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Comparative Evaluation of Dexmedetomidine and Fentanyl Citrate as Preanaesthetic to Intravenous Zoletil Anaesthesia in Goats (*Capra hircus*)

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ABSTRACT

Background: Zoletil is a proprietary combination of equal parts of tiletamine and zolazepam with relatively short duration of action which necessitates administration of several maintenance doses. Zoletil combined with dexmedetomidine and fentanyl citrate in goats has not been reported in Indian literature. Therefore, the objective of present study was to compare the sedative, analgesic, anaesthetic efficacy and suitability of peanaesthetics in combination with intravenous zoletil anaesthesia in goats.

Methods: Eighteen healthy non-descript goats of either sex, weighing between 20-25 kg were randomly divided into three groups (Group Z, DexZ and FentZ) with six animals in each. Atropine sulphate @ 0.04 mg/kg b.wt. intramuscularly was administered 10 min. prior to anaesthetic trail in all the animals of different groups. The animals of group Z received Zoletil alone @ 5.5 mg/kg by slow intravenous injection and kept as control. Ten minutes later, in groups DexZ and FentZ, dexmedetomidine @ 5 mcg/kg b.wt. and fentanyl citate @ 10 mcg/kgb.wt. were administered slow intravenously respectively. Anaesthesia was induced 10 minutes later by slow bolus dose of Zoletil @ 5.5 mg/kg b. wt. intravenously in animals of all the groups till the pedal reflex abolished.

Result: The onset of sedation and induction of anaesthesia was quicker in group DexZ followed by FentZ and Z. Duration of anaesthesia and complete recovery time were significantly ($P<0.05$) longer in group DexZ as compared to group FentZ and Z. Analgesia was excellent in all the groups but of longer duration in animals of group DexZ. To conclude dexmedetomidine-zoletil combination produced prolonged duration of anaesthesia with excellent muscle relaxation suitable for long surgical procedure.

Key words: Anaesthetic, Dexmedetomidine, Fentanyl citrate, Goat, Sedative, Zoletil.

INTRODUCTION

Small ruminants, particularly sheep and goats, are multi-functional animal and play a significant role in the economy and nutrition of landless small and marginal farmers in the country due to its unique qualities such as high fertility rate, short kidding interval, good quality chevon, milk and hairs (Maravi *et al.,* 2017). General anaesthesia is required in goats as it undergoes various surgical procedures, including hernia, dystocia and traumatic injuries and are used as a surgical model for a variety of biomedical research applications, as an animal model in many studies, especially in cardiovascular and regeneration, orthopedic and reproductive studies, therefore, needs safe and perfect general anaesthesia (Zeedan *et al.,* 2014). An anaesthetic combination with minimal cardiovascular and respiratory effects is desirable when anaesthesia is required for longer duration in small ruminants. Despite the availability of the new anaesthetic and pre-anaesthetic drugs, none of them achieves the qualities of an ideal anaesthetic agent. Therefore, the combination of pre-anaesthetic and anaesthetic agents has been broadly used in animal practice to achieve optimum analgesia, hypnosis and muscle relaxation which is known as balanced anaesthesia or multimodal anaesthesia (Verma *et al.,* 2018).

Atropine sulphate is used as preanaesthetic to prevent salivary, bronchial, tracheal and gastric secretions and to inhibit the bradycardiac effects of vagal stimulation. Dexmedetomidine is a highly selective α2-adrenoceptor agonist that is widely used as a sedative, analgesics and anaesthetic drug in veterinary medicine (Riebold, 2007). Dexmedetomidine has sympatholytic effects that manifest decrease in norepinephrine release, blood pressure and heart rate (Shah *et al.,* 2016). However, its anaesthetic, recovery and side effects in goats have not been investigated except in very few studies (Kutter *et al.,* 2006). Fentanyl is a potent synthetic μ-opioid agonist with principal

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actions of therapeutic value as analgesia and sedation and is suitable for intravenous infusion because it offers clinically desirable effects over a wide dose range and has a wide therapeutic margin (Meredith *et al.,* 2008).

