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# Physiological and haemato-biochemical responses to tiletamine-zolazepam anaesthesia for endoscopic procedures in dogs

**Asif Ayoub[1†], A.M. Pawde[2], Amarpal[2], A.C. Saxena[3], Amit Kumar[4], M.R. Verma[5], Rohit Kumar[6] and Raguvaran Raja[7]**

ICAR - Indian Veterinary Research Institute, Izatnagar- 243 122 (Uttar Pradesh)

[1]MVSc Scholar, [2]Principal Scientist, [3]Senior Scientist, [6]Scientist, Division of Surgery; [7]Senior Scientist, Division of Medicine, [4]Principal Scientist, Division of Animal Genetics, [5]Principal Scientist, Division of Livestock Economics and Statistics, ICAR-IVRI, Izatnagar.

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*The study was conducted to evaluate the physiological and haemato-biochemical responses to tiletamine-zolazepam (TZ) anaesthesia for endoscopic procedures in dogs. Twenty-four adult dogs of different breeds were used in the current study and were divided into three groups. Group I comprised normal dogs that did not exhibit any gastrointestinal signs and were used to compare the effects of anaesthesia on dogs of group II and group III. Animals of group II were affected by upper gastrointestinal (GI) disorders, whereas group III exhibited lower GI issues. Dogs were premedicated with butorphanol and midazolam (each 0.2 mg/kg body wt., i.v.), induced with TZ (2 mg/kg body wt., i.v.), and maintained with additional TZ as required. This combination provided smooth anaesthesia with minimal physiological disturbance. Group II showed reduction in heart rate, respiratory rate and rectal temperature, along with increase in haemoglobin, PCV and lymphocytes, and biochemical markers (BUN, SGPT, SGOT and glucose), indicating metabolic alterations. Whereas group III revealed elevated monocytes and basophils. Induction and recovery times were comparable across groups, but group II showed the longest anaesthetic duration with lower dosage requirements (2.16±0.06 mg/kg body wt). These findings suggest that TZ is an effective induction agent for endoscopic procedures in dogs, providing stable anaesthesia and muscle relaxation with only transient, group-specific physiological and biochemical changes, particularly in dogs with upper GI disorders. This supports the suitability of TZ for endoscopic interventions, including in breeds predisposed to gastrointestinal diseases.*

***Keywords:*** *Anaesthesia, Biochemical markers, Dogs, Endoscopy, Gastrointestinal disorders, Haematological changes.*

A combination of tiletamine hydrochloride and zolazepam hydrochloride is frequently utilized in veterinary anaesthesia due to its rapid onset and balanced sedative-anaesthetic profile (Creighton and Lamont, 2024). Its efficacy stems from the deep analgesia provided by tiletamine and the tranquilizing effects of zolazepam, rendering it particularly suitable for endoscopic procedures (Svorc *et al*., 2016). Endoscopic interventions have become increasingly prominent in veterinary medicine because of their minimally invasive nature, reduced recovery time, and improved patient outcomes (Lu *et al*., 2018). These advantages, however, place significant demands on anaesthetic agents, which must provide adequate sedation and analgesia while maintaining physiological stability throughout the procedure.

The ability of tiletamine-zolazepam (TZ) to offer smooth recovery and a wide safety margin further enhances its value during endoscopic interventions, facilitating effective visualization and manipulation in dogs (Coppola *et al*., 2020). Despite its widespread clinical use, there remains a lack of comprehensive data on the effects of TZ on physiological and haemato-biochemical parameters during endoscopic procedures in dogs (Patel *et al*., 2022). This gap in knowledge is particularly important, as understanding these effects is crucial for optimizing anaesthetic protocols, minimizing adverse reactions such as respiratory depression or cardiovascular instability, and ultimately improving animal welfare during medical interventions (Cha *et al*., 2021).

Moreover, endoscopic procedures require precise anaesthetic management to ensure stable physiological parameters, allowing for both effective visualization and manipulation (Xu *et al*., 2024). Therefore, the present study was undertaken to evaluate the physiological and haemato-biochemical responses to TZ anaesthesia for endoscopic procedures in dogs. By addressing this gap, the study aims to inform anaesthetic best practices and enhance the safety and efficacy of endoscopic interventions in veterinary medicine.

