

SEDATIVE AND RESPIRATORY EFFECTS OF INTRAMUSCULAR DETOMIDINE AND BUTORPHANOL IN DONKEYS SEDATED FOR BRONCHOALVEOLAR LAVAGE

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ABSTRACT

The aim of this study was to evaluate the effects of intramuscular (IM) detomidine and butorphanol on sedation, arterial blood gases, and bowel motility in sixteen healthy Amiata donkeys undergoing bronchoalveolar lavage (BAL). Before administration of detomidine and butorphanol, baseline values for heart rate (HR), respiratory frequency (fr), rectal temperature, arterial blood gases, and sedation score (range 0e9) were recorded as Tbase and bowel motility was assessed. Sedation was assessed with a composite sedation scale. After IM injection of detomidine 0.06 mg kg⁻¹ and butorphanol 0.05 mg kg⁻¹, HR, fr, temperature, and sedation score were registered every 5 minutes. Arterial blood was sampled when sedation score was greater than or equal to 6 right before performing the diagnostic procedure (T1) and at a sedation score of 3 or lower, which was considered the end of sedation (T2). Bowel motility was assessed every hour after the end of sedation. Sedation score of 6 or more was reached after 10 minutes in all animals. Mean sedation time was 38.8 ± 5.2 minutes. PaO₂, HR, and fr were significantly lower at T1 and T2 compared to Tbase values. Fshunt significantly increased at T2, in comparison to Tbase. Time from injection to return to normal bowel motility was 272 ± 62 minutes. Intramuscular detomidine and butorphanol provided satisfactory sedation for BAL in donkeys, in terms of reliability and duration. Clinicians should be aware of the reduction of PaO₂ that can arise.

KEYWORDS: DONKEY -- STANDING SEDATION – DETOMIDINE – BUTORPHANOL -- BLOOD GASES -- BAL

1. Introduction

Standing chemical restraint is often required to perform diagnostic procedures in equine subjects. The management of donkey's standing sedation is more challenging compared to horses, due to the stubborn nature of the former. Standing sedation in horses and donkeys has been achieved with the administration of α_2 -agonists combined with systemic analgesics [1]. Anesthetic and sedative drug doses for donkeys are generally suggested to be higher than what indicated for horses, because of differences in body fluid distribution, disposition kinetics and drug metabolism between the two species [2].

Detomidine is an α_2 -agonist whose properties have been investigated in donkeys when administered intravenously (IV) [3,4]. Butorphanol is a μ -antagonist κ -agonist opioid, frequently used in combination with α_2 -agonists to enhance sedation and analgesia in horses [5]. The combination of detomidine with butorphanol could be a valuable option to perform short procedures under field conditions, where, usually, limited equipment is available. The use of α_2 -agonists and butorphanol in donkeys by the IV route has been reported to produce adequate sedation and analgesia for standing procedures and minor surgery [6-8]. However, detomidine and butorphanol administered to horses are reported to affect the cardiovascular and respiratory functions resulting in impaired pulmonary gas exchange [9,10]. To the authors' knowledge there are no published studies evaluating the sedative effect of the combination of intramuscular (IM) detomidine and butorphanol in donkeys.

The primary aim of this study was to evaluate the sedative effects of IM detomidine plus butorphanol in Amiata donkeys. Secondary aim of the study was the evaluation of this sedation protocol on arterial blood gases during bronchoalveolar lavage (BAL) in donkeys.

The hypothesis of the present study was that a single IM injection of a combination of detomidine and butorphanol, at the employed doses, would induce the sedation needed to perform a BAL.

2. Materials and Methods

2.1. ANIMALS

Sixteen adult healthy Amiata donkeys, (10 females and 6 males, mean age 5.3 ± 2.5 years and mean body weight 276 ± 45 kg) were enrolled in a prospective, experimental study, which required performance of BAL. Ethical approval, n 9069/2014, by the Ethics Committee on Animal Experimentation of the University of Pisa, was obtained. Donkeys were housed in a paddock and divided into herds, one for females and one for males. The night before the experimental setting, donkeys were housed in 4 X 4 m boxes. Food, but not water, was withheld for 8-12 hours.

