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RESEARCH ARTICLE

Evaluation of Different Sedative-Lidocaine Combinations for Ultrasound Guided Rectus Sheath Block During Umbilical Herniorrhaphy in Calves

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Abstract

This study evaluated the analgesic efficacy of different sedative-lidocaine combinations and the applicability of ultrasonography (USG) guided bilateral rectus sheath block (RSB) for pain control before and after umbilical hernia (hernia umbilicalis) surgery in neonatal calves. Thirty healthy calves, aged between 0 and 3 months, presented to the Harran University Veterinary Faculty Animal Hospital for umbilical hernia and were randomly allocated into five groups. The groups received the following combinations: xylazine–lidocaine (XY), dexmedetomidine–lidocaine (DE), medetomidine–lidocaine (ME), midazolam–lidocaine (MI), and butorphanol–lidocaine (BU). All preanesthetic agents were administered intravenously (IV), followed by subcutaneous lidocaine infiltration and ultrasound (US) guided bilateral RSB. Analgesic efficacy was evaluated using the Bovine Pain Assessment Scale and the Visual Analog Scale (VAS) at 0, 30, 45, 60, 120, and 240 min after the calves stood up. Surgical procedures were completed without complications in all groups, and no statistically significant difference was observed between the operation times ($P > 0.05$). In the XY and MI groups, the analgesic effect was observed to have an early onset and was long lasting and stable. Although analgesia was initially effective in the BU group, it slightly decreased over time. The duration of analgesia was shorter in the ME group. In the DE group, a moderate level of stability was achieved; however, high pain scores were recorded. No systemic complications developed in any of the patients. This study demonstrated that the USG guided RSB technique is a safe and effective analgesic method for calves. XY and MI protocols provide prolonged and stable analgesia, whereas the BU protocol may be considered a suitable option for short-term surgical procedures. These findings are clinically instructive for identifying practical and effective analgesia protocols that are applicable to field conditions.

Key Words: Analgesia, calf, lidocaine, preanesthetic, rectus sheath block, umbilical hernia

Buzağılarda Göbek Fıtığı Onarımı Sırasında Ultrason Rehberliğinde Rektus Kılıf Bloğu İçin Farklı Sedatif-Lidokain Kombinasyonlarının Değerlendirilmesi

Öz

Bu çalışma, farklı sedatif-lidokain kombinasyonlarının analjezik etkinliğini ve neonatal buzağılarda göbek fıtığı (hernia umbilicalis) cerrahisi öncesi ve sonrasında ağrı kontrolü için ultrasonografi (USG) eşliğinde bilateral rektus kılıf bloğu (RSB) uygulanabilirliğini değerlendirdi. Harran Üniversitesi Veteriner Fakültesi Hayvan Hastanesine göbek fıtığı nedeniyle getirilen, 0–3 aylık yaş arasında, sağlıklı otuz buzağı rastgele beş gruba ayrıldı. Gruplara şu kombinasyonlar uygulandı: ksilazin–lidokain (XY), deksmedetomidin–lidokain (DE), medetomidin–lidokain (ME), midazolam–lidokain (MI) ve butorfanol–lidokain (BU). Tüm preanestezik ajanlar intravenöz (IV) yolla uygulandı, ardından subkutan lidokain infiltrasyonu ve ultrason (US) eşliğinde bilateral RSB yapıldı. Analjezik etkinlik, buzağıların ayağa kalkmasını takiben 0, 30, 45, 60, 120 ve 240. dakikalarda Sığır Ağrı Değerlendirme Ölçeği ve Görsel Analog Skala (VAS) kullanılarak değerlendirildi. Tüm gruplarda cerrahi işlemler komplikasyonsuz tamamlandı ve operasyon süreleri arasında istatistiksel olarak anlamlı bir fark gözlenmedi ($P > 0.05$). XY ve MI gruplarında analjezik etkinin erken başladığı, uzun süreli ve stabil olduğu görüldü. BU grubunda ise başlangıçta etkili olan analjezi zamanla hafif azaldı. ME grubunda analjezi süresi daha kısa bulundu. DE grubunda orta düzeyde stabilite sağlanmasına rağmen yüksek ağrı skorları kaydedildi. Hiçbir hastada sistemik komplikasyon gelişmedi. Bu çalışma, USG eşliğinde uygulanan RSB tekniğinin buzağılarda güvenli ve etkili bir analjezik yöntem olduğunu göstermiştir. XY ve MI protokolleri uzun süreli ve stabil analjezi sağlarken, BU protokolü kısa süreli cerrahi girişimler için uygun bir seçenek olarak değerlendirilebilir. Bu bulgular, saha koşullarına uygulanabilir pratik ve etkili analjezi protokollerinin belirlenmesi açısından klinik olarak yol göstericidir.