Zoletil is a proprietary combination of equal parts of tiletamine and zolazepam which is a non-opioid, non-barbiturate injectable anaesthetic combination. Tiletamine is an analogue of ketamine which is dissociative anaesthetic, a non-competitive N-methyl-d-aspartate (NMDA) antagonist and zolazepam, a benzodiazepine having anti-convulsant and muscle relaxant properties (Doherty *et al.,* 2002). Zoletil produces better muscle relaxation, more profound analgesia (Lin and Walz, 2014) and also prevent convulsions and induce smooth recovery from anaesthesia which has been reported in dogs, cats and exotic species (De-zhang *et al.,* 2012). Carroll *et al.* (1997) used zoletil @ 5.5 mg/kg which causes rapid induction of anaesthesia. However, zoletil has a relatively short duration of action which necessitates administration of several maintenance doses resulting in prolonged recovery. Scanty research has been published on the use of zoetil in goats and till today, regarding use of zoletil alongwith dexmedetomidine and fentanyl citrate in goats has not been published in India. Therefore, the present research work was planned to compare the sedative, analgesic, anaesthetic efficacy and suitability of dexmedetomidine and fentanyl citrate as preanaesthetic to intravenous zoletil anaesthesia in goats (*Capra hircus*).

MATERIALS AND METHODS

The present study was carried out in confinement of Department of Veterinary Surgery and Radiology at College of Veterinary Science and Animal Husbandary, Anjora, Durg and conducted on 18 healthy non-descript goats of either sex weighing between 20-25 kg which were divided into three groups (Group Z, DexZ and FentZ) comprising of 6 animals in each. All the goats were dewormed with Albendazole Tab @ 7 mg/kg b.wt. orally fifteen days before the start of anaesthetic trials. Animal of all the groups were kept off feed for 12 hours and water withheld for 6 hours respectively prior to administration of anaesthesia. The animals were kept under uniform feeding and managemental practices throughout the study period.

Anaesthetic design

Atropine sulphate @ 0.04 mg/kg b.wt. intramuscularly was administered 10 min. prior to anaesthetic trail in all the animals of different groups. The animals of group Z received bolus dose of Zoletil alone @ 5.5 mg/kg by slow intravenous injection and kept as control group. The animals of group, DexZ and FentZ, after atropine injection, 10 minutes later were administered dexmedetomidine @ 5 mcg/kg b.wt. and fentanyl citate @ 10 mcg/kgb.wt. slow intravenously respectively. Animals were kept undisturbed in a calm environment to record the onset of sedation. Then 10 minutes later, induction of anaesthesia was done by slow intravenous injection of Zoletil @ 5.5 mg/kg b. wt. in animals of all the groups until the pedal reflex abolished.

Assessment of anaesthesia

Comparative evaluation of sedative, analgesic and anaesthetic effects were done on the basis of onset of sedation (minutes), induction of anaesthesia (minutes), duration of anaesthesia (minutes) and recovery time (minutes). Recovery from anaesthesia was taken to have occurred on regaining of head rightening reflex, sternal recumbency time, standing time with ataxia, browsing time and complete recovery without ataxia. Additional various reflexes and behavioral responses were also recorded using numeric score system as depicted in Table 1 at (0) base value, sedation, 5 min after sedation, after induction and at 5, 15, 30, 45, 60 and 120 minutes interval after administration of zoletil with different pre-anaesthesia combination. The signs were observed during sedation included nodding, ptosis, development of ataxia, decrease ear flapping, salivation, onset of sternal or lateral recumbency, decreased reaction to external stimuli and loss of browsing. Analgesic effect was evaluated by observing physical response of the animal to cutaneous hypodermic needle pricks on fetlock, base of tail, abdomen and base of horn. The status of the palpebral reflex was recorded as a measure of depth of sedation and was measured by observing a blink of the eye lids on touching the area around the medial canthus of the eyes with the index finger. The status of the pedal reflex was recorded as a measure of the depth of analgesia and assessed by observing the withdrawal reflex to the pinching of the inter-digital skin of the hindfoot of the animal with thumb forcep. Relaxation of the jaw was taken as a measure of muscle relaxation. It was evaluated by observing the resistance to opening of the jaw while pulling apart the lower and upper jaws. The response of animal to anal sphincter reflex by pinching the anus with a thumb forcep. Quality of Anaesthesia was analyzed by recording different reflexes, extent of muscle relaxation and analgesia after zoletil anaesthesia. The quality of anaesthesia was recorded on a scale 1 to 4 where 1 represents poor anaethesia, 2-fair anaesthesia, 3-good anaesthesia and 4-excellent anaesthesia. Any complications like regurgitation, hypersalivation, lacrimation, tympany, muscle twitching *etc.* were noted during and after anaesthesia in each group of animal.