## Materials and Methods

A study was conducted on 24 dogs undergoing endoscopic procedures to evaluate the suitability of TZ as an induction agent. Sixteen clinical cases presenting with sub-acute to chronic vomiting, regurgitation or melena were evaluated alongside eight normal cases that were brought for routine endoscopy check-up, with the owners' consent. In total, 24 adult dogs were subjected to routine clinical, radiographic and endoscopic evaluation to rule out various disorders of upper and lower gastrointestinal

†Corresponding author; Email: asifayoub150@gmail.com

tract irrespective of breed or sex with a body weight of 30.41±3.42 kg, constituting the study material. After a thorough examination, the animals were classified into three groups, each consisting of 8 dogs. The group I was the control group, which consisted of dogs that did not show any gastrointestinal (GI) signs (normal upper and lower gastrointestinal tract) and were used to compare the effects of anaesthesia on dogs of group II and group III. The group-II included the animals having problems with the upper GI tract and the group III had affections of lower GI tract.

All dogs were premedicated with butorphanol (0.2 mg/kg body wt., i.v.) and midazolam (0.2 mg/kg body wt., i.v.), followed by induction with tiletamine–zolazepam (2 mg/kg body wt.), and anaesthesia was maintained with additional TZ @ one third or half of the initial dose as needed (Leela *et al*., 2023). For this study, a flexible fiber optic endoscope with a working length of 250 cm, outer diameter of 7.9 mm and channel diameter of 2.8 mm (KARL STORZ Veterinary Video-endoscope Xenon 100) was utilized.

**Table 1:** Scoring criteria for palpebral reflex, pedal reflex and jaw relaxation (Rafee *et al*., 2015).

| Score | Palpebral reflex | Pedal reflex | Jaw relaxation |
|---|---|---|---|
| 1 | Intact and strong reflex (quick blink) | Intact and strong reflex (strong withdrawal) | Not allowing to open the jaws |
| 2 | Intact but slow reflex (slow response) | Intact but weak reflex (slow response) | Resistance to opening the jaws and closed quickly |
| 3 | Very weak reflex (very slow and occasional) | Intact but very light reflex (slow and occasional response) | Less resistance to opening of jaws and closed slowly |
| 4 | Abolished reflex | Abolished completely | No resistance and jaws remain open |

The different observations such as palpebral reflex, pedal reflex, and jaw relaxation were recorded before induction, 15 min after TZ administration, at depth of anaesthesia during the endoscopic procedures, and after complete recovery, and were graded on a 1-4 scoring scale (Rafee *et al*., 2015) (Table 1). Blood samples were collected before anaesthesia, 15 min after TZ administration and after complete recovery to evaluate effects of TZ on various haematological parameters, including haemoglobin (g/dL), PCV (%), DLC (%), and total erythrocytic count (x103). Additionally, serum biochemical parameters such as BUN (mg/dL), creatinine (mg/dL), SGOT (IU/L), SGPT (IU/L), and blood glucose (mg/dL) were assessed. Mean induction time, recovery time, duration of anaesthesia and total dose of Zoletil (including induction and maintenance dose) were noted in all the three groups of dogs. The various clinical reflexes and scores were determined using a numeric descriptive scale (NDS) (Rafee *et al*., 2015) (Table 2).

**Table 2:** Median (range: Maximum and Minimum) values/ scores of various clinical parameters recorded at various groups at different time intervals (n=24).

| Variables | Time intervals | Group I | Group II | Group III |
|---|---|---|---|---|
| Palpebral (score 1-4) | B* | 1 (1-1)$^a$ | 1 (1-1)$^a$ | 1 (1-1)$^a$ |
| | D* | 4 (4-4)$^b$ | 4 (4-4)$^b$ | 4 (4-4)$^b$ |
| | A* | 2 (2-2)$^c$ | 3 (3-3)$^c$ | 2 (2-2)$^c$ |
| Pedal (score 1-4) | B* | 1 (1-1)$^a$ | 1 (1-1)$^a$ | 1 (1-1)$^a$ |
| | D* | 4 (4-4)$^b$ | 4 (4-4)$^b$ | 4 (4-4)$^b$ |
| | A* | 2 (2-2)$^c$ | 3 (3-3)$^c$ | 2 (2-2)$^c$ |
| Jaw relaxation (score 1-4) | B* | 1 (1-1)$^a$ | 1 (1-1)$^a$ | 1 (1-1)$^a$ |
| | D* | 4 (4-4)$^b$ | 4 (4-4)$^b$ | 4 (4-4)$^b$ |
| | A* | 2 (2-2)$^c$ | 3 (3-3)$^c$ | 2 (2-2)$^c$ |

*(B=before induction) (D=during maintenance) (A=after complete recovery)
*Values superscripted with different small letters differ significantly (Pp<0.05) in a row

Repeated-measure ANOVA with Tukey's multiple comparison test was used for statistical analysis of parametric data, while the Kruskal-Wallis test was applied for non-parametric variables. The statistical analysis was performed using SPSS software, with a 95% confidence interval, and results were deemed significant if the P values were below 0.05 (Steel and Torrie, 1960; Kruskal, 1964).

