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Research Article

Effects of Medetomidine-Ketamine Combination Anaesthesia on Electrocardiographic Findings, Body Temperature, and Heart and Respiratory Rates in Domestic Pigeons

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Abstract: The applications of medetomidine (M) as a pre-anaesthetic and ketamine (K) as an anaesthetic agent were investigated in seven domestic pigeons in terms of the degree of anaesthesia (DA) and alterations in physiological parameters. An intramuscular (IM) injection of M (200 µg/kg) was followed by administration of K (120 mg/kg, IM) after 10 min. Body temperature (BT), respiratory rate (RR), heart rate (HR), DA, and electrocardiogram (ECG) findings were determined before (0 min) and 10 min after the application of M, and 5, 15, 30, 45 and 60 min after the administration of K. All pigeons had 4th degree anaesthesia and a significant decrease ($p < 0.01$) in HR was observed starting from the 10th min and lasting until the end of the anaeasthesia period. RR was significantly decreased at the 10th min of pre-anaesthesia ($p < 0.01$). Following K application, RR increased at the 5th min and stayed high until the 30th min, but decreased again afterwards. HR decreased dramatically during pre-anaesthesia ($p < 0.01$) and gradually during anaesthesia ($p < 0.05$). An obvious prolongation of P-R and R-R intervals was the only ECG finding. It was observed that BT constantly decreased during pre-anaesthesia and anaesthesia ($p < 0.05$ or $p < 0.001$). In conclusion, it was found that M + K combination anaesthesia caused alterations in the physiological parameters in pigeons, but they did not possess a life threatening effect. The application of M + K at these dose levels might produce a reliable and deep anaesthesia lasting 15 to 60 min.

Key Words: Ketamine, medetomidine, anaesthesia, physiological changes, pigeon

Evcil Güvercinlerde Medetomidin-Ketamin Kombinasyon Anestezisinin Elektrokardiografik Bulgular, Vücut Isısı, Solunum ve Kalp Atım Sayıları Üzerine Etkileri

Özet: Bu çalışmada, 7 güvercinde preanestezik olarak medetomidin (M) ve anestezik olarak ketamin (K) uygulamasının anestezi derecesi ve fizyolojik parametrelerde oluşturduğu değişiklikler incelenmiştir. Kas içi (im) M (200 µg/kg) uygulamasını takip eden 10. dakikada K (120 mg/kg, im) uygulanmıştır. M uygulanmadan önce (0. dak.), uygulamayı takiben 10. dakika ile, K uygulamasından sonraki; 5., 15., 30., 45. ve 60. dakikalarda vücut ısısı, solunum ve kalp atım sayıları, anestezi dereceleri ve EKG bulguları belirlenmiştir. Bütün güvercinlerin 4. derece anesteziye girdiği, kalp atım sayılarında, preanestezinin 10. dakikasında başlayan ve anestezi süresince de devam eden istatistiksel olarak anlamlı ($p < 0.01$) azalmanın olduğu gözlenmiştir. Solunum sayısı preanestezinin 10. dakikasında belirgin şekilde azalmıştır ($p < 0.01$). Ketamin uygulamasını takip eden 5. dakikada solunum sayısı artmaya başlamış, 30. dakikaya kadar yüksek düzeyde kalmış ancak tekrar azalmıştır. Kalp atım sayısı preanestezi döneminde birdenbire ($p < 0.01$), anestezi döneminde ise kademeli bir şekilde azalmıştır ($p < 0.05$). Elektrokardiyogram bulguları olarak, sadece P-R ve R-R aralıklarında belirgin uzamalar bulunmuştur. Vücut ısısında hem preanestezi hem de anestezi dönemlerinde sürekli bir azalma gözlenmiştir ($p < 0.05$ veya $p < 0.001$). Sonuç olarak, M + K anestezi kombinasyonunun güvercinlerde fizyolojik değerleri değiştirdiği ancak hayati bir tehlike oluşturmadığı tespit edilmiştir. M + K in bu dozlarda uygulanması ile 15-60 dakika arasında devam eden güvenilir ve derin bir anestezi elde edilebilir.

Anahtar Sözcükler: Ketamin, medetomidin, anestezi, fizyolojik değişiklikler, güvercin

Introduction

In recent years, the application of anaesthesia in avian species has gained importance in clinics. Anaesthesia procedures for avian species are different from those in domestic mammalian species. Some physiological differences among avian species should also be taken into consideration when choosing an anaesthetic drug. The anatomical localization of the trachea, alterations in gas exchange and ventilation of the avian pulmonary system have been considered as drawbacks (1).

