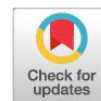


Research Article



Comparative Loco-Regional Analgesia using Lidocaine Alone and Lidocaine-Tramadol Mixture on Some Physiological Parameters in Goats Undergoing Rumenotomy

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Abstract | This study aimed to compare the time of onset, duration of action, and effects of subcutaneous lidocaine alone and lidocaine-tramadol combination on physiological parameters (pulse rate, respiratory rate, and rectal temperature) in goats undergoing an invasive surgical procedure. Sixteen (N=16) adult Red Sokoto goats weighing 20-26kg were used in the study and were randomly allocated into two groups: A and B. Group A animals received subcutaneous 2% lidocaine (7mg/kg) using an "inverted L" technique and group B received local infiltration with lidocaine-tramadol (3.5 mg/kg and 1.5 mg/kg respectively) using an "inverted L" technique. Following anesthesia, a rumenotomy was performed on each animal. Physiological parameters were measured at 0 hours (before drug administration) and then six times after drug administration at one-hour intervals while the rumenotomy was ongoing. There was a significant difference in the onset and duration of action between the lidocaine alone and lidocaine-tramadol-treated groups ($P<0.05$). There was a significant difference in pulse rate 1 hour after lidocaine administration; however, the lidocaine-tramadol group showed no significant change in the pulse rate throughout the experiment. It can be concluded that lidocaine or its combination with tramadol has no adverse effect on physiological parameters in goats undergoing rumenotomy.

Keywords | Loco-regional, Analgesia, Lidocaine-tramadol, Physiological parameters, Rumenotomy

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The inverted L block is a nonspecific localized regional block designed to selectively anesthetize the tissues surrounding the ventral aspect of the lumbar vertebrae's transverse processes and the caudal end of the thirteenth rib, as described by Noordsy and Ames (2006). In place of general anesthesia, local anesthetic, analgesia, and nerve blocks have been demonstrated to be highly successful as stand-alone treatments for many surgical procedures, especially in large animals. The cornual nerve block, epidural anesthesia, and intravenous regional anesthesia are examples of this anesthesia/analgesia where it can be used alone or as an augmentation to general anesthesia (Sharon, 2010). Several methods, such as the proximal paravertebral nerve block, the distal paravertebral nerve block, the inverted L block, and the infusion of the incision or line block, can be used to anesthetize the paralumbar fossa and abdominal wall (Shamsudeen *et al.*, 2024). These anesthetic methods are frequently applied to abdominal surgeries that involve the paralumbar fossa approach, including omentopexy, abomasopexy, rumenotomy, cesarean delivery, and other procedures (Misty, 2016). For these treatments, a variety of local anesthetic drugs may be utilized, ranging in efficacy, toxicity, and cost (Nuss *et al.*, 2012). The most widely used local anesthetic is two percent lidocaine hydrochloride due to its inexpensive cost and minimal effects. Another intermediate period of action for lidocaine is between 90 and 180 minutes (Edwards, 2001; Nuss *et al.*, 2012).

Tramadol is a synthetic substitute for codeine, and its mode of action is linked to its interaction with opioid μ -receptors located in the brain and spinal cord. By preventing the reuptake of serotonin and norepinephrine, it also reduces monoaminergic spinal pain (Dehkordi *et al.*, 2012). Unlike other opioid receptor agonists, tramadol has not been linked to respiratory or cardiovascular depression in humans, even at high dosages. This analgesic agent is useful for clinical application due to its low chance of developing tolerance and dependence, and its low incidence of constipating effects (Schug, 2003).

Many recent research studies have used epidurally delivered dosages of lidocaine and tramadol in goats, sheep, and water buffalo. According to the findings of those studies (Habibian *et al.*, 2011; Dehkordi *et al.*, 2012; Ayman *et al.*, 2015), the combination generated a noticeably longer duration of analgesia than epidural lidocaine injection alone. As a result, this approach has become increasingly popular (Ajadi *et al.*, 2017). The goal of this combination is to reduce the adverse effects of each medication while achieving a more targeted therapeutic response. Whereas epidural tramadol administration in goats offered the benefit of allowing the animals to remain upright but with poor quality analgesia, epidural lidocaine injection alone

was characterized by a quick onset of anesthesia and an extended period of recumbency (Ajadi *et al.*, 2012). Analgesia provided by an epidural combination of tramadol and lidocaine was found to last noticeably longer than an injection of lidocaine alone (Habibian *et al.*, 2011; Ayman *et al.*, 2015). The current study aimed to compare the time of onset, duration of action, and effects of subcutaneous lidocaine alone and lidocaine-tramadol combination on physiological parameters (pulse rate, respiratory rate, and rectal temperature) in goats undergoing an invasive surgical procedure.