Anahtar Kelimeler: Analjezi, buzağı, göbek fıtığı, lidokain, preanestezik, rektus kılıf bloğu

INTRODUCTION

Umbilical hernia (hernia umbilicalis) is one of the most common congenital anomalies in calves and is a significant health problem that requires surgical repair. Owing to the dense nerve innervation of the umbilical region, providing effective analgesia during surgery is of critical importance. Inadequate pain control increases the risk of postoperative complications and, in particular, raises the possibility of recurrence due to trauma to the hind limbs (1-3).

While NSAIDs and α2-adrenoceptor agonists are commonly used for pain management in cattle, their postoperative efficacy is limited. On the other hand, local anesthetics provide safe, economical, and practical analgesia by blocking nociceptive transmission. Although the use of lidocaine via infiltration or infusion has been reported for umbilical hernia surgeries, information regarding its applicability and postoperative efficacy under field conditions is limited (4,5).

The abdominal wall around the umbilicus in cattle is typically innervated by the ventromedial branches of the T10–T12 spinal nerves (6). In this area, there is a potential space between the inner border of the rectus abdominis muscle and its internal sheath where a local anesthetic can be administered. Rectus Sheath Block (RSB) is a technique that aims to provide effective, localized, and safe analgesia by targeting this anatomical space and is particularly prominent in procedures such as umbilical hernia surgery. RSB was first described in human medicine for analgesia following pediatric herniorrhaphy, and has been anatomically investigated in animal species in recent years. However, data on the clinical efficacy of ultrasonography (USG) guided RSB in calves are limited (7,8).

This study aimed to evaluate the clinical and analgesic efficacy of different sedative- lidocaine combinations administered through an ultrasound guided RSB technique in calves undergoing umbilical herniorrhaphy.

MATERIAL AND METHODS

Study Group and Anesthesia Management

The animal material for this study consisted of 30 calves (16 Simmental/14 Holstein; 17 female/13 male), aged 0–3 months, with umbilical hernias, who were brought to the Harran University Faculty of Veterinary Medicine Animal Hospital for routine diagnosis and operative procedures and were deemed suitable for inclusion in the study. The study consisted of five groups of six animals each. A different preanesthetic agent was administered intravenously (IV) to each calf group via the jugular vein. Lidocaine (Vilcain 2%, Vilsan İlaç Sanayi and Tic. A. Ş., Ankara, Türkiye) was administered subcutaneously to all calves at a dose of 4 mg/kg, using a standard infiltrative technique. The calf groups were formed as follows: Group 1 (XY): xylazine with lidocaine (Alfazyne 2% injection, Alfasan International B.V., Netherlands) (0.05–0.1 mg/kg, IV). Group 2 (DE): Dexmedetomidine with lidocaine (0.001 mg/kg, IV; Hipnodex fliptop vials, Haver Farma, Istanbul, Turkey) (0.001 mg/kg, IV). Group 3 (ME): Medetomidine with lidocaine (Domitor, Orion, Turku, Finland) (0.02 mg/kg,). Group 4 (MI): midazolam with lidocaine (Zolamid, Vem İlaç, Ankara, Turkey) (0.1 mg/kg,). Group 5 (BU): Butorphanol with lidocaine (Butomidor, Richterpharma AG, Wels, Austria) (0.01–0.02 mg/kg, IV) (9-13).