Medetomidine (M) is one of the newest alpha-2 adrenergic agonists with a higher affinity for the alpha-2 adrenoreceptor than xylazine (2). Alpha-2 agonists produce dose-dependent sedation, analgesia and muscle relaxation. They can be combined with other sedatives or tranquillisers and their effects are reversible with specific antagonists. However, alpha-2 agonists profoundly alter cardiovascular function by producing bradycardia, hypertension followed by hypotension, decreased myocardial contractility, and perfusion and dysarhythmias (3,4).

Ketamine (K) is a dissociative anaesthetic that produces poor muscle relaxation in animals. Recovery from K anaesthesia is usually uneven and there may be some excitements (5).

Domesticated pigeons are one of the most common companion birds in Turkey. Unfortunately, little is known about anaesthesia in pigeons. The purpose of this study was to investigate the anaesthetic effect of a M and K combination on pigeons for surgical interventions, and, furthermore, to define the effect of that combination on electrocardiogram (ECG) findings, heart rate (HR), respiratory rate (RR) and body temperature (BT).

Materials and Methods

The seven healthy domestic pigeons used in this study were purchased from a local breeder at least 15 days before the experiment and they were kept together in a cage until the end of the experiment. All pigeons were treated gently in a quiet room to avoid any stress-inducing factors. Their body weights varied from 245 to 255 g with a mean of 250 g. Food and water were allowed prior to the experiments.

Anaesthesia protocols: Medetomidine (Domitor, Orion Farmos, Pharmaceutical-Pfizer Animal Health, Finland) and ketamine HCl (Ketamidor, Richte Pharma CokG, Wells, Austria) injectable solutions were used. Each of the pigeons was sedated with M at a dose of 200 µg/kg by injection of the drug to the deep left pectoral muscles. Ten minutes after M application, K was injected at a dose of 120 mg/kg per pigeon to the deep right pectoral muscle.

Measurements: HR, RR, BT and ECG parameters were measured before and 10 min after premedication and at 5, 15, 30, 45, and 60 min during anaesthesia for all pigeons. ECGs were recorded by a direct writing electrocardiograph (Logos 8821). Alligator clip electrodes were attached to the skin at the base of the right and left wings and the gastrocnemius muscle of the right and left limbs. Leads I, II, III, aVR, aVL and aVF were recorded at 1 mV = 10 mm, with chart speed of 50 mm/s. The durations and amplitudes of waves on the trace were measured in lead II (6). HR was calculated from the ECG records. BT was obtained by a thermometer placed into the cloaca and RR was determined by direct observation as described by Valverde et al. (7). Recovery time was considered as the time when the animal had all motoric and sensoric functions.

Evaluation of anaesthesia depth: The sedative and anaesthetic effects of the drug combination during the whole anaesthetic protocols were evaluated according to the criteria explained below. Perfect muscle relaxation is the condition of no head or wing control when raised up, and they tend to fell down spontaneously.

First degree anaesthesia: Able to stand up, partly responsive to environmental objects and walks voluntarily when stimulated.

Second degree anaesthesia: Unable to stand up and tends to stay in lateral recumbency. Has partial needle prick response but is hardly responsive to environmental stimulations.

Third degree anaesthesia: Unable to restore body posture, and hardly has foot withdrawal response to needle prick. Good muscle relaxation.

Fourth degree anaesthesia: Deep general anaesthesia; no reflexes available including pedal, palpebral. Perfect muscle relaxation. No response to any pain reflexes.

Statistics: All measurement times were compared with each other by t-test with the MINITAB statistical program (Version 11.2, MINITAB Inc, USA). Data are presented as mean ± SEM.

Results

HR decreased dramatically during pre-anaesthesia ($p < 0.01$) and gradually during anaesthesia ($p < 0.05$; Figure 1a).

RR after M application (10 min) dramatically declined ($p < 0.001$); however, it started increasing 5 min after K injection and continued until 30 min and then started to decrease again thereafter (Figure 1b).

The average BT, which was 41.3 ºC at the beginning of anaesthesia, constantly decreased until the 45th min of anaesthesia and remained stable at around 34 ºC ($p <$ 0.05-0.001, Figure 1c).

The waves of derivations in terms of amplitude and length in ECGs at I, II, III, aVR, aVL, and aVF for each animal were investigated. The HRs were calculated based on lead II (Figure 2a). Significantly prolonged P-R and R-R intervals were observed (Figure 2b).

All pigeons under anaesthesia showed the signs of 4th degree anaesthesia. Myoclonic convulsions were observed in two pigeons while irregular respiration was observed in five pigeons during the anaesthesia. All pigeons recovered from anaesthesia in healthy condition and the time period required for recovery from anaesthesia varied from 210 to 360 min (Table).