2.2. SEDATION ASSESSMENT

Sedation was assessed always by the same investigator (MD) with a composite descriptive scale, created by the authors for the purpose (Table 1). The scale considered four categories, including general attitude, the ability to stand correctly, position of the neck, and position of the ears. The total sedation score ranged from 0 to 9 and was obtained from the sum of the scores derived from each category. A pilot study with 4 donkeys, not further included in the study, was done in order to evaluate the adequate sedation score to allow the performing of the procedure. From the pilot cases, a score of six was then considered the minimum acceptable threshold to reach before the starting of the diagnostic procedure.

2.3. ARTERIAL BLOOD GAS

In pilot cases, blood sampling and catheterization of the transverse facial artery was attempted but it resulted to be not feasible. For this reason, the carotid artery was used for arterial blood sampling. The area comprised between the vertical branch of the mandible, the ventral edge of the brachiocephalic muscle, and the ventral edge of the neck was clipped and surgically scrubbed. Arterial blood (at least 1 mL) was withdrawn from the common carotid artery in 1.5 mL balanced-heparinized syringes (Pico70, Radiometer Medical ApS, Denmark). The needle (23 G) was entered at the dorsal edge of the jugular furrow directed medially with a depth of 3e4 cm, until arterial blood was obtained. The samples were immediately analyzed for blood gases with the blood gas analyzer ABL 700 series (Radiometer, Copenhagen, Denmark) with correction for temperature. Animals were breathing room air (FiO_2 0.21) and composition of inspired gas was not modified at any time during the study.

2.4. EXPERIMENTAL PROCEDURE

Baseline values (T_{base}) for heart rate (HR), respiratory rate (f_r), rectal temperature, and arterial blood gas analysis were recorded and bowel motility was assessed by auscultation. An IM injection of 60 $\mu\text{g kg}^{-1}$ detomidine (Detogesic, Zoetis Italia srl, Roma, Italy) and 50 $\mu\text{g kg}^{-1}$ butorphanol (Nargesic, ACME s.r.l., Cavriago, Italy) was performed in the muscles of the upper third of the neck. Both drugs were drawn in one syringe, the injection was given inside the box where the donkeys were housed, and each donkey was moved to an examination room immediately after the injection. The distance of the path from the box to the examination room was the same for each donkey (about 100 m). Donkeys were entered in a stock, a 14 G IV catheter (Terumo Italia Srl) was introduced in the left jugular vein after clipping and surgical scrub of the area, electrocardiographic electrodes were placed and connected to a multiparametric monitor (EDAN M50 patient monitor, Edan Instruments Inc., P. R. China), and HR, f_r , rectal temperature, and noninvasive oscillometric blood pressure, with the cuff positioned at the base of the tail, were monitored and recorded every five minutes on a data

collecting sheet until the end of the procedure. At the same time, sedation was assessed and the score was recorded every five minutes. When the sedation score reached at least 6 points, another arterial blood sample was taken for blood gas analysis (T1). At this point, the BAL started. An IV bolus of detomidine at the dose of $10 \mu\text{g kg}^{-1}$ was planned if the adequate sedation plane was not achieved or maintained throughout the procedure. The BAL was performed with a specific catheter (BAL tube) (Bivona Inc., Gary, IN). The BAL tube was 3 meters long, 10 mm inner diameter, with an inflatable cuff. The BAL tube was passed blindly through the nasal passage, ventral meatus, and then moved caudally into the trachea, and passed to the lower airways up to the third- to fourth-generation bronchi, and then the cuff was inflated with air and 300 mL of a warmed, sterile, isotonic, crystalloid solution was flushed in the airways. Bronchoalveolar lavage fluid was collected with gentle but constant manual aspiration using 60 mL syringes. When at least 70% of the infused volume was recovered, the cuff was deflated, and the tube was removed. Prefilled 20 mL syringes with a solution of lidocaine 0.66% (Lidocaina 2%, Zoetis Italia srl, Roma, Italy) diluted with saline solution 0.9% were used to splash the tracheal lumen while advancing BAL tube before performing the BAL, for antitussive purposes [11]. The maximum total dose of lidocaine was limited to 1 mg kg^{-1} per donkey (up to 3 prefilled syringes).