Statistical analysis

The data collected was statistically analysed using analysis of variance (ANOVA) and Duncan's multiple range tests (DMRT). The mean and standard error of the recorded values were calculated. Comparison within group and between groups was made using SPSS v25 statistics software program and data was presented as Mean±S.E. The subjective data generated from the scoring of various parameters were analysed using the Kruskal Wallis Test. Statistically significant differences were considered at 5 per cent level (5%).

RESULTS AND DISCUSSION

Onset of sedation

Animals of group Z did not exhibit any signs associated with sedation as no preanaesthetic agent was given. Whereas, goats achieved marked sedation with lowering of head after intravenous administration of dexmedetomidine alongwith decreased response to external stimuli with mild to moderate salivation in animals of group DexZ. All the animals were unable to stand when disturbed but remained conscious. However, the animals of group FentZ did not show sign of sedation after intravenous administration of fentanyl citrate but exhibited signs of excitement, restlessness, increased vocalization and exaggerated tail-wagging, increased sniffing, attempts to bite at objects within the proximity, teeth-grinding, a star-gazing appearance, exaggerated dorso-flexed neck, bleating, walking on flexed carpals, pelvic limb paddling, pruritis and nibbling near objects which is consistent with findings documented by Dzikiti *et al.* (2016) and Delgado *et al.* (2021) after intravenous premedication with fentanyl citrate in goats. These behavioral changes have been reported in association with the administration of opioids in ruminants, derived from central nervous system stimulation (Valverde and Doherty, 2008) changes such as an increase in vocalization and agitation (Upton *et al.,* 2003), chewing movements and nystagmus (Pablo *et al.,* 1997) and excessive tail-wagging (Dzikiti *et al.,* 2011). Onset of sedation and sternal recumbency was quicker in group DexZ than other groups due to the onset of action of

Table 1: Numeric score system used for recording of various reflexes and responses (adopted and modified by Kumar *et al.,* 2018).

Parameters	Score			
	0	1	2	3
Analgesia	No analgesia, strong reaction to pin pricks	Mild analgesia, weak response to pin pricks	Moderate analgesia, occasional response to pin pricks	Complete analgesia, no response to pin pricks.
Relaxation of jaw	Not allowing to open the jaw	Resistant to opening the jaws and closed quickly	Less resistance to opening no resistance and closed slowly	No resistance and jaws remain open
Palpebral reflex	Intact and strong (quick blink)	Intact but weak (slow response)	Very weak (very slow and occasional)	Abolished
Pedal reflex	Intact and powerful (potent withdrawal)	Intact but weak (animal response slowly)	Intact but very light (slow and Occasional response)	Abolished completely
Muscle relaxation	Absent (tightly closed jaws and stiff limbs)	Mild (moderate resistance to opening of jaws and bending of limbs)	Moderate (mild resistance to opening of jaws and bending of limbs)	Complete (no resistance to opening of jaws, bending of limbs and flaccid abdomen)
Anal sphincter reflex	Complete anal relaxation	Moderate anal relaxation	Mild anal relaxation	Absence of anal relaxation

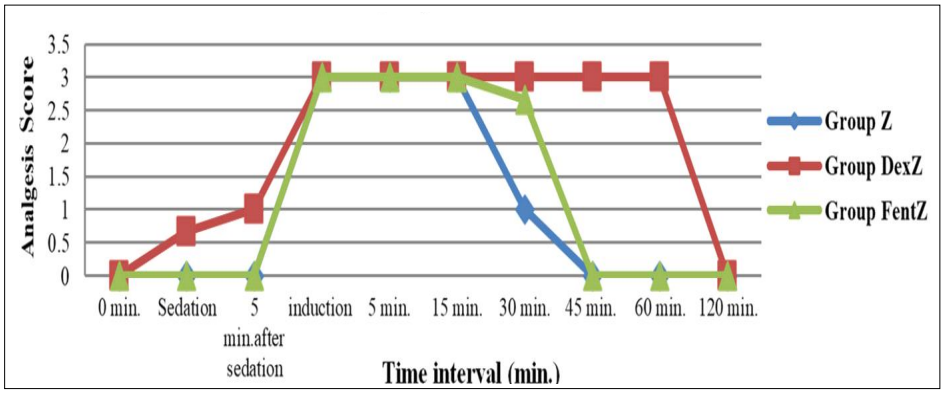

Fig 1: Effect on analgesis score following induction with zoletil in goats at various time interval in different groups.

dexmedetomidine owing to its lipophilic property (Ahmad *et al.,* 2013). Similarly, Karsh *et al.* (2022) also reported all the goats became heavily sedated after intravenous administration of 2 mg/kg dexmedetomidine. Comparison between groups revealed rapid onset and profound sedation after administration of dexmedetomidine in group DexZ.

