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Comparison of Three Different Anaesthesia Protocols in the Anaesthesia Induction of Ostriches (*Struthio camelus*)

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Abstract: This study was carried out to determine a suitable anaesthesia protocol for 12 ostriches brought to the Istanbul University Veterinary Faculty Research and Practice Hospital Surgery Clinic from Istanbul and its vicinity. Three varieties of anaesthesia induction agents were administered to 3 separate groups. The first group was given Xylazine+Ketamine+Isoflurane, the second group Diazepam+Ketamine+Isoflurane and the third group Tiletamine-Zolazepam+Isoflurane. For essential surgical procedures, these combinations were administered to cases with various lesions. Respiratory rate, body temperature and heart rate of the cases were examined at regular intervals. Anaesthesia induction, maintenance and recovery from anaesthesia was monitored. Statistical calculations were carried out using the ANOVA test. Assessment of all cases in this study showed the Diazepam+Ketamine+Isoflurane combination to be the most suitable anaesthesia protocol.

Key words: Anaesthesia, xylazine, ketamine, diazepam, tiletamine-zolazepam, isoflurane, ostrich

INTRODUCTION

Ostriches are the world's largest birds and live in tropical and subtropical areas. Ostriches cannot fly, however, they have a highly-developed running ability. Ostriches belong to the flightless birds class with the adults having a body weight of 80-160 kg and height of 1.90-2.50 m. These animals display a unique appearance with their small head and long necks (Arslan and Inal, 2001; Yucel *et al*., 2002).

Although, it is easy to handle the young of these birds, alongside experienced handlers, it has been reported that sufficient anaesthesia should be given to the adult birds. This often causes difficulty or even prevents performing a good physical examination and pre-operative assessment (Alkan *et al*., 2001; Perelman, 1999; Saroglu *et al*., 2003).

Pre-anaesthesic drugs used in ostriches are xylazine (1-2 mg kg^{-1}), diazepam (0.4-1.0 mg kg^{-1}) and midazolam (0.4 mg kg^{-1}) or the combination of these drugs (Ludders and Matthews, 1996; Linn *et al*., 1987; Lin, 1996). For anaesthesia induction, ketamine especially when combined with diazepam or following either xylazine or midazolam premedication has been reported to provide the most reliable and smooth anaesthesia. Also, induction can be performed using intravenous or intramuscular tiletamine-zolazepam, however, recovery may be problematic and prolonged. While the best location for intramuscular injections is the thick muscle mass on the lateral of the shin, intravenous injections can be given via the jugular vein (right side in particular), brachial vein on the wing or metatarsal vein in the lower extremity. It has been reported that intravenous injections in ostriches lead to rapid anaesthesia induction (Muir and Hubbell, 1989; Lin, 1996; Al-Sobayil and Omer, 2011).

Xylazine hydrochloride: A tranquiliser used widely for premedication in veterinary anaesthesia. As an alpha-2 adrenergic receptor, xylazin is an agent with analgesic and myorelaxant properties. It is used for minor surgical manipulations and diagnostic procedures in ostriches. It has a very strong cardiopulmonary effect including increasing sensitivity to catecholamines which cause second degree heart block, bradyarrhytmia and cardiac arrhytmia. It has been reported that when used on its own at high doses it can cause convulsions, excitation and respiratory depression in some species. Xylazine and ketamine combination administered to peking ducks has been seen to lead to hypoxia and hypercapnia (Al-Sobayil *et al*., 2009).

Intramuscular (IM) dosage in ostriches is recommended as 1-4 mg kg^{-1}. Intravenous (IV) dosage is not used since it is a strong cardiovascular agent (Cullen *et al*., 1995; Yucel *et al*., 2002).

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Diazepam: A kind of benzodiazepine derivative used in veterinary practice as a tranquiliser, sedative, preanaesthetic and neuroleptanalgesic drug. In ostriches, it is used for premedication, correcting behaviour, chemical restraint and as an anticonvulsant drug. IV administration is preferred due to the drug's slow and painful absorption into muscle (Perk and Gulanber, 2003; Sanli and Kaya, 1991).

It has been reported that while diazepam causes minimal cardiovascular and respiratory depression, IV injections may lead to bradycardia and hypotension. However, no acute hepatotoxic or nephrotoxic effects have been observed (Sanli and Kaya, 1991; Koc and Saritas, 2004). Literary sources have stated that due to its excellent tranquilising effect in ostriches it is mostly used on its own for catching and restraining (Perk and Gulanber, 2003; Sanli and Kaya, 1991). Recommended doses for ostriches are: 0.1-1 mg kg^{-1} IV or 0.3-1.0 mg kg^{-1} IM (Lin, 1996; Koc and Saritas, 2004).