## Results and Discussion

Palpebral reflex was intact before TZ administration and significantly abolished (P<0.05) in all groups from 15 min post-induction to recovery and had a score of 4, which indicates that the dogs were in a medium or deep plane of anaesthesia (Haskins *et al*., 1986). This could be due to the great depth of sedation induced by TZ anaesthesia (Jacobson and Hartsfield, 1993). Abolished palpebral reflex after anaesthetic administration could be due to absence of the oculocephalic reflex soon after anaesthetic administration (Grubb *et al*., 2020). Although group II showed a weak reflex after recovery, no significant difference (P>0.05) was observed between the groups throughout the study.

In the present study, the pedal reflex remained intact after administration of pre-anaesthetic drugs such as butorphanol and midazolam, but pedal reflex scores increased significantly (P<0.05) after administration of TZ in all groups and abolished completely 15 min post-induction until recovery and accordingly the score was given 4. Pedal reflex abolished due to the action of dissociative agents on NMDA, muscarinic and monoaminergic receptors, inhibiting central pain processing pathways and peripheral nerve conduction, thereby resulting in anti-nociception and local anaesthetic effects (Santhosh *et*

*al*., 2013). In group II, a light reflex (score 3) was observed after recovery, but no significant difference (P>0.05) was found between groups. The reappearance of pedal reflex and decrease in the pedal reflex scores towards the end of the observation period could be attributable to the recovery of animals from the state of anaesthesia. Manjusha *et al*. (2023) reported complete elimination of pedal reflex in dogs premedicated with atropine, dexmedetomidine, and butorphanol after induction with TZ and maintenance with isoflurane.

**Table 3:** Effect of TZ on physiological and haematological parameters at different intervals in various groups of dogs.

| Parameter | Time intervals | Group-I | Group-II | Group-III |
|---|---|---|---|---|
| HR (bpm) | B* | 98.5 ±3.2$^{aAB}$ | 102.7 ±3.1$^{aA}$ | 99.8 ±3.0$^{aA}$ |
| | D* | 88.3 ±2.8$^{aA}$ | 85.2 ±3.0$^{bB}$ | 89.1 ±3.3$^{aA}$ |
| | A* | 94.6 ±2.9$^{aB}$ | 96.4 ±3.2$^{bC}$ | 95.2 ±3.1$^{aA}$ |
| RR | B* | 22.1 ±1.5$^{aA}$ | 23.6 ±1.7$^{aA}$ | 22.9 ±1.6$^{aA}$ |
| (breaths/ | D* | 14.5 ±1.2$^{aB}$ | 12.3 ±1.1$^{bB}$ | 13.8 ±1.3$^{aB}$ |
| min) | A* | 19.3 ±1.4$^{aA}$ | 18.7 ±1.5$^{aA}$ | 19.1 ±1.5$^{aA}$ |
| RT (°F) | B* | 101.8 ±0.4$^{aA}$ | 101.6 ±0.5$^{aA}$ | 101.7 ±0.4$^{aA}$ |
| | D* | 98.6 ±0.5$^{aA}$ | 97.8 ±0.4$^{bB}$ | 98.1 ±0.5$^{aA}$ |
| | A* | 100.4 ±0.3$^{aA}$ | 100.2 ±0.4$^{aA}$ | 100.3 ±0.3$^{aA}$ |
| Hb (g%) | B* | 13.77 ±0.86$^{acA}$ | 13.87 ±0.72$^{bA}$ | 13.85 ±0.86$^{cA}$ |
| | D* | 13.72 ±0.86$^{aAB}$ | 13.82 ±0.71$^{bAB}$ | 13.72 ±0.85$^{acA}$ |
| | A* | 13.70 ±0.86$^{aB}$ | 13.78 ±0.71$^{bB}$ | 13.73 ±0.87$^{abA}$ |
| PCV (%) | B* | 44.78 ±1.71$^{aA}$ | 43.45 ±1.52$^{bA}$ | 44.71 ±1.71$^{aA}$ |
| | D* | 46.62 ±1.77$^{aB}$ | 46.92 ±1.67$^{aB}$ | 46.52 ±1.69$^{aB}$ |
| | A* | 45.60 ±1.83$^{abAB}$ | 46.47 ±1.64$^{aB}$ | 45.32 ±1.60$^{bAC}$ |
| TEC | B* | 6.40 ±0.45$^{aA}$ | 6.29 ±0.53$^{bA}$ | 6.35 ±0.45$^{aA}$ |
| (millions/ | D* | 6.37 ±0.44$^{aA}$ | 6.26 ±0.53$^{bB}$ | 6.31 ±0.44$^{aA}$ |
| mm3) | A* | 6.38 ±0.45$^{aA}$ | 6.28 ±0.53$^{bAB}$ | 6.39 ±0.45$^{acA}$ |

