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RESEARCH ARTICLE

Dissociative Anaesthesia in Foals for Umbilical Herniorrhaphy Under Field Conditions

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Summary

The aim of the present study was to investigate the effects of a dissociative anaesthetic combination of xylazine-tiletamine-zolazepam, administered for the umbilical herniorrhapy of foals under field conditions, on certain cardiorespiratory and clinical anaesthesia parameters. Eleven foals diagnosed with umbilical hernia, of 4-7 months of age (mean age 5.73±0.91 months) and 130-175 kg body weight (mean body weight 152.55±14.35 kg), 7 of which were female and 4 were male, and 8 of which were Arabian horses and 3 were English horses, constituted the material of the study. The anaesthesia protocol was xylazine (1.1 mg/kg, iv), tiletamine-zolazepam (1.65 mg/kg, iv) and half of the indicated doses after observation of the first signs of recovery 3 times at 8-10 min-intervals for sustainment, together with the subcutaneous injection of approximately 12 ml 2% lidocaine peripheral to the hernial sac in a circular pattern for local anaesthesia. In all foals after last drug injection; anaesthesia induction time, operation time, anaesthesia time and standing time were recorded. Quality of induction, anaesthesia/analgesia and recovery were evaluated. Heart rate, respiratory rate, body temparature, arterial oxygen saturation values, mean arterial blood pressure were evaluated before anaesthesia (as a baseline) and after induction of anaesthesia at 15th, 30th, 45th, 60th and 90th min. After induction of anaesthesia cardiopulmonary parameters and body temparature were decreased below baseline values in first stage of anaesthesia and then they were reached to baseline values in late stage of anaesthesia. It was ascertained in the present study that, the supplementation of the combined use of xylazine-tiletamine-zolazepam in foals under field conditions with local anaesthetics induces an anaesthesia of adequate depth for umbilical herniorrhaphy, and sustaining doses enable the prolongation of the anaesthesia period with cardiorespiratory adverse effects remaining within acceptable limits. Therefore, it is considered that, the indicated anaesthesia protocol could be tested for other surgical interventions in foals under both field and clinical conditions.

Keywords: *Xylazine, Tiletamine-Zolazepam, Dissociative anaesthesia, Field condition, Foal*

Saha Şartlarında Taylarda Umblikal Herniorafi İçin Dissosiyotif Anestezi

Özet

Sunulan bu çalışmanın amacı, saha şartlarında taylarda umblikal herniorafi operasyonu için uygulanan ksilazin-tiletamin-zolazepam dissosiyatif anestezik kombinasyonunun bazı kardiyopulmoner ve klinik anestezi parametreleri üzerine olan etkilerini araştırmaktı. Çalışmada, yaşları 4-7 ay arasında değişen (ortalama 5.73±0.91); canlı ağırlıkları 130-175 kg (ortalama 152.55±14.35); 7'si dişi, 4'ü erkek; 8'i Arap, 3'ü İngiliz ırkı olan, toplam 11 adet göbek fıtığı tanısı konulan tay kullanıldı. Taylarda anestezi protokolü olarak; ksilazin (1.1 mg/kg, iv), tiletamin-zolazepam (1.65 mg/kg, iv) ve belirtilen dozların yarısı ilk uyanma belirtisinden sonra ortalama 8-10 dakikada bir 3 kez idame olarak ve lokal anestezik olarak fıtık kesesi etrafına sirküler tarzda deri altı yolla (% 2 lidokain, yaklaşık olarak 12 ml) uygulandı. Araştırmada, taylara uygulanan son ilaç enjeksiyonundan sonra, anestezi indüksiyon, operasyon ve anestezi süresi ile ayağa kalkma zamanı; anestezi indüksiyon, anestezi/analjezi ve uyanma kaliteleri belirlendi. Kalp atım ve solunum sayısı, vücut ısısı, arteriyel oksijen satürasyonu, ortalama arteriyel kan basıncı, anesteziden önce ve anestezi süresince 15, 30, 45, 60 ve 90. dakikalarda ölçüldü. Saha şartlarında, umblikal herniorafi için taylarda uygulanan anestezi protokolü her hangi bir mortaliteye neden olmamıştır. Belirtilen anestezi protokolünün taylarda uygulanması ile klinik anestezi parametrelerine ilişkin uyanma dönemi hariç bir olumsuzluk gözlenmedi. Uyanma döneminde tayların ayağa kalkmak için birden çok atak yaptıkları belirlendi. Kardiyopulmoner parametrelerin anestezi indüksiyonundan sonraki ilk dönemde düştüğü, sonraki dönemlerde ise başlangıç değere ulaştığı gözlendi. Bununla birlikte; taylarda saha şartlarında kullanılan ksilazin-tiletamin-zolazepam kombinasyonunun lokal anestezi ile desteklenmesiyle, umblikal herniorafi için yeterli bir anestezi sağladığı, idame dozlarla anestezi süresi uzatılmasına rağmen, kardiyopulmoner yan etkilerinin de kabul edilebilir sınırlarda kaldığı gözlendi.

