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Hematological evaluation of balanced anesthetic protocols through single intramuscular administration in cats

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Abstract
Three anesthetic protocols were evaluated in twenty-seven cats to compare and evaluate the clinical efficacy as well as clinico-physiological and haemato-biochemical alterations. The study was conducted on 27 cats of different breeds, including fourteen females and thirteen males, which were presented for surgical interventions.The cats were randomly allocated into three groups (n=9 each): Group BTZ, Group DKB and Group AKB. Group BTZ received atropine sulphate (0.04 mg/kg), butorphanol (0.2 mg/kg) and tiletamine-zolazepam (10 mg/kg) intramuscularly. Group DKB was administered dexmedetomidine (25 µg/kg), ketamine (5 mg/kg) and butorphanol (0.5 mg/kg) IM, while Group AKB received acepromazine (0.2 mg/kg), ketamine (20 mg/kg) and butorphanol (0.2 mg/kg) IM. All drug combinations were prepared in 2 ml sterile syringes and injected intramuscularly into the thigh muscles following proper physical restraint. The analysis of hematobiochemical parameters indicated a non-significant reduction in total erythrocyte count, total leukocyte count, lymphocytes, monocytes, eosinophils and serum creatinine following 20 minutes of anesthesia and post-recovery, while the values remained within normal reference limits. A non-significant reduction in hemoglobin and packed cell volume was recorded at 20 minutes after anesthesia and upon recovery. Neutrophil counts and random blood sugar (RBS) showed a non-significant ($p>0.05$) increase from baseline at 20 minutes after anesthesia and during post-recovery, with all values remaining within the normal reference range. Furthermore, no significant intergroup differences ($p>0.05$) were observed at any of the evaluated time intervals. Serum glutamic pyruvic transaminase (SGPT) and serum creatinine levels demonstrated a non-significant ($p>0.05$) decline from baseline at 20 minutes post-anesthesia, followed by a non-significant rise after recovery; however, all values stayed within normal physiological limits.

Keywords: Hematological, BTZ, DKB, AKB, significant

Introduction
The domestic cat, *Felis catus*, is the sole domesticated member of the Felidae family (Clutton-Brock, 1992) [7]. Certain innate behaviors of wildcats, such as their compact size, sociable temperament, expressive body language, playful tendencies, and cognitive abilities, may have facilitated their domestication (Cameron Beaumont *et al.*, 2002) [3]. Cats offer humans companionship, emotional comfort and interactive engagement. Physical interaction, such as petting or lap holding, is known to stimulate oxytocin release, which subsequently reduces cortisol levels, thus lowering stress (Johnson, 2023) [15].

Administering anesthetic agents to cats can be particularly difficult due to their sensitivity and resistance to physical handling. Intravenous injections in stressed cats are especially problematic and can provoke fatal shock if unsuccessful (Jiwlawat *et al.*, 2022) [14]. Excessive handling during the preoperative period can rapidly induce stress in cats, which is highly undesirable. Hence, there is a need to develop and standardize balanced anesthetic protocols that minimize physical restraint by enabling the administration of general anesthesia through a single injection. Combining sedative, analgesic, and anesthetic agents into a single injection has been shown to minimize patient discomfort and stress, as evidenced by reduced postoperative cortisol levels in cats (Fazio *et al.*, 2017) [9].

Tiletamine-zolazepam, a 1:1 (w/w) formulation comprising a phencyclidine derivative and a benzodiazepine, is a non-opioid, non-barbiturate injectable anesthetic. Zolazepam (CI-716), a

pyrazolodiazepinone derivative, contributes to sedation and muscle relaxation. Tiletamine (CI-634), a dissociative anesthetic identified chemically as 2-(ethylamino)-2-(2-thienyl)-cyclohexanone hydrochloride, is approximately twice as potent as ketamine and provides a longer duration of action (Lin *et al.*, 1993) [71]. It acts at the phencyclidine receptor site, exerting non-competitive antagonism at NMDA receptors by inhibiting glutamate binding (Clarke *et al.*, 2014) [6].