Surgical Procedure and Pain Assessment

Within the scope of this study, USG guided bilateral rectus sheath block (RSB) was performed in calves, and its clinical efficacy in pain management was evaluated both preoperatively and postoperatively. Pain scores were assessed using the Bovine Pain Assessment Scale and the Visual Analog Scale (VAS) (14,15). All injections were performed by the same operator. The calves were placed in the dorsal recumbent following anesthesia induction. The ventral abdominal surface, from the xiphoid to the pubis, was shaved to 30-40 cm and prepared aseptically for surgery. A portable ultrasound device (Mindray Z60 Vet, Shenzhen, China) equipped with both a linear (8–13 MHz) and a convex (6C2P, 5–8 MHz) probe was used to visualize the anatomical landmarks and determine the precise injection site. Initially, the linear probe was employed to identify the linea alba and delineate the abdominal wall layers; however, after confirming adequate image quality with both probes, the procedure was continued using the convex probe, which provided a wider field of view and facilitated consistent needle visualization throughout the study.

The ultrasound probe was first placed transversely on the midline to localize the linea alba, after which a systematic scan of the umbilical region was performed. The targeted anatomical structures included the lateral aspect of the musculus rectus abdominis, the hypoechoic space between the inner lamina of the internal rectus sheath and the transversalis fascia (the potential injection plane), and the peritoneum as the deepest layer. Once these structures were clearly identified, a 22-gauge, 90 mm spinal needle (BD Medikal, Turkey) was advanced subcutaneously in a lateromedial direction at an angle of approximately 30°. The needle was connected to a 50-ml Luer-lock syringe containing a 1:1 mixture of lidocaine hydrochloride and methylene blue. Methylene blue was included not to increase echogenicity, but to allow post-procedure verification of the injection site. Previous studies using cadaver models have incorporated methylene blue for anatomical confirmation after dissection rather than for real-time enhancement of ultrasound contrast (4,7,8). Therefore, in the present study, the dye was used solely to facilitate visual identification of the injectate distribution during anatomical validation, without implying that it improves ultrasound echogenicity during the procedure. The needle tip was then advanced until it reached the potential space between the rectus abdominis muscle and internal rectus sheath. At this point, a 1–2 ml test dose was injected, and the correct needle position was verified by hydrodissection (Figure 1A–B).

Pain assessment was performed by the same investigator in all the cases. For each calf, baseline measurements were obtained 0 min prior to injection, followed by a 15-minute interval after anesthesia induction, after which the umbilical herniorrhaphy procedure was initiated. The surgical procedure was initiated with an elliptical skin incision, followed by subcutaneous dissection to expose the hernia defect. The marginal tissues of the hernial ring were separated from the surrounding structures by blunt dissection. The hernial sac was then opened, examined for adhesions, and

appropriately closed. Subsequently, the connective tissue, muscle layer, and skin were closed in a stepwise manner, following the anatomical layers, avoiding excessive suture tension. Protective dressing was applied over the suture line to safeguard the surgical site.

