Indian Journal of Animal Sciences **95** (5): 471–475, May 2025/Short cummunication
https://doi.org/10.56093/ijans.v95i5.158952

Clinical evaluation of tiletamine-zolazepam with xylazine and butorphanol for short duration surgical procedures in equines

ADITI SHARMA[1], AMIT KUMAR[1], ROHIT KUMAR[1], ADARSH KUMAR[1], DEEPTI BODH1, DEEPTI SHARMA[1], S P TYAGI[1], YASH KAMDI[1] and NARUTE VISHWATEJ[1]

D G C N College of Veterinary and Animal Sciences, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, H P 176 062 India

Received: 25 October 2024; Accepted: 11 August 2025

Keywords: Dissociative anaesthesia, Equine, General anaesthesia, Quality of recovery, Short-duration surgical procedures, Tiletamine-zolazepam combination, TIVA, Xylazine, Zoletil®

General anaesthesia in horses is notably riskier than in humans (Bland 2000), dogs or cats (Lagasse 2002), with a 1 per cent mortality rate for healthy horses undergoing elective procedures, and rising 9.8 times during emergency abdominal surgeries (Johnston *et al.* 2002). Total intravenous anaesthesia (TIVA) is preferred over inhalant anaesthesia for its cost-effectiveness and safety (Muir 1991) and is commonly used in field surgeries (Taylor and Clarke 1999). Drug combinations for short-term anaesthesia typically include alpha-2 adrenoceptor agonists like xylazine with dissociative anaesthetics (ketamine, Telazol) or barbiturates (Muir *et al.* 1977). Zoletil® (a tiletamine-zolazepam mixture) has recently been introduced in India, showing longer anaesthesia and better muscle relaxation when used with xylazine compared to xylazine-ketamine (Muir *et al.* 1977, Hubbell *et al.* 1989, Short *et al.* 1989). Its use in India was first documented by Babar *et al.* (2023) in horses for short-term anaesthesia in field conditions, prompting a further study of its effects combined with xylazine and butorphanol for short-duration surgeries.

MATERIALS AND METHODS

This study involved 12 clinically healthy equines undergoing various surgical procedures such as castration, fracture reduction, tumour excision etc. The equines were randomly divided into two groups: group I (n=6; 4.41±1.95 years, 206.83±10.96 kg) and group II (n=6; 5.5±2.07 years, 266.5±21.15 kg). Tetanus prophylaxis was administered two weeks prior to surgery and the animals were fasted overnight. Antibiotics were given intravenously 30 min before anaesthesia. Group I received butorphanol (0.02 mg/kg, IV), xylazine (1.1 mg/kg, IV) and tiletamine-zolazepam (1.1 mg/kg, IV), while group II received the same protocol but with tiletamine-zolazepam at 1.25 mg/kg for total intravenous anaesthesia (TIVA). Anaesthesia was evaluated through behavioural, clinical, haematological and biochemical studies. The quality of induction was assessed by a scorecard given by Marntell *et al.* (2006) in Table 1.

The signs of anaesthesia were analysed by recording different reflexes such as palpebral reflex, corneal reflex and photo-pupillary reflex. Position of the eyeball, lacrimation and nystagmus along with the presence and absence of swallowing and vocalization were also recorded. Various sites for muscle relaxation of the neck, jaws, tail and anal sphincter tone were examined and the degree of muscle relaxation was assessed by a scorecard given by Rossetti *et al.* (2008) in Table 2.

Table 1. Scorecard for quality of induction (Marntell *et al.* 2006)

Score	Quality of induction
0	Poor: Animal was induced with considerable movement and/or excitement; or could have resulted in injury.
1	Fair: The recumbency achieved, the horse fell without relaxation of limbs or with a strong forward or backward movement.
2	Good: Smooth induction, but the horse showed head or limb twitching after induction or walked forward or backward after the induction agent was administered.
3	Excellent: Smooth induction, no muscle twitching with absence of forward or backward movements.

Table 2. Scorecard for degree of muscle relaxation (Rossetti *et al.* 2008)

Score	Degree of muscle relaxation
0	Poor: Spontaneous motor activity, struggling during manipulation
1	Acceptable: Muscle rigidity
2	Good: Complete muscle relaxation, no resistance to limb manipulation

Present address: D G C N College of Veterinary and Animal Sciences, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur 176 062, H P India. ✉Corresponding author email: drasingla@gmail.com

Response to the application of nociceptive stimuli (artery forceps pinch) on the coronary band of the front and hind leg, the shoulder and the gaskin were recorded to assess the quality of analgesia by a scorecard given by Marntell *et al.* (2006) in Table 3.