MATERIALS AND METHODS

ETHICAL APPROVAL

The study was conducted at the large animal unit of the Veterinary Teaching Hospital (VTH), Usmanu Danfodiyo University, Sokoto. The study was approved by the faculty research ethical committee (FAREC) with reference no. UDUS/FAREC/2020/ AUP-R0-7.

STUDY ANIMALS

Sixteen (N=16) apparently healthy male goats weighing 20-26 kg and aged 9-16 months were selected for the study. They were acclimatized under the same housing and feed regimen for two weeks during which they were dewormed using levamisole suspension (Troy Animal Health Care, New Zealand) orally before the commencement of the experiment. Animals were fasted for 12 hours and water was withheld for 6 hours before surgery. The left flank area was prepared aseptically with 4% chlorhexidine gluconate (Savlon®, Vervaaingdeur, Johnson and Johnson (pty) Ltd, London).

GROUPING AND ANESTHETIC PROTOCOLS

The animals were randomly divided into 2 groups (A and B) of 8 animals each per group.

- Group A: Lidocaine HCl 2% (Debocaine® ALDebeiky Pharmaceutical Industries Co.) was subcutaneously injected at 7mg/kg using an "inverted L" block technique (Dehkordi *et al.*, 2012).
- Group B: a mixture of tramadol hydrochloride (100 mg/2mL) (Koralodol®, AMRIY Pharmaceuticals) and lidocaine HCl 2% at respective doses of 1.5mg/kg and 3.5mg/kg was subcutaneously injected using the inverted L block technique.

ANESTHETIC INDICES

The time interval (in minutes) from the subcutaneous injection of the drug to the loss of response to a clinical algometer in the flank region was defined as the onset of analgesia. The time interval (in minutes) from the loss and reappearance of the pain response to the clinical algometer

in the flank region was defined as the duration of analgesia, as described by Buhari *et al.* (2012).

SELECTED PHYSIOLOGICAL PARAMETERS

Rectal temperature, respiratory and pulse rates were recorded prior to anesthetic administration and subsequently at 6 different timing intervals (1, 2, 3, 4, 5 and 6 hours) after drug administration. Pulse rate was monitored via the femoral artery; beats were counted for 60-seconds. Respiratory rate was determined by counting thoracic and abdominal excursions with the help of stethoscope for 60-seconds. Temperature was measured by using a digital clinical thermometer (YD-206Dog, Yoison group, China) per rectum.

STATISTICAL ANALYSIS

Physiological parameters, pulse rates, respiratory rates, and rectal temperatures were expressed as mean $\pm$ SD and analyzed using repeated measures ANOVA. Repeated measures ANOVA was used to compare differences between the treatments over time. Fisher's Least Significant Difference (LSD) multiple comparison test was used to compare differences at each time point. A value of $P < 0.05$ was considered to be significant.

RESULTS AND DISCUSSION

The onset of analgesia in the lidocaine-alone treated group was approximately 4 minutes after administration, and the duration of analgesia was 60 minutes. The onset of action for the lidocaine-tramadol-treated group was approximately 2 minutes after administration, and the duration of action was 79 minutes (Table 1).

Table 1: Anesthetic indices of administered lidocaine, tramadol, and lidocaine-tramadol combination in goats undergoing rumenotomy.

Anesthetic Indices	Lidocaine group (n=8)	Lidocaine-Tramadol group (n=8)
Onset of Analgesia (mins)	3.78 $\pm$ 0.61	2.01 $\pm$ 0.42*
Duration of Analgesia (mins)	60 $\pm$ 5.5	79.5 $\pm$ 6.6*

* Denotes significant difference ($p < 0.05$) between lidocaine group and lidocaine-tramadol group.