Dexmedetomidine, a pharmacologically active dextrorotatory isomer of medetomidine ((+)-4-(S)-[1-(2, 3-dimethylphenyl) ethyl]-1H-imidazole monohydrochloride), functions as a highly selective and potent alpha-2-adrenoceptor agonist (Grimm *et al.*, 2015). Butorphanol is a κ-opioid receptor agonist and μ-antagonist, classified as an agonist-antagonist opioid analgesic. Compared to full opioid agonists, its peak analgesic efficacy is lower; however, its κ-agonist activity results in reduced excitatory effects in cats (Adams, 2001) [1].

Ketamine, first synthesized in the 1960s as a derivative of phencyclidine hydrochloride, is recognized as a non-competitive antagonist of N-methyl-D-aspartate receptors. It produces 'dissociative anesthesia,' a condition characterized by a pronounced sense of detachment resulting from disruption of communication between the thalamo-neocortical and limbic regions of the brain at both functional and electrophysiological levels. When administered alone, ketamine elevates heart rate and arterial blood pressure. However, it may also cause muscular rigidity, myoclonic activity, and even convulsions. To minimize these adverse effects, ketamine is generally co-administered with benzodiazepines or alpha-2 adrenergic agonists (Pusp *et al.*, 2022) [28].

Acepromazine is the most widely recognized medication and is an ataractic phenothiazine derivative. Acepromazine lowers aggressive behavior and enhances muscle relaxation and calmness. Although acepromazine does not have analgesic effects, it reduces discomfort by reducing alertness. Acepromazine and opioids work together to produce neuroleptanalgesia, and the sedation they produce together may be more potent than either of them alone (Hall & Clarke, 1983) [12].

Materials and Methods

Present study was conducted in twenty seven clinical cases of cats were enrolled for various surgical procedures. Among these, thirteen were males (48.15%) and fourteen were females (51.85%), with an average body weight of 4.01±0.18 kg (ranging from 2.4 to 5.5 kg) and an average age of 2.07±0.29 years (ranging from 1 to 8 years). The twenty seven cats were randomly divided into three groups (n=9 cats/group) *viz*., Group I, Group II, and Group III [Group BTZ (Butorphanol + Tiletamine + Zolazepam), Group DKB (Dexmedetomidine + Ketamine+ Butorphanol), and Group AKB (Acepromazine + Ketamine + Butorphanol]. All the cats in Group BTZ were administered atropine sulphate at a dose rate of 0.04 mg/kg body weight, along with a butorphanol at 0.2 mg/kg body weight and tiletamine + zolazepam combination at 10 mg/kg body weight *via* intramuscular (im) injection.

Cats of Group DKB were anesthetized using a combination of dexmedetomidine, ketamine and butorphanol at the dose rates of 25 μg/kg, 5 mg/kg and 0.5 mg/kg body weight, respectively. Cats of Group AKB were anesthetized with a combination of acepromazine, ketamine and butorphanol at 0.2 mg/kg, 20 mg/kg, and 0.2 mg/kg body weight, respectively.

The anesthetic drugs for Groups I, II and III were prepared in 2 ml sterile syringes and administered as a single IM injection following appropriate physical restraint into the thigh muscles. The cats were restrained by an assistant who held the scruff with one hand and the hind limbs with the other to minimize movement and ensure proper deep intramuscular delivery of the drug combination. Following the administration of the anesthetic injection, each cat was allowed to rest in a calm and dark environment while being continuously monitored for anesthetic parameters.

To assess the efficacy of the anaesthetic protocols, several hemato-biochemical parameters were evaluated. One ml of venous blood samples was collected in K_3 EDTA and clot activator vials before anaesthesia (considered as baseline values), 20 minutes after intramuscular injection and after recovery from anaesthesia for haematological and biochemical parameter analysis. The following parameters were estimated using an automatic analyzer within 120 minutes of blood sample collection. A. Haemoglobin (gm/dl) B. Packed cell volume (PCV) (%) C. Total erythrocyte count (TEC) (10^6/μl) D. Total leucocyte count (TLC) (10^3/μl) E. Differential leucocyte count (DLC) (%) F. Serum Glutamic Pyruvic Transaminase (SGPT) (IU/L) G. Serum creatinine (mg/dl) H. Random Blood Sugar (RBS) (mg/dl).