The quality of anaesthesia was assessed by different grades by Vende (2005) in Table 4.

Table 3. Scorecard for degree of analgesia (Marntell *et al*. 2006)

Score	Degree of Analgesia
1	Kicking
2	Distinct limb movement
3	Reaction during skin incision and/or clamping of the spermatic cord
4	No reaction

Table 4. Quality of anaesthesia (Vende 2005)

Grade	Quality of anaesthesia
A	Excellent- Good depth of anaesthesia without any complications
B	Satisfactory- Good depth of anaesthesia with slight voluntary/involuntary movements.
C	Partially satisfactory- Presence of only a few of the characteristic signs which interfere with the course of anaesthesia
D	Unsatisfactory- Absence of the characteristic signs of anaesthesia

The quality of recovery of each equine was graded based on the overall attitude during recumbency, move to sternal, sternal phase (attempts to sternal), move to stand, number of attempts to stand, presence or absence of knuckling, strength, balance and coordination using a scale proposed by Valverde *et al.* (2005) in Table 5.

Duration of anaesthesia was noted as the time taken from the onset of anaesthesia till the animal showed the first response to painful stimuli. Clinical parameters such as heart rate, respiration rate, rectal temperature, capillary refill time, blood pressure and ECG were recorded before, during and after complete recovery from anaesthesia. Blood samples were taken for haematological and biochemical analysis. Parameters such as induction quality, muscle relaxation, analgesia, anaesthesia duration and recovery (e.g. first head-righting reflex, sternal recumbency, standing attempts and recovery time) were assessed and compared between the two groups. Data were analyzed using IBM SPSS software, with significance determined via one-way ANOVA and Tukey's post-hoc test ($p<0.05$).

Table 5. Scorecard for the quality of recovery (Valverde *et al.* 2005)

Score	Overall attitude	Move to sternal
1	Frantic	Crashing, flopping over
2	Confused, dizzy	Fighting mat, but controlled
3	Calm	Smooth, methodical
Score	Sternal phase	Move to stand
1	Multiple with struggle	An organized scramble
2	Non-existent	Methodical
3	An organized pause	
Score	Number of attempts to stand	Knuckling
1	More than two attempts	All four limbs
2	Two attempts	Hind limbs only
3	Single attempt	None
Score	Strength	Balance and coordination
1	Repeated attempts due to weakness	Falls back down
2	Dog-sitting before standing	Moderate dancing
3	Mildly rubbery	Careening
4	Near full	Solid

RESULTS AND DISCUSSION

The observations of the present study were recorded before anaesthesia, during anaesthesia and up to complete recovery from anaesthesia in equines anaesthetized with butorphanol-xylazine-tiletamine-zolazepam combination. The induction quality of anaesthesia were rated as 'excellent-to-good' in equines of group I and 'excellent' in those in group II (smooth induction, no muscle twitching and no forward or backward movement), with all animals achieving lateral recumbency within one min. Similar results were found by Abrahamsen *et al.* (1991) and Matthews *et al.* (1991), who noted that horses became laterally recumbent in approximately 68±8 seconds after receiving tiletamine-zolazepam. Ocular reflexes were maintained throughout anaesthesia, with all equines exhibiting spontaneous blinking. These observations align with the findings of Romagnoli *et al.* (2018) and Babar *et al.* (2023). The eyeballs of the equines rotated ventromedially during anaesthesia and returned to a central position upon recovery. Nystagmus was noted in four equines in group I and all six in group II at varying times, consistent with reports from Romagnoli *et al*. (2018) and Babar *et al.* (2023). Lacrimation occurred in three equines across both groups. Loss of the swallowing reflex was observed in all animals, indicating sufficient relaxation of relevant muscles, necessitating tracheal intubation, as reported by Bechara *et al.* (1998) and Phutthachalee *et al.* (2012). Group I had no cases of paddling movements, while one equine in group II exhibited this after ten min in response to pain, echoing findings by Abrahamsen *et al.* (1991) and Babar *et al.* (2023). Muscle relaxation was generally good, although two equines in group I showed some resistance during gelding. Anal reflex was maintained in both groups, corroborating findings by Abrahamsen *et al.* (1991), Lin *et al.* (1992), Phutthachalee *et al.* (2012) and Ceylan (2013). Analgesia was adequate in group I and good in group II, with one equine showing paddling due to pain. Cuvelliez *et al.* (1995) noted superficial analgesia lasting 31.7±3.2 min, while Wan *et*