Induction of anaesthesia (minutes)

After intravenous administration of zoletil, the induction of anaesthesia was rapid, smooth and free from any untoward reactions like struggling and paddling in all three groups. The findings were similar to those of Sulekha *et al.* (2024). Shorter induction duration of anaesthesia was observed in group DexZ as compared to group Z and FentZ. This could be due to enhanced sedation, hypnosis and analgesia caused by dexmedetomidine *via* its α_2-receptor agonism in the locus coeruleus (Sinclair, 2003). Induction of anaesthesia was quicker in animals premedicated with dexmedetomidine as compared to animals premedicated with fentanyl citrate. Similarly, Abalos *et al.* (2016) also reported that xylazine-tiletamine-zolazepam had a significantly (P<0.05) shorter onset of anaesthesia as compared to tiletamine-zolazepam alone. The induction of anaesthesia was smooth in the present study as dexmedetomidine or fentanyl citrate was administered prior to induction with zoletil. This could be due to lipophilic nature of tiletamine as it crosses the blood brain barrier easily and thus the onset of action was rapid (Dugassa and Fromsa, 2018); Lu *et al.* (2014) opined that zolazepam provides good muscle relaxation with anticonvulsant activity and it potentiates the anaesthetic effects of tiletamine by increasing muscular relaxation, prevents convulsions and promotes a smoother induction of anaesthesia.

Duration of anaesthesia

The duration of anaesthesia was significantly (P<0.05) longer in group DexZ (64.41±3.47 min.) than group Fentz (29.81±2.15 min.) and group Z (24.33±2.12 min). Longer duration of anaesthesia in animals of group DexZ might be due to additive effect of dexmedetomidine with zoletil in terms of sedation, analgesia and muscle relaxation. However, administration of fentanyl citrate in group FentZ resulted in slightly prolonged in duration of anaesthesia as compared to group Z where zoletil was administered alone without preanaesthetic. All the reflexes were abolished completely after induction of anaesthesia with zoletil in all three groups signifying that surgical stage of anaethesia has been reached. In the present study, group Z showed shortest duration of anaesthesia when zoletil alone was administered. Abalos *et al.* (2016) recorded longer duration of anaesthesia of 86.0±24.71 min. for 4.5 mg/kg TZ+0.1 mg/kg X and shortest duration of 33.0±24.54 min

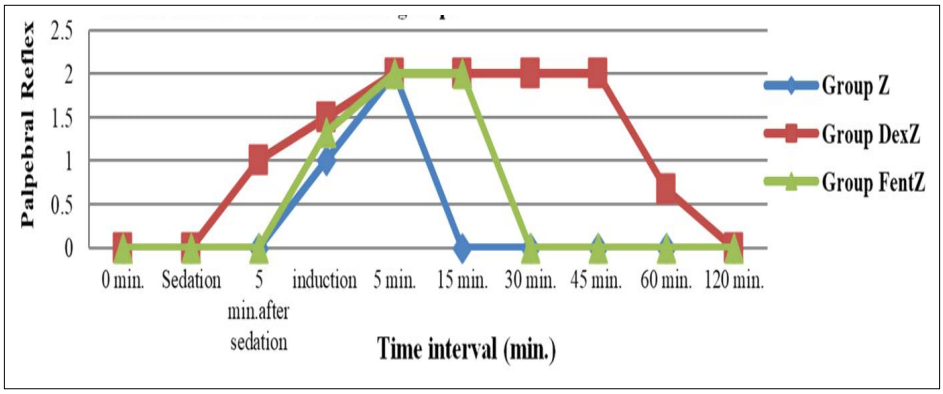

Fig 2: Effect on palpebral reflex score following induction with zoletil in goats at various time interval in different groups.

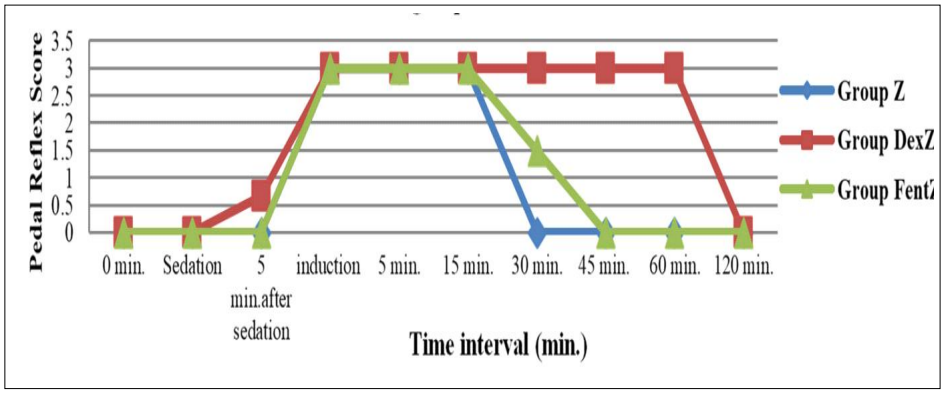

Fig 3: Effect on pedal reflex score following induction with zoletil in goats at various time interval in different groups.