Results and Discussion

Haemoglobin (gm/dl)

Mean ± SE values of haemoglobin (gm/dl) of different groups at various time interval are presented in Table 1. In cats of Groups BTZ, DKB and AKB, hemoglobin (Hb) decreased non-significantly ($p>0.05$) from baseline after 20 minutes of anesthesia and post-recovery, although values remained within the normal reference range. Comparison among groups revealed that Group AKB had significantly higher ($p<0.05$) hemoglobin values than Groups BTZ and DKB at 20 minutes of anesthesia and after recovery. In the present study, the reduction in hemoglobin concentration may be attributed to intraoperative blood loss, which likely contributed to the observed decline in Hb values. The findings of the present study are consistent with those of Spada *et al.* (2015) [34] and Patel (2022) [25] observed a non-significant reduction in hemoglobin levels in cats anesthetized with tiletamine-zolazepam. Similarly, Volpato *et al.* (2015) [36], Sayyed Mohd (2019) [39] and Sunil (2024) [35] reported a non-significant decline in hemoglobin levels during and after the procedure in cats anesthetized with dexmedetomidine-ketamine-butorphanol protocols. Singh reported no significant alterations in hemoglobin values during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations. In contrast, Zlateva and Marinov (2015) [38] demonstrated a significant post-anesthetic decrease in hemoglobin values when using xylazine-ketamine, acepromazine-propofol-isoflurane and acepromazine-butorphanol-metacam-propofol-isoflurane protocols.

Table 1: Mean ± SE values of haemoglobin (gm/dl) in cats of different groups covered under present study

Haemoglobin (gm/dl)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	12.80±0.75	11.03^{a}±0.65	10.95^{a}±0.73
Group DKB	12.56±0.75	11.53^{a}±0.70	10.98^{a}±0.59
Group AKB	14.42±0.50	13.60^{b}±0.50	13.74^{b}±0.61
Mean value with superscripts a and b differ significantly between groups (p<0.05).			

Packed cell volume (PCV) (%)

Mean ± SE values of packed cell volume (PCV) (%) of different groups at various time interval are presented in Table 2. In cats of Groups BTZ, DKB and AKB, packed cell volume (PCV) decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post-recovery, although values remained within the normal reference range. Comparison among groups revealed that Group AKB had significantly higher (p<0.05) packed cell volume (PCV) values than Groups BTZ and DKB after recovery. The decrease in PCV observed in the present study was likely due to hemodilution and intraoperative blood loss. The findings of the present study are consistent with those of Pant (2025) [24] and Patel (2022) [25] observed a non-significant reduction in PCV of cats anesthetized with tiletamine-zolazepam. Similarly, Volpato *et al.* (2015) [36] and Sunil (2024) [35] reported a non-significant decline in PCV during and after the procedure in cats anesthetized with dexmedetomidine-ketamine-butorphanol protocols. Biermann *et al.* (2012) [2] observed that cats treated with anesthetic combinations including dexmedetomidine exhibited reduced PCV when compared to other treatment groups. In contrast, Sayyed Mohd (2019) [39] reported a significant decrease in packed cell volume during the laparoscopic procedure in both groups, with Group I showing a greater reduction. However, the postoperative intergroup differences were not statistically significant. Singh reported no significant alterations in PCV values during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations. In contrast, Zlateva and Marinov (2015) [38] demonstrated a significant post-anesthetic decrease of PCV value when using xylazine-ketamine, acepromazine-propofol-isoflurane and acepromazine-butorphanol-metacam-propofol-isoflurane protocols.

