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Balanced Anaesthesia in Sheep: A Review

Review Article

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Summary

The objectives of this review were to review all scientific data regarding anaesthetic drugs and anaesthetic protocols used for pre-medication, sedation, induction and maintenance of anaesthesia in sheep. Sheep are classically considered farm animals and are often intended for the production of food, these species are used extensively in research and teaching and they are increasingly important as companion animals. Recent articles were included in the review with the most common drugs used for sedation and analgesics in Sheep were xylazine, dexmedetomidine, romifidine, detomidine, medetomidine, Fentanyl, morphine and butorphanol. For induction and maintenance of anaesthesia, the following drugs were used most commonly: propofol, Ketamine, Alfaxalone and isoflurane. The drug used for tranquilization is acepromazine. The effective doses and reported side effects were discussed. In conclusion this review provides the safety and efficacy of anaesthesia and their drug combinations used for premedication, sedation, induction and maintenance of anaesthesia in sheep.

Keywords: Sheep; Analgesic; Tranquilization; Induction; Sedation; Maintenance

Introduction

In sheep various sedatives, tranquillizing agents, pain killers and muscle relaxants are also used while animals undergo surgery. For these purposes, the commonest drugs used are ketamine, diazepam, xylazine and atropine sulphate [1]. The anesthetic and analgesic drugs and techniques should be used to ensure minimal stress and discomfort during the perioperative period [2].

In small ruminants, the commonly used sedatives before induction of general anaesthesia include: α2-adrenoceptor agonists such as xylazine; phenothiazine such as acepromazine; benzodiazepines such as diazepam and midazolam; and opioids such as butorphanol (Riebold, 2007). Administration of sedatives as premedication prior to general anaesthesia is a widely accepted concept in veterinary practice [3]. Basal or balanced anaesthesia was developed by the combination of various preanaesthetics play an important role in the intra-operative as well as postoperative surgical pain and prepares surgical patient for total anaesthesia unconsciousness, analgesia and muscle relaxation [4].

Overview of Aneasthetics Drugs used in Sheep

Phenothiazine Derivative

Acepromazine: In sheep there is sparse data on the sedative effects of a combination of acepromazine with various opioids although it is reported that sedation following the administration of acepromazine alone is similar to that created when acepromazine is administered with morphine, methadone or tramadol [5]. Acepromazine used as a preanesthetic, at a relative high IV dose of 0.5 mg/kg in sheep, prevented the occurrence of epinephrine-induced dysrhythmias from cardiac sensitization in halothane-anesthetized and conscious sheep [6]. Acepromazine reduces the dosage of Ketamine needed for a given period of analgesia, and increases the degree and duration of muscle relaxation, and prevents reflex movements of the limbs in sheep [7]. Acepromazine prolongs standing and full recovery times, in sheep [8].

Sedation

Xylazine: In sheep severe hypoxaemia is seen following IV administration of xylazine at both sedative and non-sedative doses [9]. Xylazine has a wide acceptance because of good tolerance and the optional IM or IV administration in sheep (Ndeereh, Mbithi, and Kihurani, 2001) Hypotension following the administration of xylazine to sheep has been reported [10]. Variation in the analgesic effects of xylazine has been noted in different breeds of sheep, for example, analgesia after xylazine was less in Welsh mountain sheep than in Clun sheep [11]. In sheep, it has a short elimination half-life and is rapidly cleared from plasma after IM and IV administration [12].

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Medetomidine (Domitor): In sheep, medetomidine is rapidly distributed after IM and IV injection, with an elimination half-life of approximately 30 minutes; its total body clearance is dose-dependent [13]. After the administration of 40µg/kg-1 of IV medetomidine, adult sheep lay in sternal recumbency within 7 minutes of injection [14]. Medetomidine, 0.03 mg/kg, administered IM induced a significant decrease in PaO2 but hypoxaemia in only one out of nine sheep [13]. Medetomidine (6 µg/kg) produced light to medium sedation in sheep which may be useful for physical and radiologic examination, biopsy, and for pre-anaesthetic medication [15]. Medetomidine like other α-2 agonists has been reported to induce a variable degree of hypoxaemia and pulmonary edema in sheep after IV bolus administration [16].