for 5.5 mg/kg TZ. Gicana *et al.* (2021) also reported longer duration of anaesthesia in goats anaesthetized with tiletamine-zolazepam-xylazine (TZX) 100.83±43.37 min. as compared to ketamine-xylazine (KX) 95.17±12.32 min.

Record of different reflexes and responses during anaesthesia

Moderate analgesia was observed in group DexZ after premedication with atropine sulphate-dexmedetomidine whereas no analgesia was noted in animals of group Z and FentZ after administration of atropine sulphate and atropine sulphate-fentanyl citrate respectively. Following induction with zoletil all the animals of three groups produced excellent analgesia (no response to pin prick), that could be due to its analgesic property (Fig 1). Degree and duration of analgesia was prolonged upto 60 min. post anaesthasia in group DexZ as compared to group FentZ and Z. Pereira *et al.* (2019) state that TZ alone did not provide sufficient analgesia to block the response to the supramaximal noxious stimuli whereasas dexmedetomidine (α_2-agonist) produced mild analgesia which become additive when combined with zoletil to produce longer duration of analgesia. Dissociative anaesthetic agent such as ketamine, tiletamine has a strong analgesic property

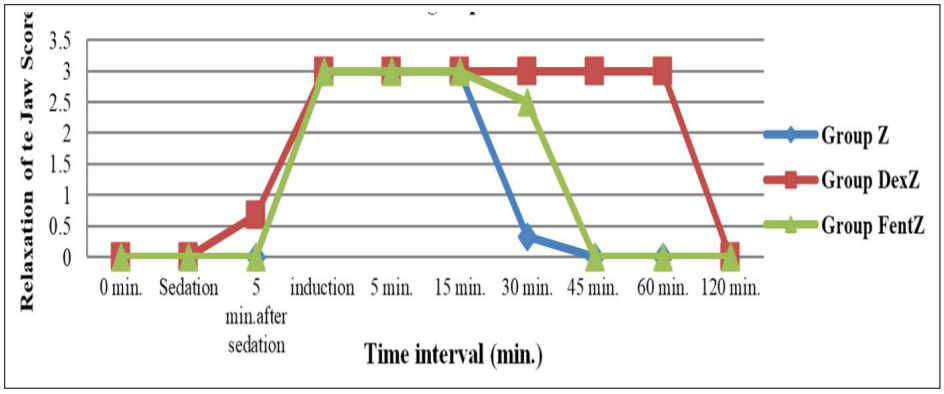

Fig 4: Effect on relaxation of jaw Score following induction with zoletil in goats at various time interval in different groups.

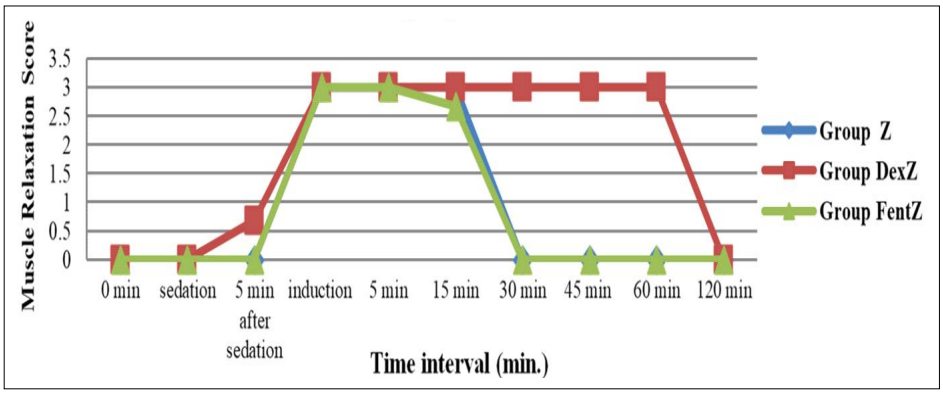

Fig 5: Effect on muscle relaxation score following induction with zoletil in goats at various time interval in different groups.