After the end of the diagnostic procedure, the last arterial blood sample was taken when sedation score returned to 3 points or lower (T2); from the pilot cases, this resulted the score at which the animals were able to properly walk out of the stock. This score was also considered the end of sedation. Sedation time, considered from time in which each animal reached a sedation score of at least 6, until the return to a score of 3 or less, was recorded. Every hour, starting from one hour after the end of sedation, bowel motility recovery was assessed, always by the same operator (MD), by auscultation of the four quadrants [12]. Normal auscultation was considered as the presence of borborygmi in each quadrant, as well as the presence of caecal discharge sounds in the dorsal right quadrant of the abdomen. A frequency of 4 contractions every 3 minutes was considered as a normal caecum motility [13]. Time to return of normal bowel sounds, starting from injection, was recorded for each animal. For each of the following time points, Tbase, T1 and T2, the value of Fshunt was determined as described by Araos et al. [14]: $[(\text{Cc}'\text{O}_2 - \text{CaO}_2)/(\text{Cc}'\text{O}_2 - \text{CaO}_2) + 3.5 \text{ mL dL}^{-1}) \times 100$. For the aforementioned time points (Tbase, T1 and T2), the following oxygen tension-based indices were also calculated: the alveolar to arterial oxygen tension difference ($\text{P[A-a]O}_2 = \text{PAO}_2 - \text{PaO}_2$) and the arterial oxygen tension to fraction of inspired oxygen ratio ($\text{PaO}_2/\text{FiO}_2$).

2.5. STATISTICS

Considering the median sedation score (7) obtained in the pilot cases and the minimum sedation score of 6 determined as an adequate score to start the procedure, with an alpha error of 0.5, the sample size needed to have a power of 0.8 was 10; we decided to enrol all the 16 donkeys, which were undergoing the BAL procedure because of potential losses. Normality was assessed with a

Shapiro-Wilk test. Sedation scores over time were analyzed by a Friedman test with a Dunn's post hoc. Parametrical data (HR, *fr*, temperature) were evaluated with a one-way analysis of variance for repeated measures with a post hoc Dunnett's test comparing the Tbase values to the subsequent times. The blood gas parameters were analyzed with a one-way analysis of variance and Tukey's post hoc test. Significance was considered for *P* value < .05. Statistical analysis was performed with a specific software (Prism 6-2; GraphPad Prism Inc. CA, USA).

