anesthetic protocol using the flank abdominal, paramedian, and midventral approaches depending on the surgeon's convenience in performing the procedure [1, 9].

One of the main causes of animal deaths is peritonitis, which is the inflammation of the peritoneal cavity [20, 33]. It is one of the complications of laparotomy as a result of injury or trauma to the peritoneal covering [17, 28, 33]. Pain and fever are the common clinical signs of peritonitis; however, sudden death also ensues as a result of shock, acid-base imbalance, and circulatory collapse in acute septic peritonitis [33]. Abdominal pain manifested as stiff gait, recumbency, or guarding of the abdomen is also observed in peritonitis [33].

Blood acts as a pathological reflector of the status of exposed animals to toxicants and other conditions [23]. Therefore, hematology is performed to diagnose several diseases and to investigate the extent of damage of several blood disorders to the body system [25, 31]. Additionally, several metabolites and other body fluid components, which play vital roles in the determination of stress as a result of pathological, dietary, biological, and environmental factors, can be assessed using serum chemistry [3, 4, 15]. Furthermore, besides establishing the diagnosis of several diseases, examining blood constituents can provide vital information on disease prognosis in animals since blood constituent is altered with a change in physiology [5, 23, 31].

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West African Dwarf (WAD) goats are widely reared in most households in the tropics. Therefore, they are of economic importance considering that people rear them as means of savings, to pay debt, and as a gift. There are undocumented reports of several post-surgical deaths following procedures involving laparotomy in ruminants, and postmortem findings revealed peritonitis without substantial antemortem clinical signs and definitive diagnosis.

Despite several reports on the use of blood parameters in the diagnosis and prognosis for several diseases [3, 4, 15, 23, 25, 31], information regarding the use of blood parameters as indicators for peritonitis in WAD goats is insufficient. We therefore hypothesized that hematological parameters can be used as indicators to predict peritonitis in WAD goats and the post-surgery day could be used to assess the significance of hematology.

MATERIALS AND METHODS

Six healthy WAD goats (4 females and 2 males) (age, 2–3 years; weight, 18–23 kg) were included in this study. These experimental animals were in apparently healthy condition but were however dewormed using ivermectin 1% (Interchemie, Venray, Holland) at 0.02 mg/kg. They were housed in a small ruminant pen at the University of Ilorin Veterinary Teaching Hospital, Ilorin, Nigeria, and fed with bean husk, wheat offal, and cassava peel while having constant access to drinking water. The animals' blood samples were obtained through jugular venipuncture daily for 3 days after a period of 2-week acclimatization, which served as the baseline values before the surgical procedure. As a routine protocol in ruminant surgery, prior to surgery, the animals were starved with food and water for 24 hr and 12 hr, respectively. A liberal area on the right flank was clipped and prepared aseptically using chlorhexidine (Purit[®], Saro Lifecare Ltd., Lagos, Nigeria) and methylated spirit (La Onyz[®], Samstella Nigeria Limited, Abule Oba, Nigeria). Chemical restraint was achieved using xylazine hydrochloride (XYL-M2[®], VMD, Arendonk, Belgium) at 0.05 mg/kg intramuscularly, while an inverted "L" block anesthetic technique using lignocaine hydrochloride (Shreechem Pharmaceuticals, Mumbai, India) at 2 mg/kg was used when inducing local anesthesia [11]. A 15 cm long skin incision was made at the middle of the aseptically prepared flank, followed by subcutaneous and abdominal muscle incisions to expose the peritoneum as described by Baird (2013). The laparotomy was timed for 20 min during which the abdomen was explored [14]. The laparotomy incision was closed in three layers as adopted by Alimi *et al.* (2018) [6]. The peritoneum and abdominal muscles and subcutaneous layer were sutured with a chromic catgut (Agary Pharmaceuticals, Jiangsu, China) using a simple continuous pattern, while the skin was sutured with nylon (Agary Pharmaceuticals) using ford interlocking pattern. The surgical sites were dressed using povidone iodine (Wosan[®], Jawa International Limited, Lagos, Nigeria). Postoperative antibiotic was not administered to any of the animals; however, piroxicam (Yanzhou Xier Kangtai Pharmaceutical, Yanzhou, China) was administered as an analgesic at 5 mg/kg intramuscularly for 3 days post-surgery [22].