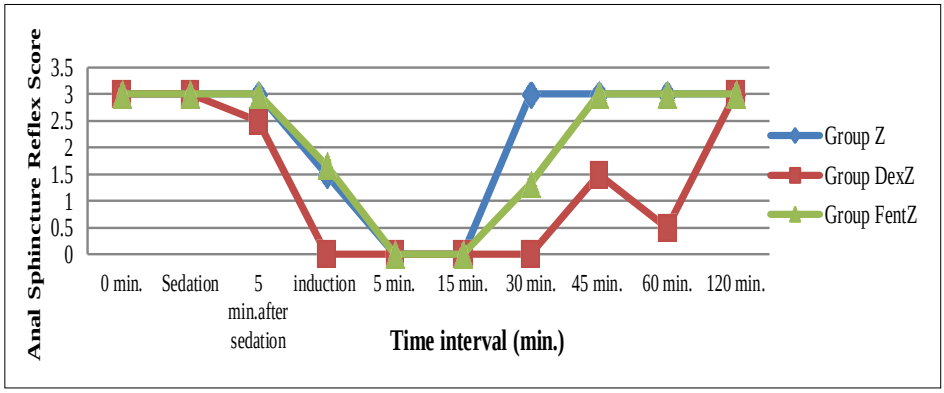

Fig 6: Effect on anal sphincture reflex score following induction with zoletil in goats at various time interval in different groups.

due to blockade of spinoreticular track, depression of lamina in the spinal cord, activated CNS and spinal cord opiate receptors and NMDA receptor antagonist. There was very weak response to palpebral reflex and complete abolition was not observed in any of the three groups after zoletil induction (Fig 2). Contrary to this, Gicana *et al.* (2021) observed presence of palpebral and corneal reflex throughout the surgical procedure using TZX and KX. Similar finding was also reported by Sulekha *et al.* (2024) as presence of palpebal reflex an open eyes are characteristic of dissociative anaesthesia (Dugassa and Fromsa, 2018) Complete abolition of pedal reflex was observed after induction with zoletil anaesthesia in all the three groups which meant that animals were at stage of surgical anaesthesia which persisted for longer duration in group DexZ upto 60 min (Fig 3). These findings were in concurrence with Pawde *et al.* (2000) in buffalo calves and Ragab *et al.* (2022) in goats after ketamine, propofol or ketamine and ketamine-propofol anaesthesia respectively upto 60 min. post anaesthesia in group DexZ than in groups Z and FentZ (Fig 4). Degree of jaw relaxation alongwith excellent muscle relaxation were prolonged upto 60 min. post Zoletil anaesthesia in group DexZ as compared to group Z and FentZ (Fig 4, 5) which might be due to α_2-agonist producing muscle relaxation by inhibiting α_2-adrenoceptor in the interneuron level of spinal cord (Sinclair, 2003). After induction with zoletil all the three groups exhibited excellent muscle and anal sphincter relaxation (Fig 6) due to complete relaxation of muscle resulting from additive effect of zolazepam to α_2-agonist (dexme-detomidine) whereas tiletamine does not relax the muscles or affect the cranial nerve and spinal reflexes. In a similar study by Sulekha *et al.* (2024) all the animals showed very good muscle relaxation due to inhibition of internuncial neurons at spinal cord by zolazepam (Hall *et al.*, 2001). Saini *et al.* (2019) reported that dexmedetomidine produced excellent analgesia and muscle relaxation and due to combined effect of dexmedetomidine with zoletil results in longer duration of relaxation of jaw, making it a suitable anaesthetic combination. Ragab *et al.* (2022) also reported moderate jaw relaxation in goat after dexmedetomidine premedication. Lin and Walz (2014) reported that combination of tiletamine and zolazepam produced better muscle relaxation, analgesia and duration of action than ketamine alone in small ruminants. Carroll *et al.* (1997) documented that tiletamine- zolazepam @ 5.5 mg alone induced sufficient analgesia for ovariectomy operation in goats. But contrast to this, Abalos *et al.* (2016) reported that tiletamine-zolazepam alone does not provide sufficient analgesia for the conduct of surgery in goats.