Table 6. Mean ± SE values of anaesthesia parameters in equines of group I and II

Parameter	Group I	Group II
Quality of induction (score)	2.5±0.22	2.83±0.16
Degree of muscle relaxation (score)	1.83±0.16	2.0±0.00
Degree of analgesia (score)	2.83±0.3	3.0±0.51
Duration of anaesthesia (min)	30.833±2.845	32.833±3.32
Sternal recumbency (min)	6.0±2.70	9.16±3.24
Standing (min)	12.83±3.134	18.0±3.55
Complete recovery (min)	16.16±3.09	22.83±3.87
Quality of recovery (score)	21.0±0.63	23.16±0.47

al. (1992) reported horses becoming responsive to surgical stimuli within 30 min under similar anaesthetic conditions. The mean duration of anaesthesia was shorter in equines of group I (30.833±2.845 min) than that in equines of group II (32.833±3.32 min), sufficient for short-duration surgical procedures. Previous studies (Matthews *et al.* 1991, Lin *et al.* 1992, Cuvelliez *et al.* 1995) reported similar findings with tiletamine-zolazepam and xylazine. Overall, group I had satisfactory anaesthesia, with mild visceral traction reported during procedures, while group II experienced excellent anaesthesia, barring one case of paddling. Historical studies by Short *et al.* (1989) and Matthews *et al.* (1991) confirmed the adequacy of anaesthesia with tiletamine-zolazepam in various equine family (horse, mule and donkey). In this study, the time taken by the equines to raise their heads in lateral recumbency was less than one minute for four equines in group I and three equines in group II. Vende (2005) reported a mean head-up time of 6.4±0.51 min for horses anaesthetized with xylazine (1.0 mg/kg BW, IV) and ketamine (2.0 mg/kg BW, IV). Babar *et al.* (2023) found head-up times of 5±0.96 min, 6.66±1.47 min, and 6.83±1.16 min in horses anaesthetized with xylazine (1.1 mg/kg BW, IV) and tiletamine-zolazepam at varying doses. The mean time to attain sternal recumbency was 6±2.70 min for group I and 9.16±3.24 min for group II, with group II taking longer. Phutthachalee *et al.* (2012) reported a shorter sternal recumbency time of 3.0±1.4 min for anaesthetized foals. Babar *et al.* (2023) recorded sternal times of 7.16±1.66 min, 9.66±2.55 min, and 16.66±1.52 min for various anaesthetic combinations. For standing, the equines in group I required 12.83±3.13 min and while those in group II required 18.0±3.55 min. Phutthachalee *et al.* (2012) noted a standing time of 4.1±7.1 min for foals. Babar *et al.* (2023) reported standing times of 11.16±2.0 min, 12.5±3.45 min, and 21.33±2.31 min for different doses. The mean complete recovery time for group I was 16.16±3.09 min while that for group II was 22.83±3.87 min, with group II recovering more slowly. Phutthachalee *et al.* (2012) reported a recovery time of 21.1±2.9 min in foals, while Babar *et al.* (2023) found recovery times of 26.16±3.51 min, 35.5±4.44 min, and 46.33±4.49 min for horses under similar anaesthesia. Animals in group I exhibited smooth and rapid recovery, while those in group II showed smooth but prolonged recovery. All animals in group I achieved sternal recumbency in a single attempt, whereas one equine in group II needed four attempts and another two attempts. All equines stood in a single attempt; however, those in group II took longer to stand (32 min and 21 min). Rapid recovery was noted in two equines from group I, with times of 8 and 9 min. Matthews *et al.* (1989) reported smooth recovery in mules requiring less than three attempts to stand after anaesthesia with xylazine (1.1 mg/kg BW, IV) and tiletamine-zolazepam (1.1 mg/kg BW, IV). Matthews *et al.* (1990) observed satisfactory anaesthesia and smooth recovery in donkeys under the same anaesthetic protocol. Matthews *et al.* (1991) noted good muscle relaxation and smooth recovery in horses anaesthetized with xylazine, butorphanol and tiletamine-zolazepam, with animals requiring fewer than three attempts to stand. Similarly, Lin *et al.* (1992) reported smooth recovery and good muscle relaxation in horses anaesthetized with xylazine and tiletamine-zolazepam. Various clinical and anaesthetic parameters were recorded before induction, immediately after induction, 10, 20, 30 and 40 min (base, immediate, T_{10}, T_{20}, T_{30} and T_{40}). In group I, a non-significant decline in heart rate was observed immediately after anaesthesia induction, while group II showed a non-significant increase in heart rate. No statistically significant differences were found between or within groups regarding respiratory rates, although group II exhibited a non-significant reduction immediately after anaesthesia. Respiratory rates increased from baseline by the 30-min mark and gradually returned to baseline as recovery progressed. Group I experienced a significant decrease in rectal temperature ($p<0.05$) at 10, 20, 30 and 40 min post-induction, while group II had a