*(B=before induction) (D=during maintenance) (A=after complete recovery)

*Values superscripted with different small letters differ significantly (P<0.05) in a row

*Values superscripted with different capital letters differ significantly (P<0.05) in a column

Jaw tone was intact in all groups before pre-anaesthetic administration, with significantly higher scores (P<0.05) and complete jaw relaxation observed 15 min post-TZ administration until recovery, facilitating easy intubation. This could be attributed to the deeper anaesthetic plane and the effect of the zolazepam content (Kwon *et al*., 2003), which induces inhibition of internuncial neurons at the spinal level (Morgan *et al*., 2012). In group II, mild resistance (score 3) was noted after recovery, but no significant difference (P>0.05) existed between groups.

The mean±SE values of physiological and haematological parameters, differential leucocyte counts and serum biochemical values at different intervals in various groups of dogs are presented in table 3, 4 and 5, respectively.

Group II showed a significantly higher heart rate (HR) before induction and after recovery, but lower during maintenance (P<0.05) compared to groups I and III. Within groups, significant changes (P<0.05) were observed across intervals in group II, while group III showed no significant variation. The decrease in HR during maintenance in group II may be attributed to anaesthetic-induced sympathetic depression and enhanced parasympathetic tone. Nam *et al*. (2013) similarly observed a significant reduction in HR within 20 min following administration of butorphanol, tiletamine-zolazepam, along with the α-2 agonist medetomidine.

All groups showed a significant decrease (P<0.05) in respiratory rate (RR) and rectal temperature (RT) during maintenance and increase after recovery, with group II exhibiting the most marked reduction. No significant differences were observed between groups before induction or after recovery. RR decreased significantly during maintenance due to anaesthetic-induced central depression, then increased post-recovery as normal drive resumed. Group II showed a greater decrease, likely due to enhanced sensitivity or cumulative effects of its anaesthetic regimen. Tiletamine–Zolazepam causes mild respiratory depression in dogs and dose-dependent respiratory compromise in cats with hypoxemia, hypercapnia, and acidosis (Hellyer *et al*., 1989). The greater decrease in RT during maintenance in group II indicates a stronger thermoregulatory effect of its anaesthetic protocol, aligning with Saikia (2016), who attributed hypothermia to muscle relaxation, reduced metabolism, and central thermoregulatory depression.

Haemoglobin (Hb) levels were consistently significantly higher (P<0.05) in group II compared to group I and group III across all intervals. No significant changes were observed in Hb levels in group I and group III throughout the study, suggesting that the TZ did not significantly impact erythropoiesis, oxygen-carrying capacity, or blood dilution effects (Spada *et al*., 2015).

All the groups showed significant increase (P<0.05) in packed cell volume (PCV) during maintenance, likely due to splenic contraction, a physiological response to sympathetic stimulation, which releases stored red blood cells into circulation. After recovery, the PCV values returned to baseline, suggesting the re-establishment of normal blood volume and distribution (Carroll *et al.*, 1997). Group II consistently showed significantly lower TEC (P<0.05) compared to the other groups, while groups I and III maintained stable values across the intervals. Anaesthetic agents used in the present study can cause peripheral vasodilation and subsequent plasma expansion, leading to a relative decrease in TEC. However, the absence of post-recovery alterations confirmed that TZ does not impact erythropoiesis or RBC integrity (Wu *et al*., 2023).

The neutrophil percentage remained stable across the intervals in all groups, with group II having a higher percentage before induction. Tiwari (2022) reported a non-significant increase in neutrophil count during anaesthesia with TZ and propofol in pre-medicated calves under sevoflurane. Group II had a significant increase in lymphocyte percentage (P<0.05) during the maintenance and recovery periods, which may reflect the compensatory immune response to the condition being investigated (Spada *et al*., 2015), while group I remained relatively stable across the intervals. The monocyte percentages were significantly (P<0.05) higher in group III across intervals, which could be attributed to chronic inflammation and immune system activation (Vovk *et al*., 2020), while group I and group II remained relatively stable. Group II exhibited a lower basophil percentage (P<0.05) across intervals, while group I and group III showed similar values. Basophil activity fluctuates during different stages of anaesthesia, reflecting acute immune responses in dogs (Mau *et al*., 2024). The eosinophil percentage remained stable across the intervals in all groups, with no significant differences among groups, indicating minimal involvement in inflammatory processes (Tvedten and Raskin, 2011).