Table 2: Mean ± SE values of packed cell volume (PCV) (%) in cats of different groups covered under present study

Packed Cell Volume (PCV) (%)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	39.66±1.99	37.21±2.05	36.19^{ab}±1.97
Group DKB	37.78±2.39	35.24±2.60	31.57^{a}±2.64
Group AKB	42.73±1.71	41.02±1.56	39.80^{b}±1.49
Mean value with superscripts a and b differ significantly between groups (p<0.05).			

Total erythrocyte count (TEC) (10^6/µl)

Mean ± SE values of total erythrocyte count (TEC) (10^6/µl) of different groups at various time interval are presented in Table 3. In cats of Groups BTZ, DKB and AKB, total erythrocyte count (TEC) decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post-recovery, although values remained within the normal reference range. Comparison among groups revealed that Group AKB had a significantly higher (p<0.05) total erythrocyte count (TEC) than Groups BTZ and DKB both before surgery and at 20 minutes of anesthesia. The findings of the present study are consistent with those of Patel (2022) [25] observed a non-significant reduction in total erythrocyte count of cats anesthetized with tiletamine-zolazepam combination with dexmedetomidine, butorphanol and glycopyrrolate, with anesthesia subsequently maintained using isoflurane. Similarly, Volpato *et al.* (2015) [36] reported no significant differences in the red blood cell count of cats restrained either physically or chemically with dexmedetomidine-butorphanol, with or without ketamine. They suggested that elevated baseline RBC values might be attributed to splenic contraction secondary to catecholamine release during stress in physically restrained cats. Hemodynamic changes leading to reduced RBC could be linked to a decline in circulating catecholamines, resulting in splenic dilation and sequestration of erythrocytes. Singh reported no significant alterations in total erythrocyte count during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations. In contrast, Zlateva and Marinov (2015) [38] demonstrated a significant post-anesthetic decrease in total erythrocyte count when using xylazine-ketamine, acepromazine-propofol-isoflurane and acepromazine-butorphanol-metacam-propofol-isoflurane protocols.

Table 3: Mean ± SE values of total erythrocyte count (TEC) (10^6/µl) in cats of different groups covered under present study

Total erythrocyte count (TEC) (10^6/µl)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	6.96^{a}±0.38	6.24^{a}±0.28	6.50±0.37
Group DKB	7.62^{ab}±0.39	7.29^{ab}±0.55	6.88±0.34
Group AKB	8.59^{b}±0.55	7.86^{b}±0.41	7.32±0.48
Mean value with superscripts a and b differ significantly between groups (p<0.05).			

Total leucocyte count (TLC) (10^3/µl)

Mean ± SE values of total leucocyte count (TLC) (10^3/µl) of different groups at various time interval are presented in Table 4. In cats of Groups BTZ, DKB and AKB, total leucocyte count (TLC) decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post-recovery, although values remained within the normal reference range. Total leucocyte count (TLC) did not differ significantly (p>0.05) between groups at any of the measured time intervals. The observed decline in total leukocyte count in the present study may be due to the pooling of circulating blood cells in the spleen. The findings of the present study are consistent with those of Spada *et al.* (2015) [34] and Patel (2022) [25] observed a non-significant reduction in total leukocyte count of cats anesthetized with tiletamine-zolazepam. Similarly, Volpato *et al.* (2015) [36] and Sayyed Mohd (2019) [39] reported a non-significant decline in WBC during and after the procedure in cats anesthetized with dexmedetomidine-ketamine-butorphanol protocols. Singh (2021) reported no significant alterations in total leukocyte count during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations.

Table 4: Mean ± SE values of total leucocyte count (TLC) (10^3/µl) in cats of different groups covered under present st**udy**

Total leucocyte count (TLC) (10^3/µl)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	11.18±0.94	9.80±0.93	10.27±0.98
Group DKB	10.01±1.30	9.53±1.58	9.12±1.06
Group AKB	10.55±0.80	9.75±0.84	9.91±0.73

Differential leucocyte count (DLC) (%)

Neutrophils (%)

Mean ± SE values of neutrophils (%) of different groups at various time interval are presented in Table 5. In cats of Groups BTZ, DKB and AKB, neutrophil (%) values increased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post- recovery, although values remained within the normal reference range. Neutrophil (%) values did not differ significantly (p>0.05) between groups at any of the measured time intervals. The findings of the present study are consistent with those of Singh reported no significant alterations in neutrophil (%) during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations. Unlike the present findings, Spada *et al.* (2015) [34] and Pant (2021) [24] documented no significant reduction in neutrophil count under tiletamine-zolazepam anesthesia in cats.

