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A New Method for On-Farm Euthanasia with Animal Welfare Considerations

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Abstract

Objective: Euthanasia of animals is a highly stressful situation for veterinarians and may be source of ethical dilemmas; also, it is very difficult to decide "which technique is more appropriate for the given situation"? The aim of this study was to describe a new humane method for on-farm euthanasia.
Design: Pilot clinical trial**.**
Animals: thirteen animals including three horses, six sheep and four goats were nominated for euthanasia.
Procedures: After induction of anesthesia by combination of xylazine-acepromazine and ketamine, according to Modified Glasgow Coma Scoring System, unconsciousness of all animals was established. Then, 4-12 mL lidocaine was injected intrathecally, and quality of death, vital signs and electrical activity of heart were assessed subsequently.
Results: The results suggest that direct application of lidocaine on medullary region of CNS after induction anesthesia may causes loss of consciousness, respiratory arrest, bradycardia, atrioventricular block and finally cardiac arrest.
Conclusion and Clinical Relevance: Results showed that this method can be considered as an inexpensive, rapid and humane way to end an animal's life.
Keywords: animal welfare, euthanasia, lidocaine, intrathecal, cardiopulmonary arrest.

Introduction

Euthanasia is the process of inducing an easy, fast and painless death. The procedure should be performed with highest degree of respect for animal and it has to be safe for the operator [1-

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[2]. The decision to humanly end the life of an animal may be necessary on the off-chance such as severe injuries, diseases and disasters [3]. On-farm euthanasia may be the best and humanly way to end an animal's pain if he/she is unable to travel, and to prevent drug residues from entering the human food chain in case of food animals[1].

Veterinarians always try to keep their patients alive, but unfortunately, this does not happen all the time. Therefore, they have to be prepared for one of the hardest things they have to think about, the euthanasia of an animal who suffers from an incurable and painful condition [4], or during an infectious disease outbreak. They also may sacrifice animals for sake of research. To demonstrate how distressing is this situation for pet owners and veterinarians, one should noted that they would rather use "putting to sleep" instead of "euthanasia" [4].

The concept and practice of Euthanasia are normally stressful, still, guilty conscience and regret must be added to it. According to Adams et al, (2000) grief for pet loss is different from grief for other losses. The most prominent factors for grief are dependency, social attitude to pet death and veterinarian professional supports [5]. In addition, most of owners feel guilty of their consent to euthanasia process, especially if it is accompanied by suffering of the animal or affect persons who watch the procedure. Therefore, the major consideration on the animal welfare is that any method should provide a rapid loss of consciousness and induce a painless, quick death [4]. A challenging job for a veterinarian is to decide "which technique is more appropriate for the given situation"? There are several techniques to accomplish euthanasia, which fall into one of these three categories:

A) Destruction of brain tissue that results in loss of brain function, such as gunshot or captive bolt pistol, B) Induction of unconsciousness, such as stunning with a non-penetrating captive bolt or using narcotics followed by exsanguinations, and C) Applying anesthetic overdose in order to depress the central nervous system (CNS) and create death, this method is usually performed by administration of a tranquilizer, followed by an overdose of a barbiturate or use of gas cage [3].

Although, methods that mentioned above have some disadvantages, they are used for animal euthanasia routinely.

The aim of the present study was to evaluate the intrathecal injection of lidocaine hydrochloride (lidocaine) after induction of anesthesia by combination of xylazine-acepromazine and ketamine as a painless and irreversible method for animal euthanasia with least adverse effects on cardiopulmonary and neuromuscular systems in several animal species (horse, sheep and goat). This method may be considered as a humane way for putting to sleep an animal, where the death is inevitable.

Materials and methods

This study has been approved by the Ethics Committee for Animal Experimentation of Bu-Ali Sina University.

From January 2009 to January 2011, thirteen animals including three horses, six sheep and four goats were nominated for euthanasia. The animals were selected based on clinical condition and medical prognosis (Table 1). To prevent difficulty in assessing the level of consciousness, animals with following characteristics were excluded: Concurrent neuromuscular disorders or quadriplegia, impaired hearing, blindness and facial or eye trauma.