3. Results

All donkeys completed the study with no adverse events. No donkeys became recumbent and no additional drugs other than the initial bolus of detomidine and butorphanol were administered. The mean dosage of endotracheal lidocaine administered for the BAL resulted $0.74 \pm 0.18 \text{ mg kg}^{-1}$. Mean sedation time was 38.8 ± 5.2 minutes. Ten minutes after injection, all the animals reached a sedation score of 6 or more. The highest median sedation score reached was 7. A median sedation score of 6 points or higher was maintained for an overall duration of 25 minutes. A significant increase of the sedation score ($P = .0001$), in comparison to the basal values, was detected after 10 minutes, until 35 minutes after injection (Figure 1). Heart rate was significantly lower than baseline ($38.7 \pm 2.8 \text{ bpm}$) from 10 ($28.4 \pm 5.9 \text{ bpm}$) to 45 ($25.6 \pm 2.9 \text{ bpm}$) minutes postinjection ($P = .0001$) (Figure 2). One donkey showed a transient second degree atrioventricular (AV) block that appeared 15 minutes postinjection and lasted less than 5 minutes. Noninvasive blood pressure measurement failed to detect the pressure in all the animals; thus, data were unavailable and not considered. As compared to baseline values ($24.9 \pm 3.8 \text{ bpm}$), respiratory rate was significantly lower from 15 ($21 \pm 3.9 \text{ bpm}$) to 45 ($21.3 \pm 2.7 \text{ bpm}$) minutes postinjection (Figure 3) ($P = .0001$). PaO_2 significantly decreased in comparison to baseline at T1 and at T2 ($P = .0007$) (Table 2). No significant differences were found at any time point for PaCO_2 values and temperature (Figure 4), pH and bicarbonates (Table 2). Lactates were significantly higher at T2 compared to Tbase (Table 2) ($P = .0001$). Fshunt (Table 3) was significantly increased at T2 compared to baseline ($P = .0494$). The alveolar to arterial oxygen tension difference (P[A-a]O_2) was significantly higher at T2 in comparison to Tbase ($P = .002$) (Table 3). $\text{PaO}_2/\text{FiO}_2$ ($P = .0007$) significantly decreased at T1 and T2 compared to baseline (Table 3). Time to return to normal bowel motility from injection was 272 ± 62 minutes.

4. Discussion

The intramuscular administration of detomidine and butorphanol, at the dosages used in this study, resulted suitable for standing sedation of Amiat donkeys undergoing BAL. In the tested population, the elapsed time to obtain an adequate level of sedation was about 10 minutes, allowing the

movement of the subjects from the box to the examination room, immediately after the injection. A median score of at least 6 points, which was the minimum threshold to consider the sedation plane as appropriate to proceed with a BAL, was maintained for about 25 minutes after the onset. This represents enough time for the diagnostic evaluation of the respiratory tract. The addition of top-up doses of detomidine could have possibly prolonged sedation time, as described in literature [6].

Sedation with detomidine and butorphanol in donkeys, administered IV at lower doses, has been reported to be longer compared to the present study [6,7]. A different way of assessing the sedation could have played a role in establishing the sedation length. Both aforementioned studies [6,7] used a simple descriptive scale from 0 to 3 points to assess sedation of donkeys, and sedation was considered to be over when donkeys did not show any obvious signs of sedation. We used a composite descriptive score from 0 to 9 points and we considered that sedation was over when the score reached 3 or less points and donkeys were able to walk out of the stock without assistance. This should be considered a limitation of the present study, because the absence of a validated sedation scale for donkeys does not allow the direct comparison of the results among studies.

In the present study, endotracheal lidocaine at the dose of about 1 mg kg⁻¹ in a 0.66% solution was administered to the donkeys. Literature reports that lidocaine, administered IV, produces depression of the central nervous system in equine patients, decreases bispectral index values in horses [15] and reduces the minimum alveolar concentration of isoflurane [16] and sevoflurane [17]. In our study, lidocaine absorbed systemically, following administration through the BAL tube, could have exerted a sedative effect in donkeys, additive to the already present effect of detomidine and butorphanol. The absence of a control group without lidocaine, which would have made possible the evaluation of an additive sedative effect in terms of sedation score or sedation length, represents another limitation of this study.

Following administration of detomidine and butorphanol, heart rate was significantly decreased starting 5 minutes after IM injection. This is consistent with what previously reported in donkeys with IV detomidine with or without butorphanol [3,6,7]. One donkey of the present study showed a transient second degree AV block, which lasted about 5 minutes. The occurrence of second degree AV blocks has been documented in horses and donkeys following administration of α_2 -agonists as a result of the inhibition of sympathetic tone and a higher vagal tone; these AV blocks are normally well tolerated by animals without cardiovascular impairment [6,18,19].