Recovery time (minutes)

Significantly (P<0.05) longer head rightening, browsing time, sternal recumbency time, standing time and complete recovery time was recorded in group DexZ followed by group FentZ and Z (Table 2). The sedative effect of dexmedetomidine

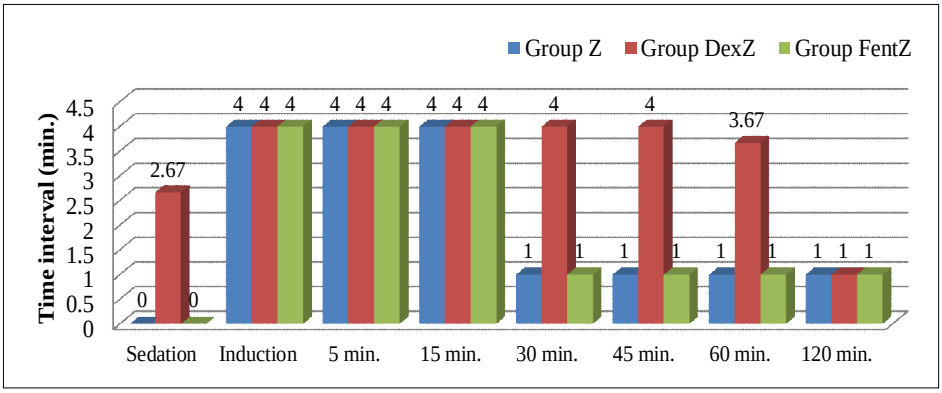

Fig 7: Quality of anaesthesia score following induction with zoletil in goats at various time interval in different groups.

Table 2: Assessment of recovery time (min.) following induction with zoletil in goats at various time interval in different groups (Mean±S.E).

Parameters	Group(n=6)		
	Z	DexZ	FentZ
Start of recovery time	24.33±3.12^{A}	64.41±3.47^{B}	29.81±4.55^{A}
Head rightening reflex (min.)	30.67±4.92^{A}	72.96±5.13^{B}	31.4±1.32^{A}
Browsing time (min.)	31.4±1.32^{A}	73.77±4.43^{B}	32.59±1.09^{A}
Sternal recumbency time (min.)	32.59±1.09^{A}	81.61±3.22^{B}	44.18±2.31^{A}
Standing time (min.)	54.5±3.33^{A}	103.47±11^{B}	66.85±5.13^{A}
Complete recovery time (min.)	70.33±1.5^{A}	126.63±5.99^{B}	89.75±3.44^{A}

ABC - Value bearing different superscript vary significantly (P<0.05) among group.

with zoletil resulted into deeper sedation, longer analgesia, anaesthesia and recovery time which resulted in reduced metabolic activity to delay redistribution and metabolism of the drugs. Shorter complete recovery time revealed faster rate of metabolic clearance of zoletil from the body in animals of group FentZ and Z. Fentanyl has an extremely short duration of action in goats, due to the rapid elimination rate and clearance coupled with a large apparent volume of distribution at steady state (Dzikiti *et al.,* 2015). However, the presence of dexmedetomidine may have influenced recovery in group DexZ, either by acting as a sedative or by prolonging the elimination of zolazepam. Abalos *et al.* (2016) noted prolongation of standing recovery time (35.2±26 min.) when tiletamine-zolazepam followed xylazine in goats than tiletamine-zolazepam (26.5±7.90 min.) alone. Similarly, Gicana *et al.* (2021) also recorded longer standing recovery time (197.67±113.74 min.) in goats anaesthetized with tiletamine-zolazepam-xylazine (TZX) as compared to ketamine- xylazine (KX) (117.83±36.86 min.). On the other hand, in the present study, group FentZ and Z had shorter standing recovery time as compared to group DexZ. This means addition of α_2-agonist such as dexmedetomidine may potentially prolong the standing recovery period when combined with tiletamine-zolazepam (group DexZ) as dexmedetomidine led to longer duration of anaesthesia and recovery time. Singh (2021) also noted sternal recumbency at 50.35 min., standing time at 81.55 min. and complete recovery time within 102.28 min. after administration with midazolam-tiletamine-zolazepam in calves. However, fentanyl citrate premedicated animals flaunted transient signs of distress which were similar to behavior observed during sedation such as restlessness, random sniffing, exaggerated tail-wagging *etc* and struggling with a shorter recovery period which are in concurrent with the results reported by Dzikiti *et al.* (2016) and Delgado *et al.* (2021) as opioid administration in ruminants are associated with central nervous system stimulation. All the animals recovered very smoothly without struggling from dexmedetomidine-zoletil and zoletil anaesthesia. However, recovery from fentanyl citrate-zoletil anaesthesia was characterized by abnormal behavioural signs with struggling. Comparison between the groups revealed there was significant ($P<0.05$) difference in the recovery time from anaesthesia.