After application of a deep sedation by combination of xylazine 2% and acepromazine 2% through the left jugular vein followed by induction of anesthesia by ketamine (horse: 0.1 mg/kg acepromazine plus 2 mg/kg xylazine and 1.7 mg/kg ketamine, sheep: 0.1 mg/kg

acepromazine plus 0.1 mg/kg xylazine and 2 mg/kg ketamine, and goat: 0.1 mg/kg acepromazine plus 0.1 mg/kg xylazine and 3-4 mg/kg ketamine) [6], the animals were left in a quiet area until the maximum effect was achieved. The animals were anesthetized when they became recumbent laterally and without any responses to environmental or painful stimuli. There are several sedation scales that include a consciousness scoring system [7]. In this study, Modified Glasgow Coma Scoring System (MGCS) was used for evaluation of consciousness level of animals. According to MGCS that has been adjusted for each species of domestic animals [8], consciousness level of all animals were recorded in terms of the responses to external stimuli every min. After establishment of unconsciousness, based on recommended dosage for epidural anesthesia (horse: 0.4 mg/kg, sheep: 4-5 mg/kg, and goat: 4-5 mg/kg) [9], 4-12 mL lidocaine 2% was injected intrathecally through foramen magnum using a 20 mL disposable syringe and a spinal needle (18g x 3.5 inch with stylet) (Table 1). In order to gain proper intrathecal injection, the animal's head was bent down 90 degrees. The spinal needle was entered into the cerebello-medullary cistern through atlanto-occipital junction. However, adequate sodium thiopental was available for use in any unexpected emergency situation whenever this method was not effective.

After intrathecal injection of lidocaine, the animal's behavior and quality of death (calm and painless death) were observed. The effect of lidocaine on electrical quality of heart was determined continuously by electrocardiography (ECG). Animal was placed in right lateral recumbency and base-apex lead was recorded for assessment of cardiac electrical activity by using a LOGOS 91 Electrocardiograph. The paper speed and sensitivity were set to 25 mm/sec and 10 mm/mV, respectively. The heart rate and electrocardiographic indices were measured. The respiratory rate and reflexes of corneal, pupil and anal were assessed every 60 sec by three veterinarians until death was confirmed. Absence of heartbeat or respiration for more than five minutes, dilated anus and fixed pupils were used to confirm definitive death [10].

Table 1. Species, sex, age, weight, reason for euthanasia and amount of drug used in studied animals

Animal No.	Species	Sex	Age (year)	Weight (kg)	Lidocaine 2% injected (mL)	Reason for euthanasia
1	Horse	Male	5	450	10	Multiple fracture of radius
2	Horse	Male	0.7	200	4	Comminuted fracture of right and left humerus
3	Horse	Female	4	400	10	Multiple fracture of femur
4	Sheep	Male	3	28	6	Severe pneumonia
5	Sheep	Male	4	34	7	Severe hepatitis
6	Sheep	Male	5	52	10	Severe pneumonia
7	Sheep	Female	3	60	12	Multiple fracture of right femur and humerus
8	Sheep	Female	5	55	11	Severe metritis
9	Sheep	Female	4	30	6	Severe pneumonia
10	Goat	Female	3	29	6	Severe pneumonia
11	Goat	Female	1	18	4	Severe pneumonia
12	Goat	Male	2.5	22	5	Severe hepatitis
13	Goat	Male	2	20	4	Severe pneumonia

Results

According to MGCS System, the drop-off of animals' alertness level indicated loss of consciousness at approximately a few sec after induction of anesthesia. All animals developed respiratory arrest in 79.7±28.8 sec after intrathecal injection of lidocaine with dilated pupils and no evidence of convulsion. Cardiac arrest was observed 331.2±51.6 sec in all animals (Table 2).

Table 2. Vital signs of animals euthanized by intrathecal injection of lidocaine hydrochloride

Species	Heart rate Before intrathecal inj. (beats/min)	Respiratory rate Before intrathecal inj. (breaths/min)	Onset of respiratory arrest (sec)	Onset of cardiac arrest (sec)
Horse (n=3)	45.3±4.16	11.6±1.53	60.1±37.96	331±50.03
Sheep (n=6)	92.8±4.96	25.6±3.78	82±16.8	302.2±36.7
Goat (n=4)	118.25±15.43	44.75±5.62	91±23.47	375±70.39

The heart rate dropped to one third of its normal rate 3.2±0.5 min after intrathecal injection of lidocaine in all animals (data not shown). A grade II atrioventricular (AV) block along with bradycardia was detected at 4±0.5 min after injection (Fig. 1). This was replaced with sinus node impulses without ventricular contraction at 5.2±0.4 min, and continued until complete cardiac arrest. It seems that overall changes of cardiac activity included a progressive rhythmic bradycardia. No arrhythmia was observed.