Measurement of blood pressure in the studied donkeys was attempted but it was not successful. The monitor frequently failed to detect noninvasive oscillometric blood pressure when a cuff was used on the proximal end of the tail. Single measurements of noninvasive blood pressure obtained by oscillometric devices are inaccurate in case of arrhythmic patients because of beat-to-beat changes of cardiac output (CO) and blood pressure [20]. In the same way, with a very low heart rate, as in our studied population, it is possible that the cuff deflation time of our monitor was too fast to correctly detect pulse oscillations and return a correct reading. Invasive measurement of blood pressure was

also not feasible. Cannulation of the transverse facial artery was not possible because this vessel in the donkey is deeper and less accessible, if compared to the horse, as it often runs under the zygomatic arch [2] and donkeys did not tolerate the manipulation of the area.

The decrease in PaO_2 that occurred after IM administration of detomidine and butorphanol is consistent with what previously described in horses [9,10] and can be explained by a decrease in pulmonary perfusion, which provoked an increase of the ventilation/perfusion (V_A/Q) ratio as reported in horses [10]. Hypoxemia, defined as PaO_2 lower than 60 mmHg [21], has not been revealed in any of the animals of the present study; however, after sedation, 7 out of 16 donkeys showed the decrease of PaO_2 under optimal values (80 mmHg). The reduction of PaO_2 caused by detomidine in horses is described to be the result of an impairment in gas exchange. Detomidine induces a decrease in pulmonary perfusion, without affecting ventilation, thus resulting in an increase in V_A/Q ratio [10]. When butorphanol is added to detomidine, lungs ventilation decreases together with pulmonary blood flow, so V_A/Q ratio improves but arterial oxygen tension remains low [10]. Detomidine in equine patients also causes alteration in systolic left ventricular function with a reduction in stroke volume, which, together with hypertension and bradycardia, results in a decreased CO [22,23]. Yamashita et al (2000) reported that IV administration of 20 and 40 $\mu\text{g kg}^{-1}$ of detomidine in horses caused a reduction in PaO_2 and cardiac index and an increase in systemic vascular resistance, suggesting that the decrease in PaO_2 might have been provoked by a mismatch in V_A/Q ratio [22]. Butorphanol alone administered IV to horses up to 400 $\mu\text{g kg}^{-1}$ is reported to produce no significant changes in arterial blood gases and respiratory rate and not to have effect on arterial pressure, heart rate, and CO [24]; on the contrary, in donkeys sedated with an association of butorphanol and detomidine, the decrease in HR is more pronounced compared to detomidine alone [7]. Both V_A/Q mismatch and decrease in HR could be explanations to the impairment in gas exchange registered in our study. The decrease in HR could have contributed to the decrease in CO and pulmonary perfusion. In our study, carbon dioxide levels remained steady and fR decreased throughout the study. This finding is consistent with what reported for horses [9], in which a combination of detomidine and butorphanol decreased fR , but the increase in tidal volume maintained the minute volume constant. In the absence of obvious hypoventilation, this suggests a non adequate compensatory ventilatory response to hypoxemia, probably due to a decrease in chemoreceptor sensitivity. Alpha_2 -agonists could have played a role because they are described to impair normal chemoreceptor response to normocapnic hypoxemia [25]. Bronchoalveolar lavage fluid in human patients might be partially responsible for the fall in PaO_2 and the increase in alveolar to arterial gradient seen after BAL in healthy subjects because of a “flooding effect” of the fluid at the alveolar level, which results in impaired gas diffusion and a low ventilation/perfusion ratio [26]. This effect could have also played a role in gas exchange impairment and reduction of PaO_2 in the studied donkeys. However, PaO_2 values, before (T1) and after (T2) the BAL, were not different, so the reduction in PaO_2 can likely be attributable to the effects of detomidine and butorphanol rather than to the presence of the BAL fluid. Atelectasis is reported to be the main reason for oxygenation