Detomidine: In sheep detomidine administered intrathecally at 10µg/kg-1 significantly reduced nociception, evaluated by electrical threshold testing, after a mean onset time of 49minutes and a mean duration of 59minutes [17]. Detomidine also decreases the partial oxygen tension due to its effect on the rate and depth of respiration in sheep [18]. Detomidine with 40µg/kg decreases RR, HR and RT, when used in sheep [19]. In sheep it was observed that Detomidine had accelerated the respiratory rate in the first 15 min. Similarly it was reported that glucose increased in sheep with Detomidine at 30µg/kg, 60µg/kg and 90µg/kg dose rates [19].

Dexmedetomidine: In sheep, Kastner et al. [20], found a significant decrease of PaO2 after premedication with dexmedetomidine. Dexmedetomidine has been used in sheep as premedication prior to general anesthesia [21]. Arterial hypoxemia and pulmonary edema have been reported in certain breeds of sheep following the administration of all α-2 agonists, including dexmedetomidine [16]. Congestion and redistribution of blood flow have been suggested as the cause of impaired oxygenation following the administration of dexmedetomidine to healthy anesthetized sheep. The hypoxemia is made worse by alveolar edema as a result of hydrostatic stress [22]. Dexmedetomidine has been compared with medetomidine in sheep, and has similar cardiopulmonary and sedative effects [3], but the effects of combinations of dexmedetomidine and opioids have not yet been described. Bradycardia has been reported following dexmedetomidine administration in sheep [23]. Dexmedetomidine administered IM to conscious sheep did not significantly affect blood pressure (Kastner et al., 2001a). Hypoxemia is often observed in sheep after administration of dexmedetomidine, even with low doses, although there may be variation among individuals [22].

Romifidine: In sheep Romifidine is a selective alpha-2 adrenoceptor agonist drug, that is commonly administered systemically or spinally to bring about sedation and analgesia [24].

Benzodiazepams

Midazolam: In sheep, midazolam in particular provides mediation of anti-nociception at the level of the spinal cord [25]. Midazolam, 0.2 mg/kg IV significantly decreased the response of sheep to a mechanical painful stimulus for 20 minutes (Kyles et al., 1995).

Diazepam: Diazepam (0.4 mg/kg, IV) in sheep and midazolam (0.4 mg/kg) in goats lowered PaO2 and did not affect PaCO2 after IV administration; however, the degree of hypoxemia is of a lesser magnitude and duration (less than 15 minutes) than with α-2 agonists (Stegmann, 1998). The actions of benzodiazepines on GABA/benzodiazepine receptors play a role in antinociception as demonstrated in midazolam-treated sheep undergoing mechanical and thermal stimulation (Kyles et al., 1995). At dose rate of 0.2 mg/kg intravenously injected Diazepam can be used to produce mild sedation for transdermal tracheal wash (Hall et al., 2001).

Opioids

Fentanyl: However, Fentanyl patches, 2µg/kg/h, applied to the forelimb between carpus and elbow or elbow and shoulder have been used as part of anaesthetic protocols in sheep with apparent beneficial effect (Raske et al., 2010). Waterman et al. [26] described a clinically useful period of analgesia in sheep receiving fentanyl bolus. Abnormal behavioral signs and restlessness were observed during recovery of anaesthesia after fentanyl administration in goats [27] and sheep [26]. The use of fentanyl CRI during inhalation anaesthesia in sheep has only been described in cardiac surgery (Levionnois and Kronen, 2008). Fentanyl (10 µg kg-1 IV) has been shown to be effective against thermal and mechanical stimuli in a nociceptive model in sheep with duration of analgesia of 60 minutes [26] and, applied as a patch, to provide good postoperative pain relief following orthopaedic surgery [28].