Table 7. Mean ± SE values of clinical parameters in equines of group I and II

Time of recording	Heart rate (bpm)		Respiration rate (breaths/min)		Rectal temperature (°F)		MAP (mm Hg)	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
Base	47±2.60	49±4.61	17.66±3.44	14.5±3.13	99.87±0.32	99.74±0.56	93.83±4.2	98.0±6.12
Immediate	44.66±6.87	53.16±6.68	17.66±2.49	13.83±2.10	99.55±0.30	98.97±0.72	99.5±2.77	102.16±5.19
T_{10}	34.33±5.04	44.66±5.33	14.0±2.01	14.0±1.48	98.63±0.34*	99.31±0.44	89.0±5.02	97.66±5.83
T_{20}	32.83±2.60	42.66±2.23	15.8± 2.16	15.33±2.56	98.15±0.28*	98.53±0.36	8.16±5.88	91.83±8.10
T_{30}	37.33±2.86	41.66±3.23	18.83±1.92	14.83±1.75	98.48±0.23*	98.46±0.5	94.0±6.37	85.33±5.82
T_{40}	46.33±5.53	45.5±3.48	21.66±3.91	14.33±1.74	98.78±0.22*	98.67±0.34	93.5±3.32	89.16±4.65

*The mean difference within the group was significant when compared with the base value ($p< 0.05$).

non-significant decline in rectal temperature. Both groups maintained these values within the normal physiological range. Capillary refill time (CRT) remained normal (less than 2 sec to 2 sec) in both groups, indicating adequate blood pressure and tissue perfusion. A non-significant decrease in SpO_2 values was noted at 20 min but began to rise after that. ECG parameters remained consistent with physiological values across both groups. Mean arterial blood pressure increased non-significantly post-induction but decreased during anaesthesia, remaining within normal physiological limits.

It may be concluded that the combination of tiletamine-zolazepam administered for induction of general anaesthesia in equines receiving butorphanol and xylazine as preanaesthetic is safe and effective for short-duration surgical procedures and tiletamine-zolazepam @ 1.1mg/kg BW, IV provided satisfactory quality of anaesthesia with acceptable muscle relaxation, adequate analgesia and smooth recovery whereas tiletamine-zolazepam @ 1.25mg/kg BW, IV provided excellent quality of anaesthesia with good muscle relaxation, good analgesia and a better quality of recovery than at the dose rate of 1.1 mg/kg BW, IV.

SUMMARY

The objective of this study was to standardize dosage of tiletamine-zolazepam in combination with xylazine and butorphanol for general anaesthesia in equines and to evaluate the anaesthetic effects by monitoring cardiopulmonary and hemato-biochemical changes. Twelve healthy equines undergoing short-duration surgical procedures were randomly divided into two groups. Both groups received pre-anaesthesia with butorphanol (0.02 mg/kg, IV) and xylazine (1.1 mg/kg, IV), followed by induction with tiletamine-zolazepam at doses of 1.1mg/kg (group I) and 1.25 mg/kg (group II), intravenously. Group I experienced satisfactory anaesthesia with adequate muscle relaxation and smooth recovery, while group II showed better muscle relaxation, analgesia and recovery quality. The anaesthesia duration was 30.83±2.84 min in group I and 32.83±3.32 min in group II, sufficient for short duration surgical procedures. Recovery times were 16.16±3.09 min and 22.83±3.87 min, respectively, with group II showing a longer but better-quality recovery.

REFERENCES

Abrahamsen E J, Hubbell J A E, Bednarski R M, Muir W W and Macioce B A. 1991. Xylazine and tiletamine-zolazepam for induction of anaesthesia maintained with halothane in 19 horses. *Equine Veterinary Journal* **23**(3): 224-25.

Babar N, Khandekar G S, Tripathi S D, Saini D, Gaikwad S V and Chauhan S A. 2023. Clinical evaluation of xylazine-zoletil anesthesia in equine under field conditions. *The Indian Journal of Veterinary Sciences and Biotechnology* **19**(1): 77-81.