Discussion

The use of anaesthetic agents in domestic fowls is new and there are many considerations which require clarification. Achieving the desired anaesthetic effect is generally obscured by the interspecies differences in the response to the dosage. For example, in chickens, the pain reflex was not lost and the animals were not suitable for surgical intervention at any stage of the anaesthesia when K was given at a dose level as high as 75 mg/kg in combination with diazepam (8). Similarly, IM or intravenous (IV) applications of K (10-30 mg/kg) with xylazine or diazepam resulted in good muscle relaxation

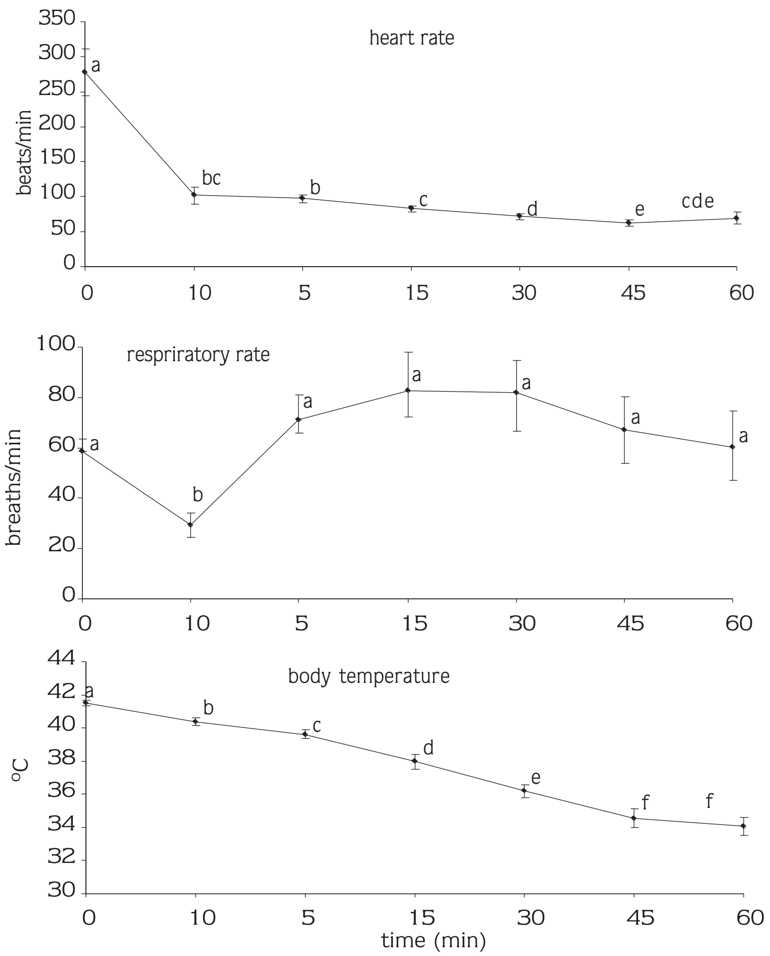

Figure 1. The effects of M + K combination anaesthesia on a) heart rate, b) respiratory rate and c) body temperature (there was no statistical significance between the values with the same letters, p > 0.05; 0-10 minutes indicate preanaesthesia values; 10-60 minutes indicate anaesthesia values).

Figure 2. The electrocardiogram from a pigeon, a) control (0 min), b) sinusal bradycardia (10 min after M, chart speed; 50 mm/s, standardisation; 1 mm = 10 mV).

Table. The effects of M and K on the degree of anaesthesia, heart rate and respiration in domestic pigeons (presented individually).

AD	T	Pigeon 1			Pigeon 2			Pigeon 3			Pigeon 4			Pigeon 5			Pigeon 6			Pigeon 7		
		DA	R	H R	DA	R	H R	DA	R	H R	DA	R	H R	DA	R	H R	DA	R	HR	DA	R	HR
Medetomidine 200 mg/kg	0	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	10	1	RE	SB	1	IR	SB	1	RE	SB	1	IR	SB	1	RE	SB	1	RE	SB	1	RE	SB
Ketamine hydrocl. 120 mg/kg pigeon	5	4	RE	SB	4	IR	SB	4	RE	SB	4	IR	SB	4	IR	SB	4	RE	SB	4	RE	SB
	15	4	RE	SB	4	IR	SB	4	RE	SB	4	IR	SB	4	IR	SB	4	RE	SB	4	RE	SB
	30	4	RE	SB	4	IR	SB	4	RE	SB	4	IR	SB	3	IR	SB	4	RE	SB	4	IR	SB
	45	3	RE	SB	3	IR	SB	4	RE	SB	4	IR	SB	3	RE	SB	3	IR	SB	3	IR	SB
	60	2	RE	SB	3	IR	SB	4	RE	SB	3	IR	SB	3	RE	SB	2	IR	SB	3	IR	SB
RA (min)		285			290			360			290			260			310			210		