Anahtar sözcükler: *Ksilazin, Tiletamin-Zolazepam, Dissosiyatif anestezi, Saha şartları, Tay*

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INTRODUCTION

In veterinary medicine, anaesthesia is performed to maintain analgesia and immobilization in patients for medical and surgical applications. In foals, one of the several cases that require treatment under general anaesthesia on the farm and in the field, is umbilical hernia. Due to the scarcity of publications available on the anaesthesia of foals, generally, reference is made to research carried out in adult horses [1-2].

Injectable anaesthetics have been widely used in combination with sedatives, tranquilizers and analgesics for diagnosis and surgical treatment in horses under field and clinical conditions [3,4]. In the field, short-term general anaesthesia can be induced safely in horses and foals by the use of injectable anaesthetics either alone or in combination with sedatives, tranquilizers and analgesics by intravenous route [3,5,6]. To date, an ideal anaesthetic combination for use in horses and foals under field conditions has not been reported, yet, it is recommended that injectable anaesthetic preparations be used with caution and patients be monitored [2,4].

The combination of tiletamine, a cyclohexamine anaesthetic, with zolazepam, a benzodiazepine tranquilizer, at a weight proportion of 1:1, induces short-term general anaesthesia in horses after premedication with alpha-2 adrenoceptor agonists (xylazine, romifidine, detomidine). Owing to certain features it displays, this short-term general anaesthesia is described as dissociative anaesthesia [3,7-9]. Many researchers have used the tiletamine-zolazepam combination in horses [5,10-13] and foals [8,14], in association with various sedatives, tranquilizers and analgesics, and have reported the induction of safe general anaesthesia, resembling that induced by the combined use of xylazine and ketamine, but longer. However, the majority of these studies have been conducted on horses and foals that were not subjected to nociceptive stimulation in clinical environment with no surgical intervention.

The aim of the present study was to investigate the effects of xylazine-tiletamine-zolazepam anaesthetic combination administered to foals for umbilical herniorrhapy under field conditions, on certain cardiorespiratory and clinical anaesthesia parameters.

MATERIAL and METHODS

Animal Material

Between the years 2002-2011 eleven foals diagnosed with umbilical hernia, of 4-7 months of age (mean age 5.73±0.91 months) and 130-175 kg body weight (mean body weight 152.55±14.35 kg), 7 of which were female and 4 were male, and 8 of which were Arabian horses and 3 were English horses, constituted the material of the study. Clinical physical examination revealed the foals to be healthy. The animals were weighed on a scale. Foals fasted for 12 h and were allowed to drink water only 1 h prior to the surgical operation. Approximately 30 minutes before the start of the operation, an IV catheter (No:14G) was placed in the jugular vein of all animals, followed by the attachment of a 3-way stopcock. All anaesthetic preparations, and during the intraoperative period 5% dextrose-lactated Ringer's solution (at a flow rate of 10 ml/kg/h), were administered through the catheter.