EFFECTS OF LIDOCAINE, TRAMADOL AND LIDOCAINE-TRAMADOL ON PHYSIOLOGICAL PARAMETERS

PULSE RATE: Pulse rates over time are not significantly different ($p > 0.05$) within the lidocaine group from the baseline value throughout the monitoring hours except at 0 and 1st hours. Values within the lidocaine-tramadol group are not significantly different ($p > 0.05$) from baseline values (Figure 1).

RESPIRATORY RATE: The mean respiratory rate over time shows that there are no significant difference in the

lidocaine group throughout the study period except between 1st and 5th hours ($p < 0.05$). There is also a significant difference within tramadol-lidocaine group at 4th 5th, 6th hours ($P < 0.05$) (Figure 2).

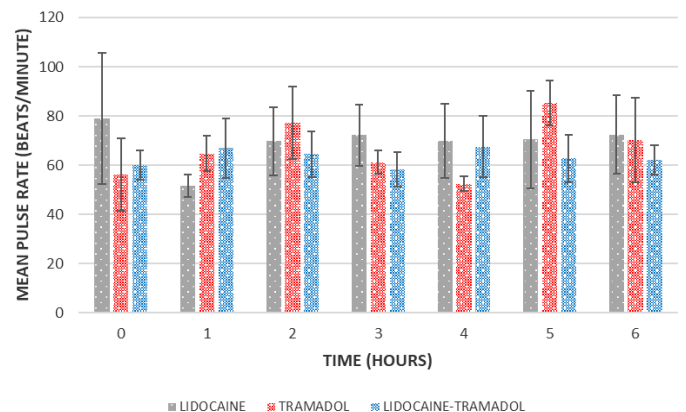


Figure 1: Mean pulse rate of goats undergoing laparotomy administered either lidocaine alone or a mixture of lidocaine and tramadol combination over time.

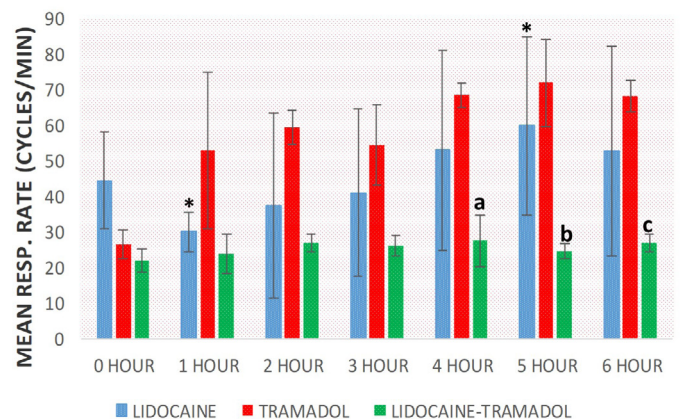


Figure 2: Mean respiratory rates of goats undergoing laparotomy administered either lidocaine alone or a mixture of lidocaine and tramadol combination over time. *Denotes significant difference ($p < 0.05$) between baseline data at 0 hour and corresponding respiratory rates at 1 hour and 5 hour in lidocaine alone group, whilst a,b and c indicates significant difference ($p < 0.05$) within lidocaine-tramadol group at 4 hour, 5 hour and 6 hour after administration of the lidocaine-tramadol mixture.

TEMPERATURE: The mean temperature over time shows that there are no significant differences between and within the groups throughout the study period except in the lidocaine-tramadol group between 1st and 3rd hours, 1st and 4th hours, as well as in the lidocaine group between baseline and 3rd hour (Figure 3).

The results of this study indicate the rapid onset of anesthesia/analgesia in the lidocaine-tramadol treated group as compared to either lidocaine alone, it also showed that the lidocaine-tramadol combination has a longer duration of action compared to lidocaine alone. This study has also

demonstrated that subcutaneous administration of lidocaine or lidocaine-tramadol combination in goats undergoing rumenotomy is an effective method for pain control and with little or no side effects in goats undergoing rumenotomy.