impairment during anesthesia in horses [27]. Alpha₂-agonists are responsible for muscle relaxation by acting at α_2 -receptor sites at the interneuron level of the spinal cord [28]. It is possible that, in standing sedated donkeys with α_2 -agonists, the muscle relaxation of the thoracic cage contributes to a reduction of functional residual capacity (FRC). Donkeys are anatomically different from horses presenting a large abdomen; thus, the myorelaxation due to the α_2 -agonists might further contribute to a reduction in FRC as a consequence of the pressure of the abdominal organs toward the diaphragm. This could contribute to the development of a compression atelectasis that, in turn, causes the occurrence of intrapulmonary shunts, provoking a decrease in V_A/Q ratio and thus impairing oxygenation. The oxygen tension indices that were calculated in this study (PaO_2/FiO_2) showed a progressive worsening in gas exchange. However, this index is unreliable for the estimation of Q_s/Q_t . Fshunt in horses has been proposed as an oxygen content-based index, which strongly correlates with Q_s/Q_t and thus allows an estimation of venous admixture only requiring the collection of a peripheral arterial sample [29]. From the results of the present study, Fshunt increased slightly after sedation with butorphanol and detomidine suggesting an increasing of the intrapulmonary shunt fraction. However, this index has not been validated in this species and physiological ranges have not been established. The latter represents a limitation of this study. Finally, the reduction of PaO_2 that resulted from sedation with IM detomidine and butorphanol in the present study could have been the result of concurrent different factors that affect the distribution of the V_A/Q ratio, mainly decreased pulmonary perfusion in the presence of a slightly increased intrapulmonary shunt.

Plasma lactates showed an increasing trend in time, being significantly higher at T2 compared to Tbase. Despite an increase in concentration, plasma lactates did not determine acidaemia. Lactates are a result of anaerobic metabolism and an increase in their plasma level can occur either in hypoxic or nonhypoxic conditions [30]. Hypoxic hyperlactatemia (type A) occurs when circulation does not adequately meet the oxygen demand of tissues. This in turn can depend on a decrease in arterial oxygen content or a decrease in tissue perfusion [31]. Nonhypoxic hyperlactatemia (type B) is caused by an oxidative disfunction of mitochondria and can occur as a result of an underlying disease, of the action of drugs or toxins or for a congenital mitochondrial dysfunction [30]. In our study, the increase of lactates could be the consequence of a higher degree of anaerobic metabolism during sedation, which could be the consequence of the recorded reduction of PaO_2 , which, together with a reduction of CO, could have been responsible for an insufficient delivery of oxygen to the tissues.

In the present study, postsedation bowel motility was assessed in terms of four-quadrant auscultation and auscultation of caecal discharge sounds. Because auscultation of the abdomen can be a subjective method of assessment [32], the counting of rushing sounds of the caecum (4 discharges in 3 minutes as described in donkeys [13]) was associated in the global assessment of bowel motility to have a more objective evaluation. The time to recover normal bowel motility appears to be longer in our study than what reported for horses [33,34], suggesting that donkeys

could be more susceptible than horses to the gastrointestinal motility depressing action of α_2 -agonists or opioids. The donkeys in this study were administered endotracheal lidocaine; this drug increases contractility of both longitudinal and circular smooth muscles in the equine intestines [35] and is the most used prokinetic drug to treat ileus in the equine patient [36]. Lidocaine used for its antitussive properties and administered endotracheally through the BAL tube could be absorbed systemically and have exerted a prokinetic effect on donkey's bowel activity, but we cannot say to which extent.

5. Conclusions

The combination of IM detomidine 0.06 mg kg⁻¹ and butorphanol 0.05 mg kg⁻¹ in Amiata donkeys provided a reliable sedation suitable for BAL lasting 20-25 minutes. The clinician should be aware of the possible occurrence of a reduction of PaO₂ and supplemental oxygenation with portable oxygen tanks or concentrators should be considered. Bowel motility should be assessed after sedation until return of normal activity.