Anaesthesia Protocol

To the test cases (the 2 cases not included in this study) xylazine (Rompun 2%, Bayer) were administered at a dose of 1.1 mg/kg by IV route (initial dose). Once the sedative effect of xylazine manifested itself within 5 min, with the observation of characteristic signs of dropping of the head, lower lip and eyelids, the tiletamine-zolazepam combination (Zoletil 50, Virbac) was administered at a dose of 1.65 mg/kg by IV route in 30 sec (initial dose). Upon the start of the operation (umbilical herniorrhaphy), it was observed that the foals reacted to the surgical manipulations. For this reason, the anaesthesia protocol was further supported by the administration of approximately 12 ml of 2% lidocaine (Adokain, Sanovel) by subcutaneous route, in a circular pattern, peripheral to the hernial sac to maintain local anaesthesia. In order to prolong the duration of anaesthesia, half of the initial doses of xylazine and tiletamine-zolazepam were administered as sustaining doses to the foals upon the observation position of the eyeball (must be central in horse during surgical plane of anaesthesia), and depending on the preference of the surgeon, three times at 8-10 minute intervals. Thereby, the surgical operation was able to be completed without any problem. The anaesthesia protocol developed using the test cases was applied to the 11 cases included in this study. The anaesthesia protocol and surgical operation were performed in the stalls, where the foals were kept (under field conditions). Following the induction of anaesthesia, none of the foals were intubated and ventilated with oxygen. However, an endotracheal tube and oxygen tube were made available in case of an emergency.

Parameters Determined

Following the initial injection with tiletamine-zolazepam, anaesthesia induction time was determined as the interval between the initial injection and the lateral recumbency of the foal; anaesthesia time was ascertained as the interval between the beginning of lateral recumbency and the first spontaneous movement of the foal after the end of the operation; the operation period was determined as the interval between the induction of anaesthesia and the completion of the last skin suture, including the preparation of the operation site; standing time was ascertained as the interval between the induction of anaesthesia and the time the animal maintained standing position. The quality of the induction of anaesthesia, anaesthesia/analgesia and recovery from anaesthesia was scored subjectively by the use of the modification of criteria previously applied by

various researchers [11,12,15]. Accordingly, good, fair and poor were scored with 3 points, 2 points and 1 point, respectively *(Table 1)*.

In order to determine the cardiorespiratory effects of the anaesthetic combinations administered, the heartbeat per minute was counted using a stethoscope, mucosal capillary refill time was ascertained by applying pressure to the oral mucosa or gingivae by a finger, the colour of the mucous membranes was appraised by observing the colour of the oral mucosa, and the number of respirations per minute was determined by observing the costo-abdominal movements of the animals. The mean arterial blood pressure was measured using the non-invasive oscillometric method by placing a cuff (IW1, Omron®, Japan) around the base of the tail (median coccygeal artery). Body temperature was measured from the rectum by means of a digital thermometer. Arterial oxygen saturation values (SpO_2 %) were measured by placing pulse oxymetre probes (Nanox 2, Medlab, Germany) into the ears of the foals and by covering the ears with a surgical drape to provide protection from light. The indicated cardiorespiratory parameters and body temperature were measured prior to anaesthesia (as a baseline value, approximately 10 min before anaesthesia), in a peaceful environment while the animals were calm, and 15, 30, 45, 60 and 90 min after the last injection. Furthermore, any physiological changes and complications (i.e. apnea, apneustic respiration, shock) observed in the foals during the conduct of the study were also recorded.

Statistical Analyses

The Minitab v 11.0 Software was used for statistical analyses. In the present study, data are given as *Mean±SD*. *Descriptive Statistics* were used for the determination of the *Mean±SD* values of the data, whilst data analysis for repeated measurements of cardiorespiratory parameters and body temperature was performed by means of T*wo-Way Anova*. Differences were considered to be significant when the P value was <0.05.

RESULTS

The anaesthesia protocol applied in this study to the foals for umbilical herniorrhapy did not cause any mortality. Excluding recovery from anaesthesia, the anaesthesia protocol followed did not cause any adverse effect on the clinical anaesthesia parameters of the foals. During recovery from anaesthesia, it was observed that the foals made multiple attempts to regain standing position.

Details of the effects of the anaesthesia protocol followed on cardiorespiratory parameters and body temperature are presented in *Table 2*, whilst the effects of the protocol on clinical anaesthesia parameters are given in *Table 3*.

During anaesthesia, the heart rate of the foals displayed moderate (P>0.05) falls at all measurement times, in comparison to the baseline value recorded. Respiratory rates and arterial oxygen saturation (SpO_2) values displayed significant decrease (P<0.05) 15, 30 and 45 min after the last injection, when compared to the baseline values, whilst it was observed that, the values recorded 60 and 90 min after the last injection had drawn closer to the baseline values. Body temperatures measured 30 and 45 min after the last injection were significantly lower than the baseline values, whilst the body temperatures recorded 60 and 90 min after the last injection had drawn closer to the baseline values. Mean blood pressure values measured 15, 30 and 45 min after the last injection were significantly higher than the baseline value (P<0.05), whilst mean values measured 60 and 90 min after the last injection were moderately higher than the baseline value *(Table 2)*.