**Table 4:** Effect of TZ on differential leucocyte count (DLC) at various intervals in various groups of dogs.

| Parameter | Time intervals | Group-I | Group-II | Group-III |
|---|---|---|---|---|
| Neutrophil (%) | B* | 65.13 ±2.93$^{acAC}$ | 67.13 ±2.76$^{bA}$ | 64.13 ±2.79$^{cA}$ |
| | D* | 63.13 ±2.93$^{aB}$ | 63.13 ±2.76$^{aB}$ | 62.13 ±2.79$^{aB}$ |
| | A* | 65.50 ±2.85$^{aC}$ | 64.25 ±2.91$^{abB}$ | 63.25 ±3.06$^{bB}$ |
| Lymphocyte (%) | B* | 25.00 ±1.21$^{aA}$ | 25.13 ±0.97$^{aA}$ | 25.75 ±0.77$^{bA}$ |
| | D* | 26.50 ±1.31$^{aB}$ | 30.25 ±1.00$^{bB}$ | 28.75 ±0.77$^{cB}$ |
| | A* | 25.50 ±1.31$^{aC}$ | 29.25 ±1.00$^{bC}$ | 27.75 ±0.77$^{cC}$ |
| Monocyte (%) | B* | 6.25 ±0.94$^{abA}$ | 5.88 ±0.83$^{aA}$ | 6.50 ±0.71$^{bA}$ |
| | D* | 6.25 ±0.94$^{aA}$ | 5.25 ±0.90$^{bB}$ | 6.50 ±0.71$^{acA}$ |
| | A* | 5.25 ±0.94$^{aB}$ | 5.25 ±0.90$^{aB}$ | 5.88 ±0.74$^{bB}$ |
| Basophil (%) | B* | 0.125 ±0.07$^{aA}$ | 0.163 ±0.06$^{abA}$ | 0.213 ±0.07$^{bA}$ |
| | D* | 0.188 ±0.07$^{aA}$ | 0.050 ±0.03$^{bB}$ | 0.150 ±0.06$^{acA}$ |
| | A* | 0.125 ±0.07$^{aA}$ | 0.163 ±0.06$^{abA}$ | 0.213 ±0.07$^{bA}$ |
| Eosinophil (%) | B* | 0.25 ±0.16$^{aA}$ | 0.25 ±0.16$^{aA}$ | 0.25 ±0.16$^{aA}$ |
| | D* | 0.25 ±0.16$^{aA}$ | 0.13 ±0.13$^{aA}$ | 0.13 ±0.13$^{aA}$ |
| | A* | 0.13 ±0.13$^{aA}$ | 0.25 ±0.16$^{aA}$ | 0.25 ±0.16$^{aA}$ |

*(B=before induction) (D=during maintenance) (A=after complete recovery)

*Values superscripted with different small letters differ significantly (P<0.05) in a row

*Values superscripted with different capital letters differ significantly (P<0.05) in a column

**Table 5:** Effect of TZ on serum biochemical values at various intervals in various groups of dogs.

| Parameter | Time intervals | Group-I | Group-II | Group-III |
|---|---|---|---|---|
| BUN (mg/dL) | B* | 12.63 ±2.72$^{aA}$ | 12.46 ±2.44$^{aA}$ | 12.72 ±2.92$^{aA}$ |
| | D* | 16.65 ±2.72$^{acB}$ | 25.90 ±4.42$^{bB}$ | 17.84 ±3.68$^{cB}$ |
| | A* | 14.11 ±2.74$^{aAB}$ | 21.39 ±3.60$^{bC}$ | 14.94 ±3.05$^{aAB}$ |
| Creatinine (mg/dL) | B* | 1.13 ±0.09$^{aA}$ | 1.17 ±0.10$^{aA}$ | 1.26 ±0.12$^{bA}$ |
| | D* | 1.21 ±0.09$^{aB}$ | 1.26 ±0.09$^{aB}$ | 1.27 ±0.12$^{aA}$ |
| | A* | 1.15 ±0.09$^{aAB}$ | 1.18 ±0.10$^{aA}$ | 1.26 ±0.12$^{bA}$ |
| SGPT (IU/L) | B* | 51.54 ±7.78$^{aA}$ | 51.46 ±7.45$^{aA}$ | 53.43 ±7.48$^{aA}$ |
| | D* | 58.91 ±7.21$^{aB}$ | 79.81 ±7.29$^{bB}$ | 63.37 ±6.82$^{aB}$ |
| | A* | 54.20 ±7.07$^{aAB}$ | 67.17 ±5.51$^{bC}$ | 57.77 ±6.27$^{aAB}$ |
| SGOT (IU/L) | B* | 51.18 ±2.77$^{aA}$ | 51.54 ±2.65$^{aA}$ | 52.05 ±2.45$^{aA}$ |
| | D* | 57.15 ±2.48$^{aB}$ | 74.20 ±2.75$^{bB}$ | 66.90 ±0.77$^{cB}$ |
| | A* | 53.56 ±2.50$^{aAB}$ | 67.09 ±2.78$^{bC}$ | 60.86 ±0.69$^{cC}$ |
| Glucose (mg/dL) | B* | 99.25 ±3.79$^{aA}$ | 99.50 ±3.50$^{aA}$ | 98.75 ±2.67$^{aA}$ |
| | D* | 108.25 ±3.48$^{acB}$ | 125.88 ±2.03$^{bB}$ | 112.63 ±2.05$^{aB}$ |
| | A* | 101.75 ±3.81$^{aAC}$ | 103.63 ±3.42$^{aAC}$ | 100.25 ±2.63$^{aA}$ |