Butorphanol: In sheep Synergistic action of butorphanol and dexmedetomidine showed excellent muscle relaxation after anaesthetic induction with propofol [23]. Butorphanol (0.5 mg kg-1) IV administered alone to conscious sheep did not affect HR [29]. Butorphanol (0.2 mg kg-1) IV had no effect on blood gases in healthy sheep, but fentanyl induced a short duration of respiratory depression. In sheep, butorphanol (0.1–0.2 mg/kg, IV) caused behavioral changes [26]. These effects are less likely to occur if the drug is given SC, as a higher dose of butorphanol (0.5 mg/kg) induced sedation and analgesia when administered subcutaneously [29].

Morphine: The behavior of sheep after IV morphine includes an increase of locomotor activity, vocalization and escape behavior [30]. Morphine administered for premedication would have provided an analgesic and sedative effect with duration close to that of the surgical procedure performed in the sheep (Riebold, 2007).

Induction Aneasthesia

Propofol: In sheep propofol produces dose-dependent respiratory and cardiovascular depression [31]. Propofol, a short–acting hypnotic agent, is usually injected as a single bolus for anaesthetic induction to allow intubation and initiation of inhalant anaesthesia [32]. Propofol has been investigated as intravenous anaesthetic in sheep (Lin et al., 1997). Combination of propofol with ketamine 'ketofol' is an alternative technique for TIVA that has been reported in sheep (Correia et al., 1996). Propofol has been used for maintenance of anesthesia using a continuous infusion in several species, including in sheep [33].

Ketamine: In an investigation of sheep undergoing experimental stifle surgery, infusions of ketamine, 0.6 mg/kg/h, and lidocaine, 1.2 mg/kg/h, significantly decreased the isoflurane requirement by approximately 23% when compared with animals not receiving infusions (Raske et al., 2010). It has been used successfully as a general anaesthetic agent in a variety of domestic animals, including cats, dogs, horses, and sheep (Thurman et al., 1975). Ketamine has been proved an acceptable anaesthesia for sheep and goats, and can be used on its own, but muscle tone and trembling makes the effect unpleasant, although the analgesia appears to be good [34]. An increase in heart rates reported to be less among sheep anaesthetised by atropine-acepromazine-ketamine than among sheep anaesthetised by ketamine alone or in a combination with atropine, because acepromazine blocks the pressor response to epinephrine (Thurman et al., 1975). A pattern of apnea has been described after ketamine, atropine-ketamine, and atropine acepromazine- ketamine injections in sheep. Apnea can be prevented by injecting the drug slowly over a period of 45 to 60 s (Thurman et al., 1973). Ketamine has been proved an acceptable anaesthesia for sheep and goats, and can be used on its own, but muscle tone and trembling makes the effect unpleasant, although the analgesia appears to be good [35].

Alfaxalone: In sheep Alfaxalone has recently been used as an induction agent [36]. Alfaxalone has been reported to be a suitable anaesthetic-induction agent at a dose of 2.00 mg/kg in unsedated sheep [37]. The decrease in pH was not clinically important since it remained within a clinically acceptable range for sheep (7.48–7.58) during the

entire study period. Furthermore, although the PaO2 decreased minimally after Alfaxan administration it also remained within the range considered normal for sheep (72–90 mm Hg) (Lin and Pugh, 2002).

Maintenance Aneasthesia

Isoflurane: In sheep isoflurane is a commonly used inhalant anaesthetic agent that produces a dose-dependent cardiovascular and respiratory. The MAC of isoflurane in sheep has been reported to be 1.53 ± 0.12 vol% [36]. Inhalation anaesthesia using isoflurane in sheep produces a dose-dependent cardiovascular and respiratory depression [37,38] that could be limited by its combination with other drugs such as anaesthetics or analgesics. Published MAC values for isoflurane in adult non-pregnant sheep are 1.42 ± 0.19% [39] and goats 1.29 ± 0.11% and 1.32% (range, 1.29–1.36%) [40]. Anaesthetic requirements for inhalants are decreased by pregnancy, and a 21% reduction in isoflurane to 1.02 ± 0.12% was measured in pregnant sheep. The cardiopulmonary effects of isoflurane, sevoflurane, and desflurane have been investigated in sheep and goats [39]. Different results have been reported in sheep in which there was a decrease in RBC during isoflurane. This decrease in the RBC count of sheep has been attributed to sequestration of RBCs in the spleen or by the shifts in body fluids [37,40-53].