Table 1. *Scoring criteria for the quality of induction, anaesthesia/analgesia and recovery in foals*
Tablo 1. *Taylarda anestezi indüksiyon kalitesi, anestezi/analjezi kalitesi ve uyanma kalitesini skorlama kriterleri*

GOOD (3 Points)	FAIR (2 Points)	POOR (1 Point)
QUALITY OF INDUCTION		
The animal enters anaesthesia within a short period of time and peacefully. Back and forth movements are very few	The entry of the animal in anaesthesia is prolonged and the animal displays slight incoordination, marked back and forth movements, and convulsions on the ground	Induction of anaesthesia is markedly prolonged than normal, associated with marked incoordination, evident back and forth movements and excessive tremor of the muscles
QUALITY OF ANAESTHESIA/ANALGESIA		
The animal gives no reaction to surgical manipulations. No tremor of the muscles of the body or extremities is observed. Muscle relaxation is satisfactory	The animal reacts to surgical manipulations with very light movements. Slight muscle tremors and moderate muscle relaxation are observed	The animal displays pronounced reaction to surgical manipulations. The animal retracts and shakes its legs. Very evident muscle tremors and marked muscular tonus are observed
QUALITY OF RECOVERY FROM ANAESTHESIA		
No excitation or incoordination is observed. The animal regains standing position calmly and at its first attempt. No marked ataxia is observed in the extremities	Slight excitation and incoordination are observed. The animal regains standing position calmly but only after 2-3 attempts. Marked ataxia is observed while standing	The animal displays convulsions on the ground with an attempt to stand up. The animal makes more than 3 attempts to regain standing position but fails. The animal may hurt itself and attending personnel

Table 2. *Mean values of cardiorespiratory parameters and anaesthesia/analgesia quality in foals (Mean±SD) (n=11)*
Tablo 2. *Taylara ait kardiyopulmoner parametreler, anestezi/analjezi kalitesi ortalama değerleri (Mean±SD) (n=11)*

Parameter	Following Induction of Anaesthesia					
	Baseline	15th min	30th min	45th min	60th min	90th min
Heart Rate (beats/minute)	69.31±5.12^{a}	63.83±2.79^{a}	68.83±9.87^{a}	66.33±7.71^{a}	68.83±4.45^{a}	67.50±5.72^{a}
Respiratory Rate (breaths/minute)	24.50±1.76^{a}	14.00±2.00^{b}	15.67±1.21^{b}	17.67±1.22^{b}	21.17±4.17^{ab}	24.83±3.87^{a}
Body Temperature (°C)	38.05±0.19^{a}	37.53±0.99^{ab}	37.32±0.88^{b}	37.27±1.07^{b}	37.52±0.81^{ab}	37.65±0.71^{ab}
Mean Blood Pressure (mm Hg)	68.30±13.58^{a}	82.49±15.61^{b}	86.22±14.47^{b}	78.17±13.22^{b}	75.27±14.32^{ab}	71.19±12.86^{ab}
SpO_2 (%)	94.33±2.50^{a}	89.00±2.61^{b}	87.17±2.32^{b}	87.50±2.26^{b}	90.17±2.23^{ab}	93.00±2.45^{a}
Quality of Anaesthesia/Analgesia*	ND	2.83±0.41^{a}	2.67±0.52^{ab}	1.83±0.75^{b}	ND	ND

Differences between mean values shown with different superscripts in the same row (a, b) were statistically significant (P<0.05). ***ND:*** *Not Determined,* *** Scored according to the criteria presented in Table 1,* ***good****=3 points,* ***fair****=2 points,* ***poor****=1 point*

Table 3. *Mean values of clinical anaesthesia parameters in foals (Mean±SD) (n=11)*
Tablo 3. *Taylara ilişkin klinik anestezi değerlendirme parametrelerinin ortalama değerleri (Mean±SD) (n=11)*

Parameter	Value
Anaesthesia induction time (sec)	40.17±5.17
Quality of the anaesthesia induction*	2.67±0.52
Operation time (min)	41.67±1.86
Anaesthesia time (min)	46.17±1.72
Standing time (min)	57.17±2.04
Quality of recovery from anaesthesia*	1.83±0.75

*** Scored according to the criteria presented in Table 1,* ***good****=3 points,* ***fair****=2 points,* ***poor****=1 point*

No adverse effects were observed on the refill time of the mucosal capillaries during the sampling periods of the foals. Neither was any disorder observed as regards the colour of the mucosal membranes (i.e. development of cyanosis).