Table 1 Composite descriptive scale for sedation of donkeys.

Category	Description	Score
General attitude	Alert	0
	Calm	1
	Unresponsive	2
	Stuporous	3
Standing ability	Good standing posture	0
	Mild ataxia	1
	Moderate ataxia	2
	Difficulty to stand	3
Head and neck	Moving head, upright neck	0
	Still head, slightly lowered neck	1
	Horizontal neck, parallel to the floor or lower	2
Ears	Straight, moving	0
	Still, horizontal	1

Total score ranges from 0 to 9.

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Fig. 1. Sedation score (median and range) of donkeys registered before (Tbase) and every 5 minutes after IM injection of detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}). The two dotted lines indicate the cutoff scores (6 and 3) when sedation was considered sufficient or finished, respectively. * significantly different ($P < .05$) from Tbase.

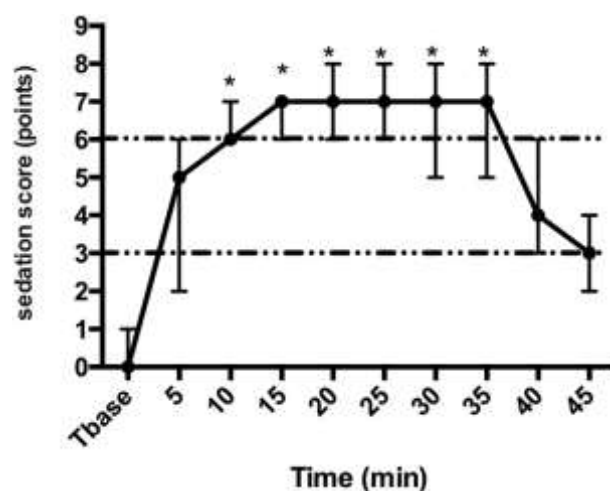
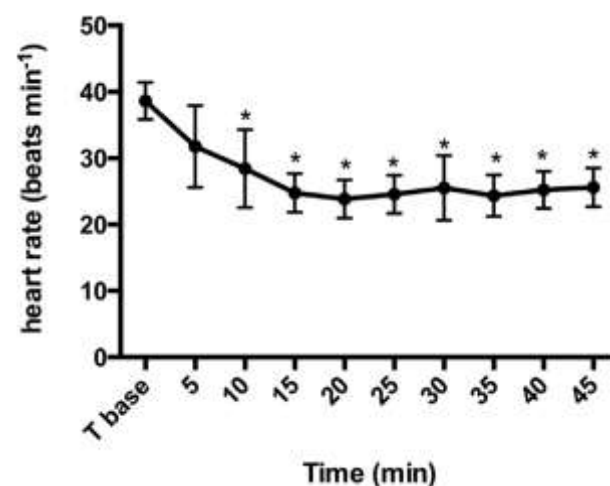


Fig. 2. Mean values and SD of heart rate of donkeys registered before (Tbase) and every 5 minutes after IM injection of detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}). * significantly different ($P < .05$) from Tbase.



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Fig. 3. Mean values and SD of respiratory rate of donkeys registered before (Tbase) and every 5 minutes after IM injection of detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}). * significantly different ($P < .05$) from Tbase.