Conclusion

In conclusion this review provides the safety and efficacy of anaesthesia and their drug combinations used for premedication, sedation, induction and maintenance of anaesthesia in sheep.

References

1. Mahmud MA, Shaba P, Yisa HY, Gana J, Ndagimba R (2014) Comparative efficacy of Diazepam, Ketamine, and Diazepam-Ketamine combination for sedation or anaesthesia in cockerel chickens. Journal of Advanced Veterinary and Animal Research 1: 107-113.
2. Lee I, Yoshiuchi T, Yamagishi N, Oboshi K, Ayukawa Y, et al. (2003) Analgesic effect of caudal epidural ketamine in cattle. J Vet Sci 4(3): 261-264.
3. Dzikiti TB, Stegmann GF, Hellebrekers LJ (2009) Sedative and cardiopulmonary effects of acepromazine, midazolam, acepromazine-butorphanol and midazolambutorphanol on propofol anaesthesia in goats. Journal of the South Africa Veterinary Association 80(1): 10–16.
4. Gangwar AK, N Kumar, KS Devi (2010) General Animal Surgery and Anaestheisiology. Pp. 179-283.
5. Nishimura LT, Villela IOJ, Carvalho LL, Borges LPB, Silva MAM, et al. (2017) The effect of acepromazine alone or in combination with methadone, morphine, or tramadol on sedation and selected cardiopulmonary variables in sheep. Veterinary Medicine International 7507616.
6. Rezakhani A, Edjtehadi M, Szbuniewicz M (1977) Prevention of thiopental and thiopental/halothane cardiac sensitization to epinephrine in the sheep. Can J Comp Med 41(4): 389–395.
7. Ali Baniadam FS (2007) Cardiopulmonary Effects Of Acepromazine-Ketamine Administration In The Sheep. Bull Veterinary Institiute Pulaway 51: 93-96.
8. Thurmon JC, Kumar A, Link RP (1973) Evaluation of ketamine hydrochloride as an anesthetic in sheep. Journal American Veterinary Medical Association 162(4): 293-297.
9. Doherty TJ, Pascoe PJ, McDonell WN, Monteith G (1986) Cardiopulmonary effects of xylazine and yohimbine in laterally recumbent sheep. Canadian Journal of Veterinary Research 50(4): 517-521.
10. Aziz MA, Carlyle SS (1978) Cardiovascular and respiratory effects of xylazine in sheep. Zentralable Veterinary medicine Aneasthesia 25: 173–180.
11. Ley S, Waterman A, Livingston A (1990) Variation in the analgesic effects of xylazine in different breeds of sheep. Veterinary Record 126(20): 508.
12. Garcia-Villar R, Toutain PL, Alvinerie M (1981) The pharmacokinetics of xylazine hydrochloride: an inter-specific study. J Vet Pharmacol Ther 4(2): 87–92.
13. Kastner SBR, Wap FP, Feige K (2003) Pharmacokinetics and sedative effects of intramuscular medetomidine in domestic sheep. J Vet Pharmacol Ther 26(4): 271–276.
14. Ranheim B, Arnemo JM, Stuen S (2000) Medetomidine and atipamezole in sheep: disposition and clinical effects. Journal Veterinary Pharmacology Therapeutic 23(6): 401–404.
15. Moolchand M, AB Kachiwal, SA Soomro, ZA Bhutto (2014) Comparison of sedative and analgesic effects of xylazine, detomidine, and medetomidine in sheep. Egypt Journal Sheep and Goat Science 9: 43-48.
16. Kastner SB, Von Rechenberg B, Keller K (2001b) Comparison of medetomidine and dexmedetomidine as premedication in isoflurane anaesthesia for orthopaedic surgery in domestic sheep. J Vet Med A Physiol Pathol Clin Med 48(4): 231–241.