DISCUSSION

Foals differ from adult horses in pharmacodynamics and pharmacokinetics due to physiological differences, including among others, the proportion of extracellular fluid to body weight being high, liver enzyme activities being low, renal functions having not been fully developed, the cardiovascular system being regulated differently, the blood-brain barrier having low efficacy and the autonomous nervous system having not been fully developed [7,16-20]. Therefore, within the context of anaesthesia applications, some researchers [1,16,18,19], classify foals as neonatal foals (≤ 1 month of age) and developing foals (pediatric, juvenile, aged 1-3 months), whilst some other researchers [2,17], include foals up to the age of 6 months in the neonatal-pediatric category and foals aged ≥6 months in the category of adult animals. The latter [2,17] have reported that, foals younger than 6 months bear greater risk for anaesthesia, when compared to adult horses. In the present study, the 11 foals constituting the study material were diagnosed with umbilical hernia at an average age of 1-3 months. However, in accordance with the recommendation of Mair et al.[21], due to the possibility of spontaneous healing, in most of the cases, operative treatment was not performed until 6 months of age. The foals, for which the average age was calculated as 5.73 months, were anaesthetized as described for adult horses [3,5,10-13]. The anaesthesia protocol applied did not cause any mortality or serious complication. Moreover, the protocol applied yielded adequate unconsciousness and immobilisation, satisfactory muscular relaxation and a general anaesthesia characterized by analgesia, which enabled the success of the umbilical herniorrhaphy operations performed.

The anaesthesia protocol followed in the present study caused moderate falls in the heart rate of the foals at all sampling times, when compared to the baseline values *(Table 2)*. Nevertheless, the critical heart rate of ≤25 beats/minute, reported to be a serious bradycardia for horses [22], was observed in none of the foals. The moderate falls determined in the heart rates at all sampling times were attributed to xylazine having reduced sympathetic activity in the central nervous system [3,7,9,23].

In the present study, it was determined that, respiratory rates measured 15, 30 and 45 min after the last injection had decreased significantly compared to the baseline value, consequential to xylazine-tiletamine-zolazepam anaesthesia (P<0.05), leading to decrease in SpO_2 values at the indicated sampling intervals *(Table 2)*. Owing to the sedation it causes by depressing the central nervous system, xylazine causes respiratory depression [3,7,9]. On the other hand, cyclohexamine anaesthetics (ketamine, tiletamine), induce dose-dependent respiratory depression in most animal species [3,8,10,14]. Furthermore, it has been reported that, hypoxaemia may be observed in horses under general anaesthesia, the severity depending on the position of recumbency and the duration of anaesthesia (>60 min), such that oxygen ventilation is recommended for the prevention of the occurrence of such cases [1,4,10]. In the light of these data, the decrease observed in the respiratory rates and SpO_2 values could have arisen due to the drugs administered and the animals being maintained in dorsal

recumbency for the performance of the operation. Furthermore, serious hypoxaemia (SpO_2 <80%) having not been encountered could be attributed to anaesthesia having lasted shorter than 60 min (on average 46 min).

Several researchers [3,17,24] have reported that general anaesthesia causes decrease in body temperature. These researchers have described such decrease as a result of vasoconstriction caused by the anaesthetics administered, heat loss due to the shaving and alcohol disinfection of the operation site, disrupt of thermoregulation due to the inhibition of the limbic-hypothalamic centres and the disrupt of body temperature haemostasis due to reduced metabolic activity. The decrease observed in the body temperatures of the foals in the present study *(Table 2)* could also be attributed to these mechanisms.

Bidwell [2] has reported that, in foals, the average blood pressure should be maintained at a level of ≥70 mm Hg throughout anaesthesia. In the present study, it was observed that the average blood pressure of the foals was higher than the baseline value at all sampling times, yet was maintained at a level of ≥70 mm Hg as suggested by Bidwell [2]. This could be attributed to the peripheral stimulation of alpha-1/2 adrenoreceptors in the early stage of intravenous xylazine anaesthesia [25] and to the sympathomimetic effect of tiletamine [3,10,26].