*(B=before induction) (D=during maintenance) (A=after complete recovery)

*Values superscripted with different small letters differ significantly (P<0.05) in a row

*Values superscripted with different capital letters differ significantly (P<0.05) in a column

Group II had a significant increase in BUN during the maintenance period (P<0.05), while group I and group III remained relatively stable across the intervals. The creatinine level was significantly (P<0.05)

higher in group III across intervals, while group I and group II remained relatively stable. The significant rise in BUN in group II and creatinine in group III during maintenance was probably due to transient reductions in renal blood flow and GFR (Turcu *et al*., 2023). Their return to baseline post-recovery indicates temporary changes, not permanent renal impairment (Hamed, 2009).

Group II showed a significant increase in SGPT during the maintenance period (P<0.05), while group I and group III remained relatively stable across the intervals. SGOT levels were significantly higher in group II and group III during the maintenance and recovery periods (P<0.05), while group I remained relatively stable across the intervals. The significant increase in SGPT and SGOT during anaesthesia in group II was consistent with the findings of Koli *et al*. (2021) and Dehariya *et al*. (2024), reporting similar transient elevations. This rise likely reflects mild hepatic stress from anaesthetic agents affecting liver metabolism and perfusion (Pinto, 2014).

The glucose levels observed during the maintenance period were significantly (P<0.05) higher in group II, while group I and group III remained relatively stable across the intervals. The consistent hyperglycaemic response in group II was attributed to stress-induced catecholamine release during anaesthesia, leading to increased glycogenolysis and gluconeogenesis (Chang *et al.,* 2024).

The induction time (sec), recovery time (min), total duration of anaesthesia (min) and the total dose of TZ (mg/kg body wt.) are shown in table 6.

**Table 6:** Mean±SE of induction time (sec), recovery time (min), total duration of anaesthesia (min) and the total dose of TZ including both induction and maintenance dose (mg/kg body wt.) in various groups of dogs.

| Groups | Induction time (s) | Recovery time (min) | Total duration of Total dose of anaesthesia (min) TZ (mg/kg) |
|---|---|---|---|
| Group I | 55.88 | 56.25 | $43.50\pm0.97^{a}$ |
| | ±1.09 | ±1.51 | $2.66\pm0.06^{a}$ |
| Group II | 53.63 | 59.50 | $53.50^{\pm}0.97^{b}$ |
| | ±1.19 | ±1.81 | $2.16\pm0.06^{b}$ |
| Group III | 54.00 | 59.25 | $44.50\pm0.91^{a}$ |
| | ±1.24 | ±1.34 | $2.76\pm0.06^{a}$ |

* Values superscripted with different small letters differ significantly (P<0.05)

The induction time was rapid in group II followed by group III and slowest in group I. It could be due to altered drug absorption and distribution, leading to faster systemic availability. The pre-anaesthetic medication reduces fear and anxiety resulting in smooth induction, dose reduction and smooth recovery (Grubb *et al*., 2020). Comparison among the groups revealed that there was no significant (P>0.05) difference between the groups.

The recovery time values were slightly higher in group II followed in decreasing order by group III and group I. Comparison among the groups revealed that there was no significant (P>0.05) difference between the groups. Slightly longer recovery time in group II could be attributable to the effect of gastric lesions on metabolic rate of the drugs. The quality of recovery from anaesthesia was smooth in all groups, consistent with reports of excellent induction and recovery with TZ (Hellyer *et al*., 1989; Kwon *et al*., 2003).

In the present study, group II had a significantly longer duration of anaesthesia and required a lower dose of TZ (P<0.05) for endoscopic procedure, followed by group III and group I. This could be attributable to the more dehydration and altered metabolism in group II plausibly due to persistent vomiting in animals of this group.

In conclusion, administration of TZ following premedication with midazolam and butorphanol, produced a satisfactory depth of anaesthesia sufficient for the safe and effective performance of endoscopic procedures involving both the upper and lower GI tract in dogs. The anaesthetic protocol ensured smooth induction, stable maintenance, and uneventful recovery, with only minor and transient alterations in physiological and haemato-biochemical parameters. While the protocol was well-tolerated in healthy dogs, careful monitoring was warranted in dogs with upper GIT disorders.