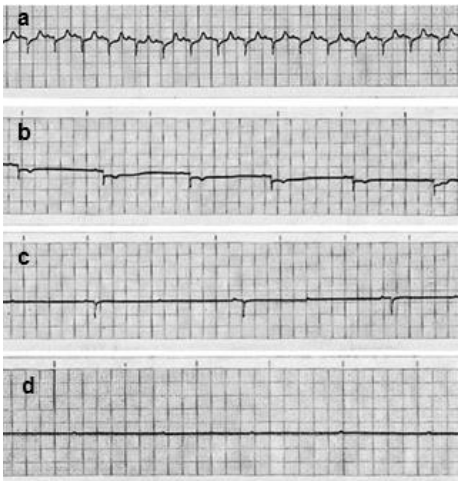

Figure 1. Electrocardiogram of one of studied goats. **a)** Before intrathecal injection of lidocaine hydrochloride (heart rate = 136/min); **b)** 3 min after injection (heart rate = 48/min); **c)** 4.5 min after injection (heart rate = 29/min); **d)** 5.2 min after injection (heart rate = 0)

Discussion

Euthanasia of animal is a highly stressful situation not only for owner of animal that is required to be killed but also for veterinarian who must perform such procedure.

There are several methods for putting an animal in rest to minimize pain and suffering, when it is needed. Yet, it is sometimes hard to choose the best option concerning animal welfare. Most of the common methods, if not all, have some adverse effects. For example: 1) Gunshot and captive bolt are effective and relatively inexpensive ways to perform on-farm euthanasia whenever the use of drugs is inappropriate. However, these techniques are emotionally displeasing. Moreover, in many countries, a gun has to be strictly used by a licensed person. 2) Exsanguination is a less routine technique and should not be considered as a sole means of euthanasia, because of anxiety that comes with extreme hypovolemia. In addition, the procedure has disturbing effects on the owner. 3) Electrocution is a relatively humane way, if is done when animal is unconscious. Nevertheless, it may cause some adverse effects on cardiovascular system. In addition, it may not result in death in small animals less than 5 kg of weight. This occurs because ventricular fibrillation and cardiovascular collapse do not always persist after ending of electrical current. 4) Carbon dioxide has been used to euthanatize animals as an inexpensive method with no tissue residues, but, it may take longer than other techniques. 5) Administration of a tranquilizer, followed by a barbiturate overdose is a relatively fast and convenient technique, which is used frequently. Compared to others, this method brings a lesser amount of emotional side effects to the owner. However, the carcass of the animal contains significant amount of barbiturate, therefore, should not be scavenged by other animals-; also, this technique approximately is expensive [1].

Here in this study, we introduce euthanasia by intrathecal injection of lidocaine after induction of anesthesia as a rapid, inexpensive and effective method that may be used in several animal species along with considering animal welfare.

Lidocaine acts as a local anesthetic through binding to and blocking off the sodium channels, thus, prevents traveling the self-propagating depolarization signal along the length of the axon [11-12]. This mechanism gives rise to anesthetic and some therapeutic effects of this agent [13]. Systemic administration of lidocaine generates two major types of neurologic and cardiologic toxicities. Main neurologic signs include respiratory depression, dizziness and paresthesia which may lead to psychosis, loss of consciousness and seizure. There are several signs of cardiologic toxicity such as dysrhythmia, sinus bradycardia, and QRS widening [14].

Our data suggest that direct application of lidocaine on medullary region of CNS may directly affect cardiopulmonary centers and consequently causes respiratory arrest, bradycardia, AV block and finally cardiac arrest.

The respiratory arrest preceded cardiac arrest. A progressive bradycardia was seen until fifth min, which led to cardiac arrest [15]. These findings may be due to:

a) Xylazine and acepromazine when use in combination with ketamine effect through tonic sympathetic nervous system inhibition, prevention of norepinephrine release from sympathetic nerve endings, and or releasing acetylcholine from cardiac parasympathetic nerves in response to primary vasoconstriction [16], or

b) Direct effects of lidocaine on cardiac and respiratory centers adjacent to the spinal cord similar to effects on rat in another study [17].

A second-degree AV block from fourth min onward was seen due to disconnection of effective impulses from sinoatrial node to AV node. This might has happened as a result of a progressive hypoxia which was noticed just after respiratory arrest (79.7±28.8 sec), because of cumulative cardiac effects of acepromazine, xylazine and ketamine, or even due to presence of lidocaine in peripheral blood circulation [18]. However in another study, lidocaine concentration of serum was not observed until 120 min after epidural administration [19]. The presence of lidocaine was not determined in serum of our studied animals.

There are some reports that claim a progressive hypoxia after spinal anesthesia may lead to asystolic cardiac arrest [20-21].