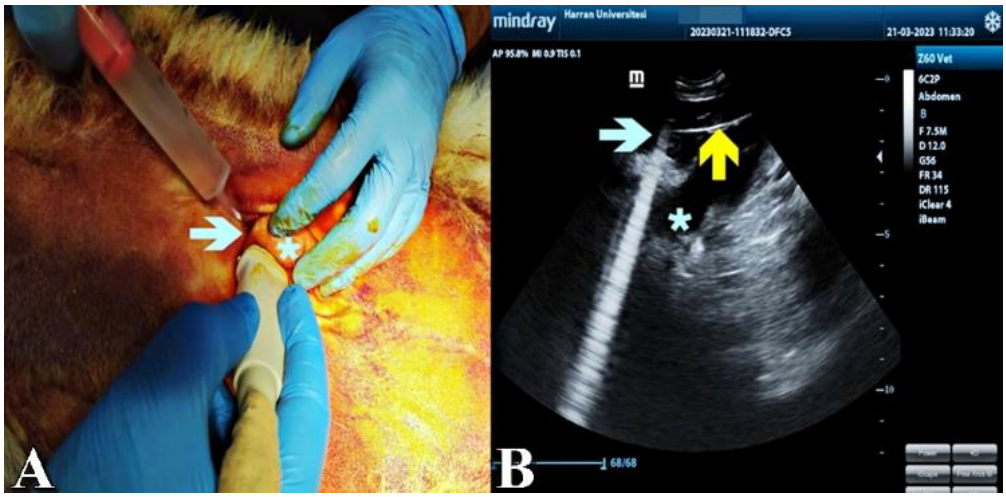


Figure 1. A: Administration of the local anesthetic agent over the mus:culus rectus abdominis under USG guidance prior to surgical intervention (white arrow). **B:** Injection of the local anesthetic agent into the musculus rectus abdominis under USG guidance to assess the pain threshold (yellow arrow: needle) (MI group, case 5). The hernial sac is indicated by an asterisk (*).

Throughout the entire surgical and postoperative periods, pain assessment for each calf was performed at 30, 45, 60, 120, and 240 min after the animals stood up. For pain scoring, the Bovine Pain Assessment Scale and Visual Analog Scale (VAS), both validated in cattle, were utilized (14,15). Bovine Pain Assessment Scale: This scale is based on four primary behavioral categories: head movements, vocalization, locomotion, and pain response. Head movements were scored as normal (0), slight head shaking or scratching (1), or excessive movements such as continuous head shaking (2). Vocalization was scored as silent (0), low moaning (1), or loud groaning/shouting (2). Locomotion was scored as normal walking (0), slight limping or slowing (1), or inability to walk/pronounced limping (2). Pain response was scored as no response (0), moderate response such as slight jumping (1), or severe response such as fleeing or striking (2). The total Bovine Pain Assessment Scale score for each calf was calculated by summing the four category scores (maximum score: 8). These scores were interpreted as follows: 0–2 = no or mild pain; 3–5 = moderate pain; and 6–8 = severe pain. These values were used as reference thresholds for planning analgesic interventions when required. VAS: In addition to the Bovine Pain Assessment Scale, a 10-cm Visual Analogue Scale was used, ranging from 0 (no pain) to 10 (worst possible pain). The observer assigned a score based on the animal's overall behavioral and physiological appearance. Scores of 0–2 were interpreted as 'no or very mild pain,' 3–5 as 'mild to moderate pain,' and 6–10 as 'moderate to severe pain,' the latter indicating the need for immediate analgesic intervention (4).

Statistical Analysis

The data were analyzed using SPSS version 22.1. and normality was assessed using the Shapiro-Wilk test. Descriptive statistics are presented as mean ± standard deviation. For comparisons between groups, one-way ANOVA was used for normally distributed data, whereas the Kruskal-Wallis test was applied for non-normally distributed data. Repeated measures analysis of variance (ANOVA) or the Friedman test was applied to evaluate changes over time. The relationships between the variables were examined using Pearson's correlation analysis. The level of statistical significance was set at $P<0.05$.

RESULTS

Animal Characteristics and Group Distribution

In all study groups, IV administration of preanesthetic agents and infiltrative local anesthesia applications to the umbilical region were performed successfully and without complications. Minimal physical restraint was required during these procedures, and no significant hypermotility (excessive movement) was observed in the calves in response to the injections.

A total of 30 calves were included in the study (16 Simmental, 14 Holstein), with a mean age of 42.9±3.6 days and a mean body weight of 66.3±7.9 kg. Data obtained from the anamnesis (history) indicated that the umbilical hernia was congenital in all calves, and they were brought to the clinic without any prior treatment. Only cases that showed no signs of infection or inflammation in the hernial region during clinical examination were included in the study.