Blood samples were collected from the experimental animals through jugular venipuncture 24 hr post-surgery and daily for 7 days. The blood samples were collected into ethylenediaminetetraacetic acid sample bottles (JRZ Plastilab, Beirut, Lebanon), and hematology was performed within 2 hr of blood collection. Hematological analysis was performed manually using the standard techniques described by Jain (1986) [18] and Otitoloju *et al.* (2012) [27].

The study was approved by the ethical approval committee of the Faculty of Veterinary Medicine, University of Ilorin (approval reference number: FVER/005/2018).

The data were expressed in International System of Units and analyzed statistically using one-way analysis of variance with repeated measures using the GraphPad PRISM 5[®] for Windows version 5.03 (2010). All values were expressed in mean $\pm$ standard error of mean (SEM), and $P < 0.05$ was considered significant.

RESULTS

In this study, laparotomy was performed successfully, and the experimental animals recovered uneventfully from the effect of xylazine sedation. The hematological results obtained are summarized as mean $\pm$ SEM and presented in Table 1.

The surgical wounds healed without any clinical complications, and the stitches were removed on the 10th postoperative day. The hematological results were compared using the pre-surgical and post-surgical values. The relative neutrophil count significantly increased ($P < 0.05$), while the relative lymphocyte count significantly decreased ($P < 0.05$). Moreover, red blood cell (RBC) count, hemoglobin (Hg) concentration, and packed cell volume (PCV) significantly decreased ($P < 0.05$). However, the absolute differential counts, mean corpuscular volume (MCV), mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and platelet count did not differ significantly pre- and post-surgery.

DISCUSSION

Complications following abdominal surgeries are hardly detected in the early stage [2, 14]. Hematology has been used as an indicator for health status, assessing disease conditions, establishing the diagnosis and prognosis of several diseases [2–5, 13–15, 23–26, 33], and even evaluating the presence of peritonitis in Iranian goats [14]. This study therefore evaluated the hematological parameters predicting peritonitis and determined the post-surgery day that hematology was considered significant in WAD goats. The results herein obtained were therefore compared with the reported values of healthy intact animals.

Although there was no statistical significance in the number of white blood cell (WBC) count when the post-surgical values

Table 1. The hematological parameters (mean $\pm$ standard error of mean) of West African Dwarf goats before and after exploratory laparotomy (n=6)