N: control values, HR: heart rate, SB: sinusal bradycardia, R: respiration, DA: degree of anaesthesia, RE: regular, IR: irregular,
RA: Recovery from anaesthesia. AD: anaesthesic drug, T: time.

and sedation in companion birds and, therefore, were found to be suitable and reliable only for light anaesthesia for 10-30 min (1). Mohammed et al. (5), however, found that the usage of K (10-20 mg/kg) and detomidine (0.3 mg/kg) in combination caused good anaesthesia in chickens in a dose-dependent manner. Forbes (9) also obtained good surgical anaesthesia for 30 min when K (4-10 mg/kg IM) was used in combination with M (150-350 µg/kg IM) in avian species. In our study, the usage of K after premedication with M led to deep anaesthesia in all pigeons. It was found that the K doses used in the current study produced deep anaesthesia for approximately 30 min in pigeons when combined with M. On the other hand, Machin and Caulkett (10) used M, midalozam and K in combination and this resulted in the death of one duck out of 12 and three other ducks required resuscitation to prevent death. The dose of K used in the current study was 12 times higher than that used by Machin and Caulkett (10), but none of the pigeons died. The healthy recovery of all pigeons from M + K combination anaesthesia showed that this combination was safe for pigeons.

In the current study, RR dramatically declined in all seven pigeons immediately after the application of M. However, this decrease was reversed by K injection at the 10^{th} min. (Figure 1b). In addition, irregular respiration was observed in five pigeons at different periods of anaesthesia (Table). M as a new pre-anaesthetic agent has different effects on the RR in various animal species. In dogs, M alone or in combination with butorphanol decreased the RR (11,12). In contrast, M + K combination anaesthesia did not affect the RR in cats or cynomolgus monkeys and even increased it in lambs (13-15). Although the pigeons used in the current study showed an M- dependent decrease in RR, this effect was not life-threatening. In addition, it has beneficial effects on sedation, analgesia and muscle relaxation and its negative effects are reversable by specific antagonists (3,15). Therefore, M seems to be a good alternative as a pre-anaesthesic agent in healthy pigeons when used with K. However, the possiblity of complication in M application in pigeons with respiratory disorders should not be ignored.

On the other hand, HR was also dramatically decreased by M injection until the injection of K (Figure 1a). Young et al. (14) reported decreases in HR in cynomolgus monkeys after using K and K + M. Similarly, Ko and McGrath (15) found significant decreases in HR using M + Yohimbin, in lambs. In our study, however, the decrease seems to be more than that in monkeys and lambs. To the best of our knowledge, the magnitude of decrease obtained in our study for pigeons was observable only in dogs (16). It is reported that, in avian species, T waves became smaller and eventually disappeared and R waves increased in magnitude while S waves decreased during anaesthesia (1). In dogs, Ko et al. (12) observed second degree atrioventricular heart block during M and M + Butorphanol anaesthesia, and Schumacher et al. (17) noted significant decreases in RR intervals in propofol anaesthesia in wild turkeys. Although K is generally known as an anaesthetic agent that alters ECG findings, in pigeons we failed to observe any significant changes except for increases in R-R and P-R intervals and durations of P and T waves, which are all related to a regular sinus bradycardia (Figures 1a and 1b). Although arythmia, heart blocks and disappearance of waves did not occur in K + M anaesthetised pigeons, bradycardia should be a consideration.

In the present study, interestingly, cloacal temperature gradually dropped to 33-34 ºC until 45 min, and after this time it stayed relatively stable. In other studies in fowls, however, BT was within the range of 42.03-40.67 ºC (8). The reason for the dramatic decrease in BT in pigeons remains unknown. In order to be able to observe natural changes in BT, we tended not to use a heated blanket. However, it seems that a heated blanket is useful.

It has been suggested that the anaesthetic effect of K varies for avian species. K cannot be a sole agent for anaesthesia as it causes muscular tremors and myoclonic convulsions in domestic fowl (8). Christensen et al. (8) reported that the animals were able to recover easily and that K and diazepam were not sufficient for providing profound anaesthesia for laparotomy operations.

In the present study, a fairly deep anaesthesia was observed in all pigeons. All animals recovered easily without any complications although the M + K combination caused bradycardia and decreased BT. Furthermore, the profound anaesthetic effect only lasted about 15-60 min. Therefore, when M + K combination anaesthesia was appllied to pigeons, one should bear in mind that pigeons might recover shortly after anaesthesia. We suggest that this drug combination should be used carefully due to a possibility of life-threating effects on the respiratory system.

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