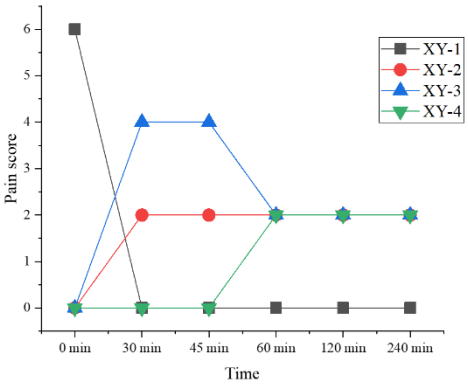
Intraoperative and Postoperative Observations

The umbilical herniorrhaphy procedure was completed in similar durations across all calves, with no statistically significant differences observed between the groups (P=0.746). The mean operation time was recorded as XY (48±9.5 min), DE (45±2.5 min), ME (47±3.5 min), MI (50±1.5 min), and BU (53±6.5 min). All the surgical procedures were completed without complications. No intraoperative or postoperative complications were noted. During the postoperative follow-up period, feedback from the animal owners and clinical checks confirmed that no complications had developed in any case.

Pain Assessment Results

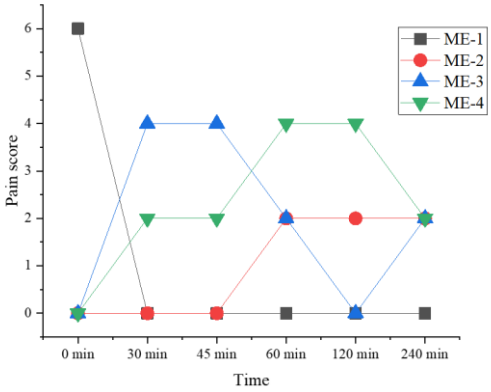
Evaluation using the pain scale showed no statistically significant differences between the groups at any time point (P=0.74). However, time-dependent analyses determined that the pain scores changed significantly in the XY, MI, and BU groups (P=0.035). In calves administered the XY protocol, the analgesic effect had an early onset and followed a significantly stable course starting from the 60th min (P=0.042). The MI group showed long-lasting, moderate, and stable analgesia. The BU group provided effective initial analgesia, but showed a slight, non-significant tendency to decrease over time (P=0.25). Analgesic effects were shorter in the ME group. Although a moderate level of analgesia was generally provided in the DE group, a high pain score of 6 points was noteworthy. The findings demonstrated that all protocols were suitable for clinical use, but the XY and MI combinations were more advantageous in terms of stability and continuity of analgesic duration (Charts 1–5).

Chart 1. The XY group (xylazine + lidocaine), which included six calves, had their pain scores evaluated at 0, 30, 45, 60, 120, and 240 min using the Bovine Pain Assessment Scale and the VAS behavioral pain scale.



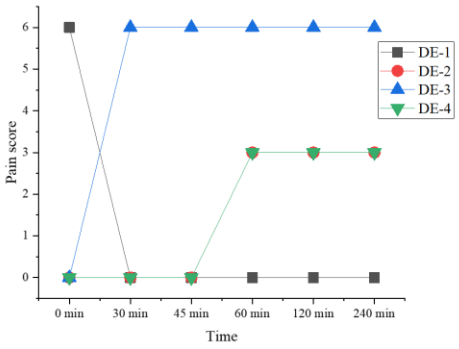
Pain assessment was based on four behavioral categories (XY-1, head movements; XY-2, vocalization; XY-3, gait/ambulation; and XY-4, pain response), with each category scored in the 0–2 point range. The total pain score was calculated using a scale of 0–10. Scores were classified as follows: 0–2, mild or no pain; 3–5, moderate pain; and 6–10, severe pain (requiring analgesic intervention).