Bechara J N, Barros P S D M, Fantoni D T, Cortopassi S R G and Silva L C D. 1998. Intraocular pressure evaluation of equines anesthetized with romifidine, tiletamine/zolazepam, halothane and vecuronium. *Ciência Rural* **28**(1): 59-64.

Bland M. 2000. *An Introduction to Medical Statistics*, 3rd ed. Oxford University Press, Oxford, UK: pp 294-95.

Ceylan C. 2013. Dissociative anaesthesia in foals for umbilical herniorrhaphy under field conditions. *Kafkas Universitesi Veteriner Fakultesi Dergisi* **19**: 87-92.

Cuvelliez S, Rosseel G, Blais D, Salmon Y, Troncy E and Lariviere N. 1995. Intravenous anesthesia in the horse: Comparison of xylazine-ketamine and xylazine-tiletamine-zolazepam combinations. *Canadian Veterinary Journal* **36**: 613-18.

Hubbell J A., Bednarski R M and Muir W W. 1989. Xylazine and tiletamine-zolazepam anesthesia in horses. *American Journal of Veterinary Research* **50**(5): 737-42.

Johnston G M, Eastment J K, Wood J L N and Taylor P M. 2002. The confidential enquiry into perioperative equine fatalities (CEPEF): mortality results of phases 1 and 2. *Veterinary Anaesthesia and Analgesia* **29**: 159-70.

Lagasse R S. 2002. Anesthesia safety: Model or myth? *Anesthesiology* **97**: 1609-17.

Lin H C, Branson K R, Thurmon J C, Benson G J, Tranquilli W J and Olson W A. 1992. Ketamine, telazol, xylazine drug combinations in ponies. *Acta Scandinavica Veterinarian* 33: 109-15.

Marntell S, Nyman G and Funkquist P. 2006. Dissociative anaesthesia during field hospital conditions for castration of colts. *Acta Veterinaria* 47(1): 1-12.

Matthews N S, Hartsfield S M, Cornick J L, Williams J D and Beasley A. 1991. A comparison of injectable anesthetic combinations in horses. *Veterinary Surgery* **20**(4): 268-73.

Muir W W, Skarda R T and Milne D W. 1977. Evaluation of xylazine and ketamine hydrochloride for anesthesia in horses. *American Journal of Veterinary Research* **38**(2): 195-201.

Muir W W. 1991. Intravenous anesthetics and anesthetic techniques in horses, in Muir, W.W.III, Hubbell, J.A. (eds): *Equine Anesthesia: Monitoring and Emergency Therapy. St. Louis: Mosby Year Book*; 419-43.

Phutthachalee S, Cherdchutham W, Laikul A, Phetudomsinsuk K, Chanda M and Phukudom S. 2012. Comparison of the anesthetic effects of tiletamine HCl–zolazepam–xylazine and ketamine–diazepam–xylazine in older foals under field conditions. *Agriculture and Natural Resources* **46**(2): 190-99.

Romagnoli N, Rinnovati R, Lambertini C and Spadari A. 2018. Short-term general anesthesia with tiletamine/zolazepam in horses sedated with medetomidine for castration under field conditions. *Journal of Equine Veterinary Science* **67**: 50-54.

Rossetti R B, Cortopassi S R G, Intelizzano T, Machado T S D L, Ferreira da Cruz R S. 2008. Comparison of ketamine and S(+) ketamine, with romifidine and diazepam, for total intravenous anaesthesia in horse. *Veterinary Anaesthesia and Analgesia* **35**(1): 30-35.

Short C E, Tracy C H and Sanders E. 1989. Investigating xylazine›s utility when used with telazol in equine anesthesia. *Veterinary Medicine (USA)* **84**(2): 228-33.

Taylor P M and Clarke K W. 1999. (ed): *Handbook of Equine Anaesthesia*. 1st ed. PA, W.B. Saunders, Philadelphia. p 41.

Valverde A, Gunkel C, Doherty T J, Giguère S and Pollak A S. 2005. Effect of a constant rate infusion of lidocaine on the quality of recovery from sevoflurane or isoflurane general anaesthesia in horses. *Equine Veterinary Journal* **37**: 559-64.

Vende S S. 2005. Comparative study on propofol and ketamine anaesthesia in equine gelding. M.V.Sc. thesis, Maharashtra Animal and Fishery Sciences University, Nagpur, India.

Wan P Y, Trim C M and Mueller P E. 1992. Xylazine-ketamine and detomidine-tiletamine-zolazepam anesthesia in horses. *Veterinary Surgery* **21**(4): 312-18.