Ketamine hydrochloride: Ketamine is a phenycylidine derivative, dissociative anaesthetic drug, characterized by neuroleptanalgesia, generating general anaesthesia. Ketamine is partly a good analgesic and anti-arrhytmic drug. Therefore, it is superior to other analgesic drugs in being risk-free in cases where a rapid induction is required. Ketamine when combined with diazepam or following xylazine or midazolam premedication has been reported to produce the most reliable induction in ostriches. When used on its own, it can lead to an extreme loss of coordination, partial ataxia and struggling. Anaesthesia is produced rapidly with IV injection (Bailey *et al*., 2001; De Lucas *et al*., 2007; Izci, 1996).

Ketamine does not cause tissue irritation and therefore may be administered both via IM and IV route. IM dosage is 16-25 mg kg^{-1} and IV dosage is 3.8-19 mg kg^{-1} (Perk and Gulanber, 2003; Hall, 1976).

Tiletamine-zolazepam hydrochloride: Tiletamine-zolazepam combination is a non-narcotic and non-barbiturate injectable anaesthetic obtained by mixing in equal amounts (1:1) the dissociative anaesthetic tiletamine and benzodiazepine derivative zolazepame (Sanli and Kaya, 1991; Koc and Saritas, 2004). Tiletamin-zolazepam dosage in ostriches is 4-5 mg kg^{-1} IM and 3.7 mg kg^{-1} IV (Tiletamine 2-8 mg kg^{-1} and Zolazepam 4-12 mg kg^{-1} IV) (Ludders and Matthews, 1996; Hall, 1976).

Isoflurane: Isoflurane mask intubation in ostriches is effective and stable (Perelman, 1999; Onuk *et al*., 2010).

Intubation of ostriches is similar to other avian species, the larynx is easily accessible and there is no epiglottis (Komnenou *et al*., 2003; Skadhauge and Dawson, 1999). Depending on their size, ostriches can be intubated using endotracheal tubes with an inside diameter of 10-18 mm (mean 14 mm) (Lin, 1996; Skadhauge and Dawson, 1999).

Isoflurane is recommended for anaesthesia maintenance in ostriches. For ostriches weighing <130 kg, a semi-closed circuit system anaesthesia machine for small animals is used while for larger ostriches the large animal semi-closed circuit system anaesthesia machine is used. Anaesthesia induction concentration is 4-5% and this is continued with a maintenance concentration of 2-3%. Reaching a stable plane of anaestheisa may require 30-60 min (Al-Sobayil and Omer, 2011; De Lucas *et al*., 2007).

Although, anaesthesia is made shallower for ostriches towards the end of the operation, recovery from inhalation anaesthesiais usually prolonged. During recovery period, the ostrich should be allowed to recover in a darkened, quiet place with high ceilings, smooth walls, padded surfaces and plenty of bedding. If necessary, benzodiazepine derivative drugs (Diazepam) may be administered to prevent further trauma (Sanli and Kaya, 1991; Skadhauge and Dawson, 1999).

MATERIALS AND METHODS

The material of this study comprised a total of 12 ostriches (8 female and 4 male) African ostriches (*Struthio camelus*) with a mean age of 29.5 months and mean body weight of 81.25 kg, brought to the Istanbul University, Veterinary Faculty, Research and Practice Hospital Surgery Clinic. The cases were divided into three groups and 3 different induction agents were administered. The first group was given a combination of Xylazine+Ketamine+Isoflurane; the second group Diazepam+Ketamine+Isoflurane and the third group Tiletamine-Zolazepam+Isoflurane. In order to perform surgical procedures, these combinations were administered to the cases, all of which had individual lesions (Table 1).