Chart 2. The ME group (medetomidine + lidocaine), which included six calves, had their pain scores evaluated at 0, 30, 45, 60, 120, and 240 min using the Bovine Pain Assessment Scale and the VAS behavioral pain scale.



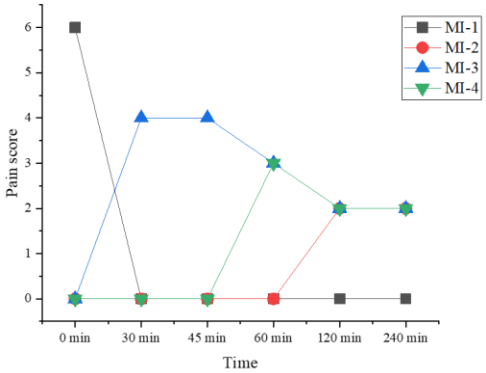
Pain assessment was based on four behavioral categories (ME-1, head movements; ME-2, vocalization; ME-3, gait/ambulation; and ME-4, pain response), with each category scored in the 0–2 point range. The total pain score was calculated using a scale of 0–10. Scores were classified as follows: 0–2, mild or no pain; 3–5, moderate pain; and 6–10, severe pain (requiring analgesic intervention).

Chart 3. The DE group (dexmedetomidine + lidocaine), which included six calves, had their pain scores evaluated at 0, 30, 45, 60, 120, and 240 min using the Bovine Pain Assessment Scale and the VAS behavioral pain scale.



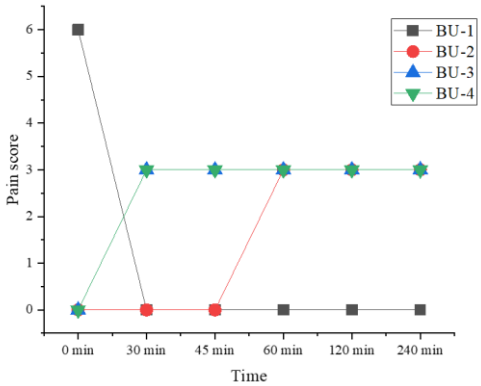
Pain assessment was based on four behavioral categories (DE-1, head movements; DE-2, vocalization; DE-3, gait/ambulation; and DE-4, pain response), with each category scored in the 0–2 point range. The total pain score was calculated using a scale of 0–10. Scores were classified as follows: 0–2, mild or no pain; 3–5, moderate pain; and 6–10, severe pain (requiring analgesic intervention).

Chart 4. The MI group (midazolam + lidocaine), which included six calves, had their pain scores evaluated at 0, 30, 45, 60, 120, and 240 min using the Bovine Pain Assessment Scale and the VAS behavioral pain scale.



Pain assessment was based on four behavioral categories (MI-1, head movements; MI-2, vocalization; MI-3, gait/ambulation; and MI-4, pain response), with each category scored in the 0–2 point range. The total pain score was calculated using a scale of 0–10. Scores were classified as follows: 0–2, mild or no pain; 3–5, moderate pain; and 6–10, severe pain (requiring analgesic intervention).

Chart 5. The BU group (butorphanol + lidocaine), which included 6 calves, had their pain scores evaluated at 0, 30, 45, 60, 120, and 240 min using the Bovine Pain Assessment Scale and the VAS behavioral pain scale.



Pain assessment was based on four behavioral categories (BU-1, head movements; BU-2, vocalization; BU-3, gait/ambulation; and BU-4, pain response), with each category scored in the 0–2 point range. The total pain score was calculated using a scale of 0–10. Scores were classified as follows: 0–2, mild or no pain; 3–5, moderate pain; and 6–10, severe pain (requiring analgesic intervention).

DISCUSSION AND CONCLUSION

This study evaluated the use of different preanesthetic lidocaine combinations in conjunction with the RSB technique to provide analgesia during and after herniorrhaphy in calves with umbilical hernia. Our findings indicate that USG guided RSB is a technically feasible, safe, and effective analgesia method and that the selection of a preanesthetic agent plays a decisive role in the duration and stability of analgesia. Furthermore, lidocaine administered via RSB provided more stable and longer-lasting analgesia, particularly when combined with midazolam and xylazine.