## References

Carroll, G.L., Hartsfield, S.M. and Hambleton, R. 1997. Anaesthetic effects of tiletamine-zolazepam, alone or in combination with butorphanol, in goats. J. Am. Vet. Med. Assoc. **211**: 593-597.

Cha, K., Jeong, W.J., Kim, H.M. and So, B.H. 2021. Intravenous zoletil administration for the purpose of suicide. Clin. Exp. Emerg. Med. **8**: 149.

Chang, L.J., Weng, H.Y., Lien, C.Y. and Chen, K.S. 2024. Retrospective comparison of the anaesthetic effects of tiletamine–zolazepam with dexmedetomidine and ketamine with dexmedetomidine in captive Formosan Serow (*Capricornisswinhoei*). Diagnostics **14**: 1413.

Coppola, F., D'Addio, E., Casini, L., Sagona, S. and Felicioli, A. 2020. Field chemical immobilization of free-ranging crested porcupines with Zoletil®: A reviewed dosage. Vet. Sci. **7**: 194. doi: 10.3390/vetsci7040194.

Creighton, C.M. and Lamont, L.A. 2024. Sedatives and tranquilizers. *In*: Veterinary Anesthesia and Analgesia, The 6th edition of Lumb and Jones, Lamont, L., Grimm, K., Robertson, S., Love, L. and Schroeder, C. (Eds). Wiley-Blackwell. pp 333-354.

Dehariya, V., Tandia, N., Kumar, D., Singh, P., Meher, B., Wadiwa, S. and Singh, H. 2024. Clinicophysiological and haemodynamic effects of dexmedetomidine, xylazine and butorphanol as pre-anaesthetic agents in conjunction with tiletamine-zolazepam in dogs. Ann. For. Res. **67**: 272-284.

Grubb, T., Sager, J., Gaynor, J.S., Montgomery, E., Parker, J.A., Shafford, H. and Tearney, C. 2020. Anaesthesia and monitoring guidelines for dogs and cats. J. Am. Anim. Hosp. Assoc. **56**: 59-82.

Hamed, M.N.E. 2009. Update of Anaesthesia in Renal Transplantation, Doctoral Dissertation, Faculty of Medicine, Sohag University.

Haskins, S.C., Patz, J.D. and Farver, T.B. 1986. Xylazine and xylazine-ketamine in dogs. Am. J. Vet. Res. **47**: 636-641.

Hellyer, P., Muir III, W.W., Hubbell, J.A. and Sally, J. 1989. Cardiorespiratory effects of the intravenous administration of tiletamine-zolazepam to dogs. Vet. Surg. **18**: 160-165.

Jacobson, J.D. and Hartsfield, S.M. 1993. Cardiorespiratory effects of intravenous bolus administration and infusion of ketamine midazolam in dogs. Am. J. Vet. Res. **54**: 1710-1714.

Koli, P.H., Parikh, P.V., Mahla, J.K. and Barot, H.M. 2021. Clinical attributes of tiletamine-zolazepam-induced anaesthesia with and without xylazine premedication in dogs. Indian J. Vet. Sci. Biotechnol. **17**: 61-65.

Kruskal, J.B. 1964. Nonmetric multidimensional scaling: A numerical method. Psychometrika **29**: 115-129.

Kwon, Y.S., Jeong, J.H. and Jang, K.H. 2003. Comparison of tiletamine-zolazepam, xylazine-tiletamine-zolazepam, and medetomidine-tiletamine-zolazepam anaesthesia in dogs. J. Vet. Clin. **20**: 33-41.

Leela, M.S., Singh, S. and Pawde, A.M. 2023. Evaluation of zoletil, ketamine midazolam and propofol CRI anaesthesia for ovariohysterectomy in dexmedetomidine premedicated female dogs with pyometra. Pharm. Innov. J. **12**: 908-911.

Lu, Zhiqiang, Wenyuan Li, Huiyu Chen and Yanning Qian. 2018. Efficacy of a dexmedetomidine–remifentanil combination compared with a midazolam–remifentanil combination for conscious sedation during therapeutic endoscopic retrograde cholangio-pancreatography: a prospective, randomized, single-blinded preliminary trial. Dig. Dis. Sci. **63:** 1633-1640.

Manjusha, K.M., Kinjavdekar, P., Amarpal, Rohit Kumar, Khan Sharun, Islam, Saxena, A.C. and Pawde, A.M. 2021. Evaluation of tiletamine-zolazepam as an induction agent for ovariohysterectomy under isoflurane anaesthesia in dogs. Indian J. Vet. Surg. **44**: 37-40

Mau, A., Keller, S.M. and Kol, A. 2024. A clinical and haematologic approach to basophilia in dogs, cats, and horses. Vet. Clin. Pathol. 54: 24-34.