Table 5: Mean ± SE values of neutrophils (%) in cats of different groups covered under present study

Neutrophils (%)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	62.60±1.89	63.64±1.92	64.76±1.89
Group DKB	66.10±1.75	67.29±1.36	68.87±1.32
Group AKB	61.15±1.15	64.13±0.97	64.62±1.04

Lymphocytes (%)

Mean ± SE values of lymphocytes (%) of different groups at various time interval are presented in Table 6. In cats of Groups BTZ, DKB and AKB, lymphocyte (%) values decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post- recovery, although values remained within the normal reference range. Lymphocyte (%) values did not differ significantly (p>0.05) between groups at any of the measured time intervals. The findings of the present study are consistent with those of Pant (2021) [24], who reported a non-significant decline in lymphocyte counts during both the operative and postoperative phases in cats induced with intramuscular tiletamine-zolazepam or intravenous propofol and maintained on isoflurane, with values remaining within the normal physiological range. Similarly, Singh reported a non-significant decline in lymphocyte counts across intervals in cats anesthetized with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine, with anesthesia maintained using isoflurane. In contrast, Spada *et al.* (2015) [34] reported a non-significant increase in lymphocyte counts in feline blood donors anesthetized with tiletamine-zolazepam.

Table 6: Mean ± SE values of lymphocytes (%) in cats of different groups covered under present study

Lymphocytes (%)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	30.94±1.28	30.71±1.38	30.16±1.41
Group DKB	28.67±1.59	28.00±1.13	27.14±1.13
Group AKB	32.84±1.33	31.67±1.35	31.03±1.30

Monocytes (%)

Mean ± SE values of monocytes (%) of different groups at various time interval are presented in Table 7. In cats of Groups BTZ, DKB and AKB, monocyte (%) values decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post- recovery, although values remained within the normal reference range. Monocyte (%) values did not differ significantly (p>0.05) between groups at any of the measured time intervals. The findings of the present study are consistent with those of Pant (2021) [24], who reported a non-significant decline in monocyte counts during both the operative and postoperative phases in cats induced with intramuscular tiletamine-zolazepam (Group A) or intravenous propofol (Group B) and maintained on isoflurane, with values remaining within the normal physiological range. Similarly, Singh (2021) reported a non-significant decline in monocyte counts across intervals in cats anesthetized with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine, with anesthesia maintained using isoflurane.

Table 7: Mean ± SE values of monocytes (%) in cats of different groups covered under present study

Monocytes (%)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	3.21±0.86	3.55±0.61	2.96±0.59
Group DKB	3.32±0.47	2.66±0.33	2.44±0.29
Group AKB	3.88±0.36	2.92±0.43	2.86±0.48

Eosinophils (%)

Mean ± SE values of eosinophils (%) of different groups at various time interval are presented in Table 8. In cats of Groups BTZ, DKB and AKB, eosinophil (%) values decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post- recovery, although values remained within the normal reference range. Eosinophil (%) values did not differ significantly (p>0.05) between groups at any of the measured time intervals. The findings of the present study are consistent with those of Pant (2021) [24], who reported a non-significant decline in eosinophil counts during both the operative and postoperative phases in cats induced with intramuscular tiletamine-zolazepam (Group A) or intravenous propofol (Group B) and maintained on isoflurane, with values remaining within the normal physiological range. Singh (2021) reported a non-significant decline in eosinophil counts across intervals in cats anesthetized with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine, with anesthesia maintained using isoflurane. In contrast, Spada *et al.* (2015) [34] reported a non-significant increase in eosinophil counts in feline blood donors anesthetized with tiletamine-zolazepam.