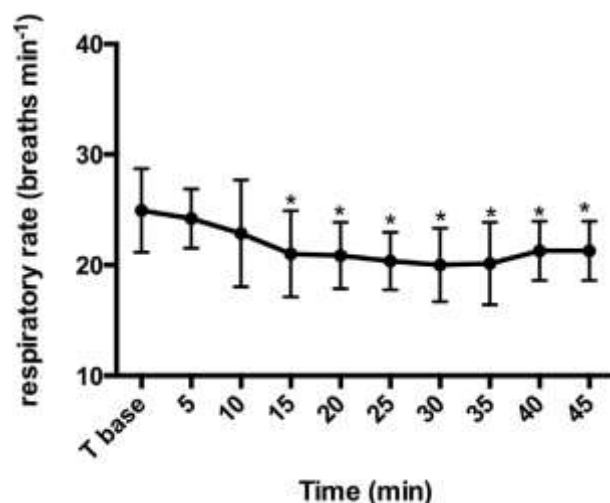


Table 2 Mean $\pm$ SD pH, PaO_2 , PaCO_2 , bicarbonates, lactates, temperature, heart rate (HR), and respiratory rate (fr) in donkeys ($n = 16$) sedated with IM detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}) for bronchoalveolar lavage at baseline (Tbase), at T1 with a sedation score ≥ 6 , right before performing the diagnostic procedure, and at T2 with a sedation score ≤ 3 , which was considered the end of sedation.

Parameter	Tbase	T1	T2
pH	7.43 ± 0.03	7.41 ± 0.03	7.44 ± 0.04
PaO_2 (mm Hg)	100 ± 8.9	84.1 ± 14.3^a	79.9 ± 10.9^a
PaO_2 (kPa)	13.2 ± 1.1	11.2 ± 1.9^a	10.7 ± 1.5^a
PaCO_2 (mmHg)	35.9 ± 3.5	36.7 ± 4.7	36.2 ± 3.9
PaCO_2 (kPa)	4.8 ± 0.5	4.9 ± 0.6	4.8 ± 0.5
HCO_3 (mmol L^{-1})	24.0 ± 1.2	23.4 ± 2.1	24.2 ± 2.1
Lactates (mmol L^{-1})	0.6 ± 0.2	0.8 ± 0.2	1.0 ± 0.3^a
Temperature (C)	36.9 ± 0.5	37.1 ± 0.3	37.0 ± 0.2
HR (beats minute ⁻¹)	38.6 ± 2.8	24.8 ± 2.9^a	24.3 ± 3.1^a
Fr (breaths minute ⁻¹)	24.9 ± 3.7	21 ± 3.9^a	20.1 ± 3.7^a

^aSignificantly different from Tbase ($P < .05$).

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Fig. 4. Mean values and SD of temperature of donkeys registered before (Tbase) and every 5 minutes after IM injection of detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}).

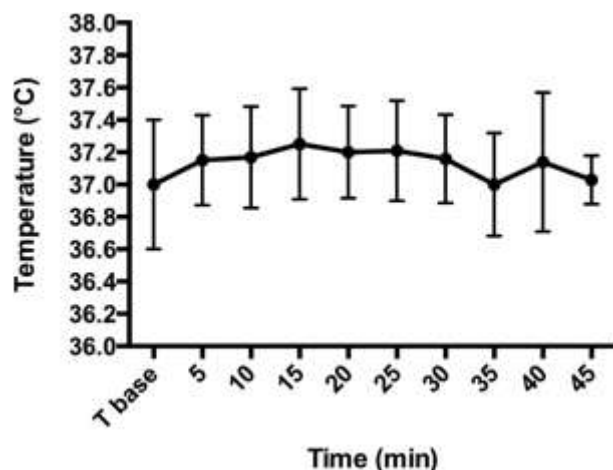


Table 3 Mean $\pm$ SD oxygenation indices in donkeys ($n = 16$) sedated with IM detomidine (0.06 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}) for bronchoalveolar lavage at baseline (Tbase), at T1, with a sedation score ≥ 6 , right before performing the diagnostic procedure, and at T2 with a sedation score ≤ 3 , which was considered the end of sedation.

Parameter	Tbase	T1	T2
Fshunt (%)	16.5 ± 2.3	20.1 ± 6.0	21.4 ± 5.9^a
(P[A-a]O ₂)	9.8 ± 5.3	20.4 ± 12.2	24.9 ± 8.1^a
PaO ₂ /FiO ₂	466.6 ± 48.0	396.8 ± 67.6^a	377.1 ± 51.6^a

^a Significantly different from Tbase ($P < .05$).

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