17. Haerdi-Landerer MC, Schlegel U, Neiger-Aeschbacher G (2003) Analgesic effect of intrathecally applied α-2 agonists (xylazine and detomidine) in sheep and the systemic antagonisation with atipamezole. Vet Anaesth Analg 30: 88–99.
18. Waterman AE, Nolan A, Livingston A (1987) Influence of idazoxan on the respiratory blood gas change induced by α-2-adrenoceptor agonist drugs in conscious sheep. Veterinary Record 121(5): 105–107.
19. Singh J, Singh AP, Peshin PK, Sharifi D, Patil DB (1994) Evaluation of Detomidine as a sedative in sheep. Indian Journal Animal Science 63(3): 237-238.
20. Kastner SB, Kull S, Kutter APN, Boller J, Bettschart–Wolfensberger R, et al. (2005). Cardiopulmonary effects of dexmedetomidine in sevoflurane anesthetized sheep with or without nitric oxide inhalation. Am J Vet Res 66(9): 1496–1502.
21. Funes FJ, Granados Mdel M, Morgaz J (2014) Anaesthetic and cardiorespiratory effects of a constant rate infusion of fentanyl in isoflurane-anaesthetized sheep. Vet Anaesth Analg 42(2): 157–164.
22. Kastner SBR, Ohlerth S, Pospischil A (2007) Dexmedetomidine-induced pulmonary alterations in sheep. Res Vet Sci 83(2): 217–226.
23. Monsang SW (2011) Comparison of medetomidine and dexmedetomidine with and without butorphanol and midazolam as preanaesthetics to propofol anaesthesia in sheep. Indian Veterinary Research Institute; India: p. 45.
24. Celly CS, McDonell WN, Young SS (1997) The comparative hypoxaemic effect of four α 2 adrenoceptor agonists (xylazine, romifidine, detomidine and medetomidine) in sheep. J Vet Pharmacol Ther 20(6): 464–471.
25. Lizarraga I, Chambers JP (2012) Use of analgesics for pain management in sheep. New Zealand Veterinary Journal 60(2): 87–94.
26. Waterman AE, Livingston A, Amin A (1990) The antinociceptive activity and respiratory effects of fentanyl in sheep. Journal Association Veterinary Anaesthesia 17: 20–23.
27. Dzikiti TB, Stegmann GF, Dzikiti LN, Hellebrekers LJ (2010) Total intravenous anaesthesia (TIVA) with propofol-fentanyl and propofol-midazolam combinations in spontaneously breathing goats. Veterinary Anaesthesia and Analgesia 37(6): 519–525.
28. Ahern BJ, Soma LR, Boston RC (2009) Comparison of the analgesic properties of transdermally administered fentanyl and intramuscularly administered buprenorphine during and following experimental orthopedic surgery in sheep. Am J Vet Res 70: 418–422.
29. O'Hair KC, Dodd KT, Phillips YY (1988) Cardiopulmonary effects of nalbuphine hydrochloride and butorphanol tartrate in sheep. Lab Anim Sci 38(1): 58–61.
30. Verbeek E, Ferguson D, Monjour PQ (2012) Opioid control of behaviour in sheep: effects of morphine and naloxone on food intake, activity and the affective state. Application Animal Behavioral Science 142(1-2): 18–29.
31. Upton RN, Martinez AM (2003) The contribution of the coronary concentrations of propofol to its cardiovascular effects in anesthetized sheep. Anesthesia and Analgesia 96(6): 1589-1597.
32. Short CE, Bufalari A (1999) Propofol anesthesia. Veterinary Clinics of North America Small Animal Practice 29(3): 747-777.

33. Ludbrook GL, Upton RN, Grant C (1996) Brain and blood concentrations of propofol after rapid intravenous injection in sheep, and their relationships to cerebral effects. Anaesth Intensive Care 24(4): 445–452.