Morgan, D.R., Scobie, S. and Arthur, D.G. 2012. Evaluation of Zoletil and other injectable anaesthetics for field sedation of brushtail possums (*Trichosurusvulpecula*). Anim. Welf. **21**: 457-462.

Nam, S.W., Shin, B.J. and Jeong, S.M. 2013. Anaesthetic and cardiopulmonary effects of butorphanol-tiletamine-zolazepam-medetomidineand tramadol-tiletamine-zolazepam-medetomidine in dogs. J. Vet. Clin. **30**: 421-427.

Patel, K.D., Suthar, D.N., Jhala, S.K., Dabas, V.S., Bhanderi, D.R. and Bhatt, A.B. 2022. Effects of ketamine-midazolam and tiletamine-zolazepam as induction and isoflurane as maintenance anaesthetic agents on clinico-physiological and haemato-biochemical parameters in cats. Pharma Innov. J. 11: 32-35.

Pinto, R.A. 2014. Evaluation of the effects of laparoscopic surgeries on hepatic enzymes. Master's thesis, Rajiv Gandhi University of Health Sciences, India.

Rafee, M.A., Kinjavdekar, P., Amarpal, and Aithal, H.P. 2015. Effect of dexmedetomidine with or without butorphanol on the clinico-physiological and haemodynamic stability in dogs undergoing ovariohysterectomy in midazolam and ketamine anaesthesia. Int. J. Recent. Sci. Res. **45**: 241-249.

Tvedten, H. and Raskin, R.E. 2011. Leukocyte disorders. In: Small Animal Clinical Diagnosis by Laboratory Methods. Willard, M.D. and Tvedten, H. (Eds), 5th edn. Saunders, Philadelphia. pp 63-91.

Saikia, A. 2016. Romifidine and its combination with ketamine in dog, Doctoral dissertation, Assam Agricultural University, Khanapara, Guwahati (Assam), India.

Santosh, K.M., Amarpal, A., Ahmad, R.A., Kinjavdekar, P., Aithal, H.P., Pawde, A.M. and Dinesh Kumar 2013. Evaluation of midazolam-ketamine with dexmedetomidine and fentanyl for injectable anaesthesia in dogs. Vet. Arh. **8**3: 509-523.

Spada, E., Proverbio, D., Bagnagatti De Giorgi, G., Perego, R., Valena, E.,; Della Pepa, A. and Baggiani, L. 2015. Clinical and haematological responses of feline blood donors anaesthetized with a tiletamine and zolazepam combination. J. Feline. Med. Surg. **17**: 338-341.

Stanton, M.E. and Bright, R.M. 1989. Gastroduodenal ulceration in dogs. J. Vet. Intern. Med. **3**: 238-244.

Steel, R.G. and Torrie, J.H. 1980. Principles and Procedures of Statistics, a Biometrical Approach. 2nd edn. McGraw-Hill Book Company, New York.

Svorc, P., Bacova, I., SvorcJr, P., Novαkovα, M. and Gresova, S. 2016. Zoletil anaesthesia in chronobiological studies. Biol. Rhythm. Res. **47**: 103-110.

Tiwari, K. 2022. Studies on the effects of tiletamine-zolazepam, propofol, and sevoflurane anaesthesia in dexmedetomidine and butorphanol premedicated dogs. Doctoral Dissertation, GB Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar-263145 (Uttarakhand), India.

Turcu, M.R., Mic'a, C., Ioniã, L. and Costea, R. 2023. The effect of general anaesthesia on urea and creatinine values in a group of dogs. Sci. Works Ser. C. Vet. Med. **69:** 109-112.

Vovk, A.N., Karantysh, G.V., Kosenko, P.O. and Medvedev, D.S. 2020. Principles of therapy and care of laboratory animals after chronic administration into Xylasine-Zoletyl® Anaesthesia. Int. J. Vet. Sci. Res. **6**: 114-117.

Wu, T., Chen, Y., Yang, M., Wang, S., Wang, X., Hu, M., Cheng, X., Wan, J., Hu, Y., Ding, Y. and Zhang, X. 2023. Comparative plasma and urine metabolomics analysis of juvenile and adult canines. Front. Vet. Sci. **9**: 1037327.

Xu, L., Li, Y., Zheng, H. and Wang, R. 2024. Optimizing perioperative anaesthesia strategies for safety and high-quality during painless gastrointestinal endoscopy diagnosis and treatment. Anaesth. Perioper. Sci. **2**: 21.