	Control	Postoperative days						
		1	2	3	4	5	6	7
WBC $\times 10^9 / l$	6.37 $\pm$ 0.57	6.63 $\pm$ 0.58	7.02 $\pm$ 0.65	6.96 $\pm$ 0.53	6.13 $\pm$ 0.64	6.90 $\pm$ 0.67	6.17 $\pm$ 0.56	5.55 $\pm$ 0.41
Neut $\times 10^9 / l$	2.23 $\pm$ 0.16	2.45 $\pm$ 0.25	2.60 $\pm$ 0.26	2.84 $\pm$ 0.19	2.60 $\pm$ 0.26	2.98 $\pm$ 0.37	2.43 $\pm$ 0.27	2.23 $\pm$ 0.17
Lym $\times 10^9 / l$	4.03 $\pm$ 0.46	4.13 $\pm$ 0.35	4.32 $\pm$ 0.45	3.94 $\pm$ 0.33	3.42 $\pm$ 0.41	3.82 $\pm$ 0.39	3.64 $\pm$ 0.33	3.25 $\pm$ 0.25
Mono $\times 10^9 / l$	0.11 $\pm$ 0.02	0.04 $\pm$ 0.02	0.09 $\pm$ 0.03	0.11 $\pm$ 0.04	0.11 $\pm$ 0.01	0.07 $\pm$ 0.02	0.09 $\pm$ 0.02	0.04 $\pm$ 0.02
Eosino $\times 10^9 / l$	0.01 $\pm$ 0.01	0.01 $\pm$ 0.01	0.01 $\pm$ 0.01	0.03 $\pm$ 0.02	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Baso $\times 10^9 / l$	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Neut (%)	35.5 $\pm$ 1.93	36.67 $\pm$ 0.95	37.17 $\pm$ 2.25	41.00 $\pm$ 1.53	42.50 $\pm$ 1.93	43.00 $\pm$ 2.13 ^{a)}	39.17 $\pm$ 1.30	40.17 $\pm$ 0.70
Lym (%)	62.67 $\pm$ 1.86	62.33 $\pm$ 0.88	61.50 $\pm$ 2.35	56.67 $\pm$ 1.50	55.67 $\pm$ 1.94	55.50 $\pm$ 2.08 ^{a)}	59.17 $\pm$ 1.49	58.50 $\pm$ 0.89
Mono (%)	1.67 $\pm$ 0.21	0.83 $\pm$ 0.31	1.17 $\pm$ 0.40	1.50 $\pm$ 0.43	1.83 $\pm$ 0.17	1.16 $\pm$ 0.31	1.50 $\pm$ 0.34	0.83 $\pm$ 0.31
Eosino (%)	0.17 $\pm$ 0.17	0.17 $\pm$ 0.17	0.17 $\pm$ 0.17	0.33 $\pm$ 0.21	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Baso (%)	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
RBC $\times 10^{12} / l$	4.51 $\pm$ 0.32	4.54 $\pm$ 0.41 ^a	4.04 $\pm$ 0.31	3.93 $\pm$ 0.28	4.14 $\pm$ 0.30	3.75 $\pm$ 0.28	3.59 $\pm$ 0.23 ^{b)}	3.80 $\pm$ 0.19
Hg (g/dl)	8.38 $\pm$ 0.41	8.37 $\pm$ 0.58	7.57 $\pm$ 0.43	7.38 $\pm$ 0.56	7.43 $\pm$ 0.36	6.78 $\pm$ 0.48 ^{a)}	6.67 $\pm$ 0.49 ^{b)}	6.90 $\pm$ 0.44 ^{c)}
PCV (%)	27.17 $\pm$ 1.64	27.50 $\pm$ 1.95	25.00 $\pm$ 1.83	23.50 $\pm$ 1.84	24.33 $\pm$ 1.65	22.33 $\pm$ 1.80 ^{a)}	22.17 $\pm$ 1.62 ^{b)}	22.50 $\pm$ 1.18 ^{c)}
MCV (FL)	60.67 $\pm$ 0.71	61.00 $\pm$ 1.75	61.67 $\pm$ 0.21	61.33 $\pm$ 0.49	60.83 $\pm$ 0.65	60.33 $\pm$ 0.99	60.17 $\pm$ 1.99	60.00 $\pm$ 0.77
MCH	18.70 $\pm$ 0.40	18.62 $\pm$ 0.44	18.82 $\pm$ 0.40	19.03 $\pm$ 0.26	18.58 $\pm$ 0.50	18.68 $\pm$ 0.47	18.68 $\pm$ 0.49	18.08 $\pm$ 0.62
MCHC	30.93 $\pm$ 0.34	30.38 $\pm$ 0.39	30.47 $\pm$ 0.56	30.63 $\pm$ 0.40	29.80 $\pm$ 0.64	30.43 $\pm$ 0.47	30.50 $\pm$ 0.41	29.88 $\pm$ 0.72
PLT ($\times 10^9 / l$)	232.17 $\pm$ 14.46	223.50 $\pm$ 30.04	236.50 $\pm$ 14.66	239.83 $\pm$ 18.00	246.17 $\pm$ 21.68	256.00 $\pm$ 19.19	231.83 $\pm$ 17.71	193.33 $\pm$ 16.89