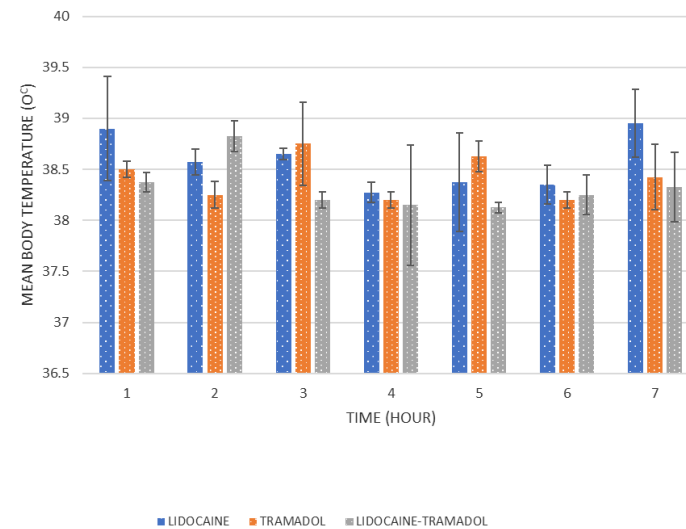


Figure 3: Mean body temperature of goats undergoing laparotomy administered either lidocaine alone or a mixture of lidocaine and tramadol combination over time.

The onset of action was shorter in the lidocaine-tramadol-treated group than in the lidocaine group. The duration of action in the lidocaine-treated group was, however, significantly different from the lidocaine-tramadol treated group, was significantly different from the tramadol and lidocaine-treated groups, finding was similar to that observed previously in goat, lamb, and water buffalo (Habibian *et al.*, 2011; Ayman *et al.*, 2015) but contrary to the findings observed in West African Dwarf sheep by Ajadi *et al.* (2017).

The respiratory rate of all the animals was high in all groups compared to baseline values; however, the values were within the normal respiratory range of goats. Furthermore, no significant difference was found within and between the treatment groups ($P>0.05$). The increase in respiratory rate might be due to the stress of surgery, handling, and restraint. It is well documented that anxiety during restraint in animals results in tachypnea (Layton *et al.*, 2023) and the respiratory rate also increases when in pain, as reported by Udegbonam *et al.* (2012).

The mean rectal temperatures were not significantly different in comparison with baseline values throughout the study in all the treatment groups, except in group A at 3rd hour (37 ± 2.1). This finding is in line with the findings of Natalini and Robinson (2000); Bigham *et al.*, (2010); Dehkordi *et al.*, (2012); Azari (2014), in which they found a significant increase in respiration during their studies.

The pulse rate in the lidocaine and lidocaine-tramadol treated groups was high compared to baseline values; however, the pulse rate of the animals in all groups was within the normal range of pulse rate in goats (Hassan and Hassan, 2003). However, there was no significant difference in pulse rate in the lidocaine-tramadol treated group.

The findings of this study revealed a significant decrease in the pulse rate compared to the baseline values in the lidocaine group at the 1st hour, followed by a consistent non-significant decrease throughout the experiment. There was no fluctuation in the lidocaine-tramadol group throughout the experiment. Lidocaine has been reported to affect heart rate, possibly because of sympathetic nerve block and vasodilation induced by the local anesthetics. Furthermore, in their study, Habibian *et al.* (2011) observed that the lidocaine-tramadol combination resulted in stable heart rates with no significant fluctuations throughout the experiment, consistent with the observations in this study.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrated that the lidocaine-tramadol combination offers a better onset of action and a prolonged duration of analgesia compared to lidocaine alone. Additionally, neither lidocaine nor its combination with tramadol caused profound adverse effects on the monitored selected physiological parameters in goats undergoing rumenotomy. While these findings are promising, further studies utilizing other parameters, such as pupil size and reactivity, pain intensity scales, and behavioral pain assessments, are encouraged to enhance the understanding of analgesic efficacy and safety comprehensively.

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NOVELTY STATEMENTS

This study endeavours to utilise a combination of lidocaine, a widely employed local anesthetic agent, and a tramadol, a potent synthetic opioid, to produce regional analgesia sufficient for performing rumenotomy in goat. The combination provides a longer duration of analgesia with minimal systemic involvement; this new loco-regional anesthetic regiment can serve as an alternative to general anaesthesia, which has the significant drawback of systemic side effects.

The study was conceptualised by NA, SB, ASY. AAA and MSI designed the experimental protocols. Animal experimentation was conducted by HBA, HYN, AD, SZ, and USA. AAA, MSI, and NA conducted the data analysis. All authors participated in drafting and reviewing the manuscript.

CONFLICT OF INTEREST

We declare there was no conflict of interest.

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