34. Taylor PM (1991) Anaesthesia in sheep and goats. In Practice 13: 31-36.

35. Saberi Afshar F, Baniadam A, Marashipour SP (2005) Effect of xylazine-ketamine on arterial blood pressure, arterial blood pH, blood gases, rectal temperature, heart and respiratory rates in sheep. Bullet Veterinary Institute Pulaway 49: 481-484.

36. Bernards CM, Kern C, Cullen BF (1996) Chronic cocaine administration reversibly increases isoflurane minimum alveolar concentration in sheep. Anesthesiology 85: 91–95.

37. Hikasa Y, Saito K, Takase K (2000) Clinical, cardiopulmonary, hematological and serum biochemical effects of sevoflurane and isoflurane anesthesia in oxygen under spontaneous breathing in sheep. Small Rumininant Resource 36(3): 241–249.

38. Mohamadnia AR, Hughes G, Clarke KW (2008) Maintenance of anaesthesia in sheep with isoflurane, desflurane or sevoflurane. Veterinary Record 163: 210–215.

39. Okutomi T, Whittington RA, Stein DJ (2009) Comparison of the effects of sevoflurane and isoflurane anesthesia on the maternal-fetal unit in sheep. J Anesth 23: 392–398.

40. Dzikiti TB, Stegmann FG, Dzikiti LN (2011b) Effects of fentanyl on isoflurane minimum alveolar concentration and cardiovascular function in mechanically ventilated goats. Veterinary Record 168(16): 429.

41. Kästner SB (2006) α2-agonists in sheep: a review. Vet Anaesth Analg 33(2): 79–96.

42. Kastner SB, Boller M, Kutter A, Akens MK, Bettschart WR (2001) Clinical comparison of preanaesthetic intramuscular medetomidine and dexmedetomidine in domestic sheep. Deutsch Tierärztliche Wochenschrift 108(10): 409-413.

43. Celly CS, McDonell WN, Black WD, Young SS (1997a) Cardiopulmonary effects of clonidine, diazepam and the peripheral α-2 adrenoceptor agonist ST-91 in conscious sheep. Journal Veterinary Pharmacology Therapeutic 20: 472–478.

44. Galatos AD (2011) Anesthesia and analgesia in sheep and goats. Vet Clin North Am Food Anim Pract 27: 47–59.

45. Genccelep M, Atasoy N, Tas A (2004) The effects of inhalation anaesthetics (halothane and isoflurane) on certain clinical and haematological parameters of sheep. Small Ruminant Research 53:157–160.

46. Hall LW, Clark KW (1992) Veterinary Anaesthesia, 9th edition; p. 81-83.

47. Hall LW, Clarke KW, Trim CM (2003) Veterinary Anesthesia (10th ed.). Balliere, Tindal, London; p. 88-90.

48. Kutter APN, SBR Kastner, R Bettschart-Wolfensberger, M Huhtinen (2006) Cardiopulmonary effects of dexmedetomidine in goats and sheep anaesthetized with sevoflurane. The Veterinary Record 159(19): 624-629.

49. Lumb WV, Jones EW (1996) Veterinary Anesthesia. 3rd Ed. Williams and Wilkins: Maryland; USA: pp.199-202.

50. Muge DK, Chamber JP, Livingstone A, Waterman AE (1994) Analgesic effects of medetomidine in sheep. Veterinary Record 135(2): 43-44.

51. Thurmon JC, Tranquilli WJ, Benson GJ (1999) Essentials of Small Animal Anaesthesia and Analgesia (1st edn), Williams and Wilkins: Baltimore; Maryland: USA.

52. Thurmon JC, Kumar A, Cawley AJ (1975) Changes in the acid base status of sheep anaesthetized with a combination of atropine sulfate acepromazine and ketamine hydrochloride. Aust Vet J 51(10): 484-487.

53. Tranquili JW, JC Thurmon, KA Grimm (2007) Lumband Jones Veterinary Anesthesia and Analgesia. (4th ed).: 241-271, 585-587.