Matthews and Hartsfield [4] and Hall et al.[3] have recommended the refill time of mucosal capillaries to be determined and the colour of mucosal membranes to be observed for the purpose of monitoring cardiovascular performance in anaesthetized horses and foals. In the present study, no abnormality having been observed in the foals for any of these parameters, and the relevant values having remained stable within normal limits, were considered as indicators of the anaesthesia protocol applied not to have triggered any adverse effect on these parameters.

In previous studies carried out in horses and foals by administering different doses of the anaesthetic combination of xylazine-tiletamine-zolazepam for the induction of general anaesthesia [5,8,10-14], anaesthesia induction time was reported to range between 34-75 sec, the duration of anaesthesia between 22.5-35.7 min, and the period of regaining standing position (standing time) between 30-50 min. Furthermore, it has been indicated that, if required, the duration of anaesthesia could be prolonged by administering half or one-third of the initial doses of the anaesthetics used for sustainment, yet, in such cases, complications such as serious hypoxaemia, myositis and delayed recovery from anaesthesia could be encountered as a result of cardiovascular/pulmonary depression [1,3,4,6,11,27]. In the present study, the clinical anaesthesia parameters resulting from the anaesthesia protocol applied *(Table 3)* was found to be in compliance with the findings of the studies referred to above. In several studies [1,3,8,10-14], it has been reported that, in horses, tiletamine-zolazepam anaesthesia, and in particular anaesthesia prolonged by the administration of sustaining doses, tend to be problematic due to the continuous attempts of the animals to stand up, the standing position of the animals being unsafe owing to ataxia, and consequential falls of the animals. These problems have been indicated to result from the half life elimination time (t ½) of zolazepam from the organism taking a longer time than that of xylazine and tiletamine, thereby, leading to longer muscle relaxation and ataxia during recovery from anaesthesia. In view of the adverse effects that may be encountered during recovery from anaesthesia, in order to prevent the injury of the patient and attending personnel and to allow for adequate time to pass for horses and foals being able to fully regain standing position, it is suggested that the animals be tied and maintained immobilised on the ground for a certain period [3,28].

In a previously conducted study, Short et al.[13], used different doses of xylazine (1.1 mg/kg, IV) and tiletamine-zolazepam (1.1-1.65-2.2 mg/kg, IV) in horses for surgical interventions such as intubation, suturing of lacerations and castration, and reported that the three anaesthetic doses administered induced an adequate anaesthesia for the indicated applications. Furthermore, Ozba et al.[29], in a study in which they administered a combination of tiletamine-zolazepam (3 mg/kg, IM) following premedication with atropine (0.05 mg/kg SC) and xylazine (0.1 mg/kg IM), ascertained that an anaesthesia of adequate depth and duration was induced for the operative treatment of umbilical lesions in calves. However, in the present study, in the test cases, reactions that adversely affected the performance of the surgeon were encountered, and in view of maintaining the safety of anaesthesia, in order to prevent the development of such reactions in the operated foals, instead of increasing the dose of the xylazine-tiletamine-zolazepam combination, it was preferred to modify the anaesthesia protocol by administering lidocaine by subcutaneous route into the periphery of the hernial sac. Gunkel [30] has reported that, as the pain threshold of foals is lower than that of adult horses and other animal species, even under an adequate depth of anaesthesia, foals may react to the first incision. In the present study, it was observed that, rather than to the incision of the skin, the foals reacted to the dissection of the inner hernial sac. Nonetheless, the addition of local anaesthesia to the anaesthesia protocol was in agreement with the report of Burns [17], which suggests that the need for general anaesthetics and, thereby the risk of cerebro-cardiorespiratory depression in foals, could be reduced by the use of local and regional anaesthesia techniques.

It was ascertained in the present study that, the supplementation of the combined use of xylazine-tiletamine-zolazepam in foals under field conditions with local anaesthetics induces an anaesthesia of adequate depth for umbilical herniorrhaphy, and sustaining doses enable the prolongation of the anaesthesia period with cardio-respiratory adverse effects remaining within acceptable

limits. Therefore, it is considered that, the indicated anaesthesia protocol could be tested for other surgical interventions in foals under both field and clinical conditions.

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