Table 8: Mean ± SE values of eosinophils (%) in cats of different groups covered under present study

Eosinophils (%)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	2.62±0.43	2.08±0.26	2.12±0.19
Group DKB	1.91±0.25	2.04±0.24	1.87±0.28
Group AKB	2.11±0.31	1.70±0.26	1.48±0.23

Serum Glutamic Pyruvic Transaminase (SGPT) (IU/L)

Mean ± SE values of serum glutamic pyruvic transaminase (SGPT) (IU/L) of different groups at various time interval are presented in Table 9. In cats of Groups BTZ, DKB and AKB, serum glutamic pyruvic transaminase (IU/L) values decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and were followed by a non-significant increase after recovery, although values remained within the normal reference range. Comparison among groups revealed that Group AKB had significantly higher (p<0.05) SGPT values than Groups BTZ and DKB before anesthesia, at 20 minutes of anesthesia and after recovery. The findings of the present study are consistent with those of Patel (2022) [25], who observed a non-significant reduction in serum glutamic pyruvic transaminase values of cats anesthetized with tiletamine-zolazepam combination with dexmedetomidine, butorphanol and glycopyrrolate, with anesthesia subsequently maintained using isoflurane. In contrast to present study, Pant (2021) [24] reported that mean SGPT values decreased significantly during both operative and postoperative phases in cats induced with intramuscular tiletamine-zolazepam (Group A) or intravenous propofol (Group B) and maintained on isoflurane, although values remained within the normal physiological range. Similarly, Sunil (2024) [35] reported that alanine aminotransferase (ALT) showed a non-significant increase during the anesthetic period in cats administered xylazine-ketamine-butorphanol and dexmedetomidine-ketamine-butorphanol combinations. In contrast, Sayyed Mohd (2019) [39] reported a non-significant decline in serum glutamate-pyruvate transaminase (SGPT) value during and after the procedure in cats anesthetized with dexmedetomidine-ketamine-butorphanol protocols. Singh (2021) reported that ALT values remained stable with only minor, statistically non-significant (p<0.05) variations across intervals in cats anesthetized with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine, with anesthesia maintained using isoflurane. In contrast, Kim *et al.* (2019) [5] reported a significant increase in ALT levels in the ACE group compared to baseline in cats anesthetized with intramuscular alfaxalone (ALF), acepromazine (ACE) or their combination (AA).

Table 9: Mean ± SE values of serum glutamic pyruvic transaminase (SGPT) (IU/L) in cats of different groups covered under present study

Serum Glutamic Pyruvic Transaminase (SGPT) (IU/L)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	42.87^{a}±4.52	41.96^{a}±4.12	43.25^{a}±3.99
Group DKB	56.24^{ab}±7.68	54.90^{ab}±6.88	57.09^{ab}±6.65
Group AKB	67.27^{b}±6.06	65.94^{b}±6.60	68.01^{b}±6.86
Mean value with superscripts a and b differ significantly between groups (p<0.05).			

Serum creatinine (mg/dl): Mean ± SE values of serum creatinine (mg/dl) of different groups at various time interval are presented in Table 10. In cats of Groups BTZ, DKB and AKB, serum creatinine (mg/dl) values decreased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and were followed by a non-significant increase after recovery, although values remained within the normal reference range. Serum creatinine values did not differ significantly (p>0.05) between groups at any of the measured time intervals. The findings of the present study are consistent with those of Patel (2022) [25] observed a non-significant decrease in serum creatinine concentrations of cats anesthetized with tiletamine-zolazepam combination with dexmedetomidine, butorphanol and glycopyrrolate, with anesthesia subsequently maintained using isoflurane. In contrast, Pant (2021) [24] reported a highly significant rise in serum creatinine during anesthesia in cats of Group B, which were induced with intravenous propofol, whereas Group A was induced with intramuscular tiletamine-zolazepam; anesthesia in both groups was maintained with isoflurane. Sayyed Mohd (2019) [39] reported that blood urea nitrogen (BUN) and serum creatinine concentrations remained stable, with no significant alterations observed either within or between groups, suggesting that the anesthetic protocols involving dexmedetomidine-ketamine-butorphanol and dexmedetomidine-ketamine-propofol were devoid of nephrotoxic effects in cats. Singh observed that serum creatinine remained statistically unchanged at all observation periods in both groups. A slight elevation was recorded only at the final interval in group A, during anesthetic maintenance using butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations.