Quality of anaesthesia

Quality of anaesthesia was excellent after administration with zoletil in all the three groups characterized by rapid induction, excellent muscle relaxation with good analgesia which might be due to rapid uptake of ZT on intravenous administration, into the CNS and rapid redistribution from the brain to other tissue and its efficient elimination from plasma by metabolism (Ko *et al.,* 2007). All the reflexes abolished completely after induction with zoletil in all three groups which signify that surgical stage of anaesthesia had reached (Fig 7). In the current study, animals premedicated with dexmedetomidine had excellent quality of anaesthesia compared to those premedicated with fentanyl citrate. Animals of group DexZ showed excellent quality of anaesthsiaupto 60 min. however, group FentZ and Z resulted in excellent quality of anaesthesia upto 15 min. respectively. Zoletil alone also produce very good muscle relaxation but for short duration which must be due to central muscle relaxing properties of zolazepam as exhibited by group Z. So, the muscle relaxation and sedation provided by the alpha 2 agonist might have improve zoletil induced muscle relaxation in terms of duration and quality of anaesthesia as also evidence by Singh *et al.* (2024).

Complication (If any)

All the animals in group Z and DexZ recovered very smoothly without struggling after zoletil anaesthesia with no post recovery complications. However, animals of group FentZ administered with fentanyl citrate showed excitement during recovery from anaesthesia. The above findings are concurrent with Dzikiti *et al.* (2016) and Delgado *et al.* (2021) following intravenous premedication with fentanyl citrate in goats. These behavioral changes have been reported in association with the administration of opioids in ruminants, deriving from central nervous system stimulation (Tranquilli *et al.,* 2007 and Valverde and Doherty, 2008) such as an increase in vocalization and agitation (Upton *et al.,* 2003), chewing movements and nystagmus (Pablo *et al.,* 1997) and excessive tail-wagging (Dzikiti *et al.,* 2011). Animals of group DexZ voided larger amount of urine during zoletil anaesthesia as compared to group Z and group FentZ that might be due to dexmedetomidine administered prior to zoletil. α_2-agonists drugs act on renal α_2-adrenergic receptors affecting micturition pressure and volume producing large amount of dilute urine which is voided. Animal administered xylazine-zolazepam-tiletamine (XZT) voided urine during recovery stage from anesthesia as reported by Fani *et al.* (2008) which could be because of stress induced gluconeogenesis due to effects of anaesthesia suppressing insulin and resulted in increased production of glucose in liver. The incidence of regurgitation was not observed in goats following zoletil anaesthesia which ensures that deeper anaesthesia was induced by dexmedetomidine, fentanyl citrate and tiletamine-zolazepam which causes depression of laryngeal and swallowing reflexes. Additionally, Jud *et al.* (2010) also reported no regurgitation in goats during ketamine anaesthesia alongwith α_2-adrenoceptor agonist because laryngeal and swallowing reflexes are maintained during ketamine anaesthesia but as dexmedetomidine was intravenously administered prior to ketamine it led to depression of both the reflexes. Group DexZ showed mild salivation whereas no salivation was observed in animals of group Z and FentZ as atropine sulphate was administered in all the three groups prior to premedication. Following induction with zoletil, group Z and FentZ animals

showed mild to moderate salivation while that of group DexZ showed moderate salivation upto a period of 45 min. post anaesthesia. Salivation after induction with zoletil in the present study might be due to delayed effect of α_2-agonist, dexmedetomidine or due to decreased swallowing reflex. Similarly, Kumar *et al.* (2018) also recorded very mild salivation in goats anaesthetized with dexmedetomidine-butorphanol-propofol and dexmedetomidine- butorphanol-ketamine respectively. Gautam *et al.* (2018) reported mild degree of salivation in goats after administration of dexmedetomidine-ketamine while Kumar *et al.* (2014) found copious watery salivation following midazolam-ketamine anaesthesia in buffalo calves.

CONCLUSION

Zoletil premedication with dexmedetomidine produced excellent quality of anaesthesia and muscle relaxation along with prolonged duration of anaesthesia, analgesia and sedation which appears to be suitable for long duration surgical procedure in goats as compared towhen premedicated with fentanyl citrate. However, animals premedicated with fentanyl citrate showed unusual behavioral signs *viz.*, excitement, restlessness, increased vocalization *etc.* during sedation and recovery. Therefore, intravenous dexmedetomidine-zoletil combination can be safely used for inducing surgical anaesthesia in goats.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Institute of Animal Ethical Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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