In terms of pain assessment, the scores obtained using the Bovine Pain Assessment Scale and the VAS started at a low level in all groups during the early period and continued stably over time, particularly in the XY, MI, and BU groups. Previous studies have reported that epidural and intrathecal approaches failed to provide adequate analgesia, sometimes requiring supplementation with local infiltration, and were associated with cardiorespiratory complications (16,17). Another study using a combination of xylazine and lidocaine reported that when the local anesthetic was applied through a blind technique, moderate pain was felt at the 4th postoperative hour (14). This suggests that local infiltration without anatomical targeting may be insufficient for nociceptive blockade. In the current study, RSB application required no supplemental analgesic intervention, and no systemic complications were observed in any case. This finding supports the idea that RSB is a practical method in terms of both its analgesic efficacy and safety.

The rapid and stable analgesia observed in the XY group was consistent with the α2-adrenergic agonist effect of xylazine, which provides analgesia and sedation via the central nervous system. This finding has been similarly reported in studies conducted by Kamiloğlu et al. (18) and Singh et al. (19). Although midazolam is generally known for its sedative effects, its combination with lidocaine prolonged the duration of analgesia and resulted in stable pain scores in the MI group (18,19). Clarke and Trim (20) and Farouk and Aly (21) similarly reported that co-administration of benzodiazepines with local anesthetics creates synergistic effects (20,21).

In the BU group, the initial analgesic efficacy decreased over time but remained stable at a certain level. This is consistent with butorphanol's opioid structure, which exhibits partial agonist-antagonist properties and aligns with previous studies stating that it is a short-acting analgesic (22,23). In contrast, Maidanskaia et al. (13) reported that the analgesic efficacy of butorphanol significantly increased when combined with other agents (13). Therefore, the BU protocol could be considered a preferable option, especially for short-term surgical or interventional procedures.

The moderate and stable analgesia observed in the DE group can be attributed to the high α2 of selectivity. However, in some cases, this group also exhibited higher pain scores. The literature suggests that dexmedetomidine combined with lidocaine may increase analgesic stability, but its effect might be limited to reaching a maximum level (11,24). Moreover, our findings, which indicate that the depth of the analgesic effect may remain limited despite its continuity, are consistent with data reported by Yoshitomi et al. (25) and Murrell and Hellebrekers (26). The shorter duration of analgesia observed in the ME group compared to other protocols is associated with the lower binding affinity for α2-adrenergic receptors (27,28). This finding parallels the short duration of the observed sedative effect.

The main limitations of this study include the limited number of calves in each group and lack of pharmacokinetic evaluation. Pain assessment was restricted to behavioral scoring only, and biochemical or physiological parameters were not utilized. Furthermore, the findings are limited to applications in healthy neonatal calves; therefore, results may differ in different age groups or in cases of systemic disease.

This study demonstrated that preanesthetic lidocaine combinations supported by the RSB technique provide safe and adequate analgesia in calves. Although the XY and MI protocols offer a long and stable analgesic effect, the BU protocol may be a suitable option for short-term surgical procedures. These findings serve as clinical guidelines for determining effective analgesia protocols under field conditions.

FINANCIAL SUPPORT

There was no funding from any organization to conduct this research.

CONFLICT OF INTEREST

There is no conflict of interest to be declared by the authors.

AUTHOR CONTRIBUTIONS

KY, AH, ÜY and MSH took part in the study planning and sample collection. Clinical studies were carried out by KY, MSK, KDİ and MSH. The writing of the study and final checks were carried out with the contributions of all authors.

ETHICAL STATEMENT

The study protocol was approved by the Local Ethics Committee on Animal Experiments, Harran University (session and permit number: 2024/006/05).

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