Thomas et al. (1986) showed that using an equal number of molecules of either bupivacaine or lidocaine in rats significantly decreased both mean arterial pressure and heart rate. Also applying both of these local anesthetics at intermediolateral column and nucleus tractus solitarius (NTS) of the medulla resulted in ventricular arrhythmias (14-38%), although the magnitude of effects tended to be less severe in lidocaine experiment. The local administration of anesthetics causes a significant decrease in cell firing rate when applied to the NTS [17]. Our study showed that application of local anesthetics within subarachnoid space of the medulla oblongata can result in bradycardia, and probably AV block grade II, but no ventricular arrhythmia. The latter is not in agreement with others' studies [15,22-24].

It should be noted that we observed no type of seizures or arrhythmias; however, the intrathecal injection was performed under anesthesia by a combination of acepromazine, xylazine and ketamine. In addition, it has been found in other studies that simultaneous use of acepromazine, xylazine and ketamine creates no significant irregularity such as grade II AV block [6,25]. Blockade of myocardial alpha adrenergic receptors by acepromazine may prevent the development of ventricular arrhythmias [26]. In addition, xylazine is a potent tranquilizer that can be used in excited and restless animals [26-28]. Also, when a combination of acepromazine and xylazine, with different mechanism of action, used together, the tranquilization effect of them will be increased, while some side effects of these drugs are decreased. Also, they abolish the cardiac and neurological effects of anesthetic agents [6,25]. Therefore, loss of consciousness before injection of lidocaine and no evidence of convulsion and arrhythmia would have been created by the potent tranquilization and antiarrhythmic effects of acepromazine-xylazine combination, plus the anesthetic effect of ketamine. In addition, probably, the direct effect of lidocaine on cardiopulmonary centers is responsible for grade II AV block and subsequently cardiac and respiratory arrest in all studied animals.

Basically, in order to execute euthanasia properly, the animal should be unconscious before onset of cardiac and respiratory arrest and loss of brain function. The results of this study showed that direct application of lidocaine within subarachnoid space of medulla oblongata can be used in horse, sheep and goat to induce a "good on-farm death" through direct effect on cardiopulmonary centers after induction of anesthesia by acepromazine, xylazine and ketamine combination. Also assessment of the effects of this method on cardiac and respiratory systems and observation of animal behavior shows that this technique has minimal distressing effects on the animal. It should be noted that, based on many studies, anesthetizing by means of acepromazine, xylazine and ketamine combination is necessary and using of intrathecal injection of lidocaine in conscious animal may be lead to neuro-cardiac toxicity and it resulted to an inhumane slaughter [29-31].

Furthermore, speed of action, lack of adverse effects on heart and CNS, minimal discomfort of the animal, lower doses of drugs that should be used and reduces unnecessary pain, distress and suffering of the animal that has to be put down are of its advantages. However, this method needs to be performed under supervision of a well trained veterinarian.

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چکیده

یک روش جدید برای آسان کشی در مزرعه، با درنظرگرفتن اصول آسایش حیوانات

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هدف- آسان کشی درحیوانات یک وضعیت بسیار پراسترس برای دامپزشکان و احتمالاً منشاء برخی مشکلات اخلاقی و حقوقی است. همچنین تصمیم گیری در مورد اینکه کاربرد کدام روش در موقعیت حاضر مناسب تر است بسیار مشکل می باشد. هدف از این مطالعه توصیف یک روش جدید و انسانی برای آسان کشی در مزرعه می باشد.

مطالعه- آزمون بالینی پایه

حیوانات- سیزده راس حیوان شامل سه راس اسب، شش راس گوسفند و چهار راس بز به منظور آسان کشی در نظر گرفته شدند.

مواد و روش کار- پس از القای بیهوشی بوسیله ترکیب زایلازین-آسپرومازین و کتامین بر اساس سیستم ارزیابی کمای تغییر یافته گلاسکو، عدم هوشیاری در تمام حیوانات مورد آزمایش، تایید شد. متعاقب تزریق داخل نخاعی ۱۲-۴ میلی لیتر لیدوکائین، کیفیت مرگ، علائم حیاتی و فعالیت الکتریکی قلب ارزیابی گردید.

نتایج- نتایج حاصل نشان داد که تزریق مستقیم لیدوکائین در ناحیه بصل النخاعی پس ازالقای بیهوشی می تواند منجر به ازدست دادن هوشیاری کامل، قطع ناگهانی تنفس، برادی کاردی، بلوک دهلیزی-بطنی وسرانجام ایست قلبی شود.

نتیجه گیری- نتایج نشان داد که این روش می تواند به عنوان یک شیوه ارزان، سریع و انسانی به منظور خاتمه دادن به حیات حیوان در نظر گرفته شود.

کلید واژگان- آسایش حیوانات، آسان کشی ، لیدوکائین، داخل نخاعی، ایست قلبی-تنفسی.