Table 10: Mean ± SE values of serum creatinine (mg/dl) in cats of different groups covered under present study

Serum creatinine (mg/dl)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	1.30±0.12	1.22±0.05	1.36±0.04
Group DKB	1.22±0.08	1.12±0.05	1.24±0.08
Group AKB	1.34±0.06	1.30±0.07	1.37±0.06

Random Blood Sugar (RBS) (mg/dl)

Mean ± SE values of random blood sugar (RBS) (mg/dl) of different groups at various time interval are presented in Table 11. In cats of Groups BTZ, DKB and AKB, random blood sugar (RBS) (mg/dl) values increased non-significantly (p>0.05) from baseline after 20 minutes of anesthesia and post-recovery, although values remained within the normal reference range. Comparison among groups revealed that Group AKB had significantly lower (p<0.05) random blood sugar values than Groups BTZ and DKB before anesthesia, at 20 minutes of anesthesia and after recovery. The observed non-significant rise in random blood sugar might result from dexmedetomidine-mediated suppression of pancreatic insulin secretion or from the hyperglycemic activity associated with tiletamine. The findings of the present study are consistent with those of Patel (2022) [25] observed a non-significant increase in random blood sugar of cats anesthetized with tiletamine-zolazepam combination with dexmedetomidine, butorphanol and glycopyrrolate, with anesthesia subsequently maintained using isoflurane. Singh reported that glucose values

exhibited a noticeable increase; however, the changes were statistically non-significant ($p>0.05$), most likely attributable to surgical stress and perioperative management during anesthetic maintenance with butorphanol-dexmedetomidine-ketamine and butorphanol-acepromazine-ketamine combinations. Similarly, Kim *et al.* (2019) [5] reported that no significant alterations in glucose concentrations were observed in any group of cats anesthetized with alfaxalone (ALF), acepromazine (ACE) or their combination (AA).

Table 11: Mean ± SE values of random blood sugar (RBS) (mg/dl) in cats of different groups covered under present study

Random Blood Sugar (RBS) (mg/dl)			
Groups	**Before surgery**	**20 minutes after anesthesia**	**After recovery**
Group BTZ	89.73^{b}±1.48	90.24^{b}±1.75	91.68^{b}±1.71
Group DKB	94.93^{ab}±2.38	95.57^{ab}±2.23	96.04^{ab}±1.97
Group AKB	87.63^{b}±1.89	86.92^{a}±1.72	87.07^{a}±1.67
Mean value with superscripts a and b differ significantly between groups ($p<0.05$).			

Conclusion

All hematobiochemical parameters remained within normal limits, with no significant changes from baseline in total erythrocyte count, total leukocyte count, lymphocytes, monocytes, eosinophils, or serum creatinine levels. A non-significant reduction in hemoglobin and packed cell volume was observed at 20 minutes after anesthesia and at recovery. Neutrophil counts and random blood sugar showed a non-significant increase from baseline at 20 minutes and during post-recovery. Serum glutamic pyruvic transaminase and serum creatinine levels showed a non-significant decline at 20 minutes post-anesthesia, followed by a non-significant rise after recovery, but all values remained within normal physiological limits. Heart rates decreased significantly from baseline at 30 minutes, then gradually increased to near-baseline levels by 90 minutes. Respiratory rates also showed a significant reduction from baseline before gradually rising toward baseline by 90 minutes. Rectal temperature steadily declined throughout the anesthetic period in all groups. SpO_2 levels dropped significantly at 30 minutes in all groups, followed by a gradual increase, returning toward baseline by 90 minutes. All three combinations are recommended for various types of surgical procedures in cats under field conditions.

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