Means bearing different superscripts along the same row differ significantly from the control ($P > 0.05$) along the rows. WBC, White blood cell count; Neut, Neutrophils; Lym, Lymphocytes; Mono, Monocytes; Eosino, Eosinophils; Baso, Basophils; RBC, Red blood cell count; Hg, Hemoglobin; PCV, Packed cell volume; MCV, Mean corpuscular volume; MCH, Mean corpuscular hemoglobin; MCHC, Mean corpuscular hemoglobin concentration; PLT, Platelet.

were compared to the pre-surgical values, the obtained value in this study was lower than the values reported by Opara *et al.* (2010) in WAD goats in South Eastern Nigeria; Akinrinmade and Akinrinade (2012) in their survey of WAD goats without rumen impaction in Ibadan, South Western Nigeria; Daramola *et al.* (2005) in WAD goats in the same study area; and Tambuwal *et al.* (2002) in Red Sokoto goats (RSGs) in North Western Nigeria.

However, the control values decreased in the range values reported for total WBC by Daramola *et al.* (2005) in their study to establish the normal hematological parameters of WAD in the current study area. Nevertheless, a progressive increase in the total WBC count from day 1 to day 5 post-surgery was observed. This is indicative of a systemic response to the trauma of the peritoneum. This observation was also reported in the study of Dehgani *et al.* (2000).

Similar with other ruminants, in this study, lymphocyte counts were higher than neutrophil counts, a result consistent with the results of the previous studies in WAD goats [5, 13, 26] and RSGs [30]. However, in this study, neutrophil and lymphocyte counts increased and decreased from day 1 to day 7 post-surgery respectively, but became statistically significantly on day 5 when compare with the control. This result is consistent with the result of Dehgani *et al.*'s study (2000), who conducted similar work in Iranian goats, which is possibly attributed to the ongoing aseptic peritonitis as a result of mechanical abrasion and desiccation of the peritoneum [10, 16, 29]. Furthermore, leukocytosis, neutrophilia, and lymphocytopenia are usually observed in less severe acute peritonitis [12, 14, 18, 19, 21, 29, 33]. Considering this result, it could be presumed that marked leukocytic response is observed on day 5.

The PCV obtained for the control in this study was lower than the PCV obtained based on Daramola *et al.*'s study (2005) in their work to establish normal hematological parameters of WAD in the same study area and Akinrinmade and Akinrinade (2012) in WAD goats without rumen impaction. However, the PVC for the control in this study was higher than that of Tambuwal *et al.* (2002) and was similar to that of Azab and Abdel-Maksoud (1999) in Baladi goats [8].

The value obtained in the current study decreased progressively from day 2 post-surgery to the last day of observation. Compared to the control, red blood cell count, hemoglobin concentration, and packed cell volume were significantly lower on days 5, 6, and 7, respectively, a result that is not consistent with the results of the previous studies [5, 13, 26, 30]. However, RBC count and Hg concentration significantly decreased on days 1 and 6 post-surgery and days 5, 6, and 7 post-surgery, respectively. Anemia is therefore constant with any inflammatory process, stress, and surgery as observed in this study and in previous studies [5, 7, 32].

Although insignificant, increasing MCV and decreasing Hg concentration revealed that anemia was macrocytic, hypochromic, and regenerative. Considering that Hg concentration and RBC count significantly decreased at day 6 onward, it could thus be inferred that response to anemia in WAD goats begins at day 6 post-hemorrhage. This finding was in contrast to the findings of Roland *et al.* (2014) in cattle who reported that erythrocyte regeneration begins 2 days post-hemorrhage.

In conclusion, hematology is considered a useful tool in monitoring peritonitis in WAD goats, and a significant result will be achieved on days 5 and 6, as shown in the current study.

CONFLICT OF INTERESTS. The authors declare no conflict of interest.

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