The first group was given 2 mg kg^{-1} IM xylazine HCl (Fig. 1) followed 30 min later by 10 mg kg^{-1} IV ketamine HCl. Intubation tubes with an inner diameter ranging between 14 mm were inserted (Fig. 2) and isoflurane was used for maintenance of anaesthesia. The second group was given IV 0.5 mg kg^{-1} diazepam followed by IV 10 mg kg^{-1} ketamine. Intubation tubes with inner diameters ranging between 14 mm were inserted and anaesthesia was maintained using isoflurane. The third

Table 1: Distribution of the cases'age, gender, bodyweight, indication for surgery and anaesthesia induction

Case No.	Age (month)	Weight (kg)	Sex	Anesthesia induction	Indication
1	43	80	F	Xylazine+Ketamine+Isoflurane	Tendovaginitis
2	22	80	F	Xylazine+Ketamine+Isoflurane	Arthrodesis
3	34	95	F	Xylazine+Ketamine+Isoflurane	Prolapsus cloaca
4	48	90	F	Xylazine+Ketamine+Isoflurane	Tendovaginitis
5	29	85	F	Diazepam+Ketamine+Isoflurane	Plate removal
6	24	80	F	Diazepam+Ketamine+Isoflurane	Eye tumour
7	47	95	M	Diazepam+Ketamine+Isoflurane	Wound revision
8	6	40	M	Diazepam+Ketamine+Isoflurane	Postoperative management
9	13	75	M	Tiletamine-Zolazepam+Isoflurane	Wound revision
10	28	80	F	Tiletamine-Zolazepam+Isoflurane	Femur fracture
11	32	90	F	Tiletamine-Zolazepam+Isoflurane	Postoperative management
12	29	85	M	Tiletamine-Zolazepam+Isoflurane	Prolapsus cloaca

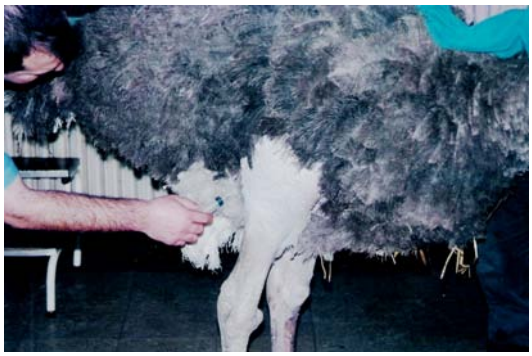

Fig. 1: Intramuscular injection application in ostrich

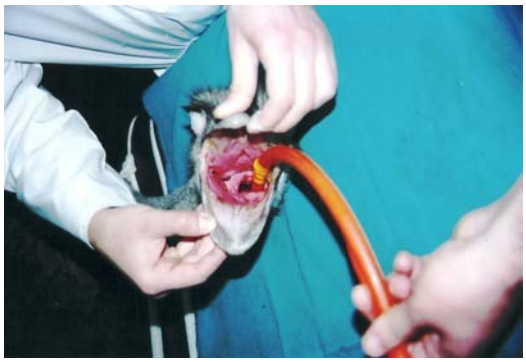

Fig. 2: Endotracheal tube application in ostrich

group was given tiletamine-zolazepam combination at a dose of 3.7 mg kg^{-1} IV. Intubation tubes with inner diameters ranging between 14 mm were applied and anaesthesia was maintained using isoflurane. Semi-closed circuit anaesthesia was carried out in all cases (SurgiVet Foal Circuit Set, Smith Medical North America, Waukesha, WI, USA) (Fig. 3).

Clinical findings, respiratory rate, heart rate and rectal temperature was recorded before premedication injection and after anaesthesia induction was established. The effects of anaesthesia carried out using these combinations on clinical findings, respiratory and circulatory systems and body temperature were evaluated.

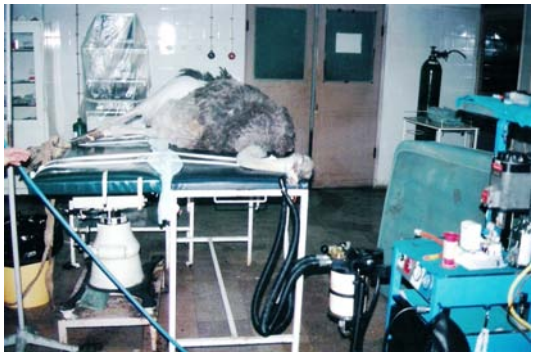

Fig. 3: Semi-closed circuit system anaestheisa application in ostrich

RESULTS AND DISCUSSION

The first group exhibited noticeable convulsions, excitation and anxiety within 15-20 min after IM injection of xylazine. After IV injection of ketamine, anaesthesia was achieved with difficulty in approximately 10-15 min. Cases were then intubated and connected to a semi-closed circuit anaesthesia machine. Despite the high vaporisator setting (4%), it took 30-40 min to reach a stable level of anaesthesia. Therefore, anaesthesia was started with 4% and maintained at 2% isoflurane.

The second group was given an IV injection of diazepam followed immediately by IV ketamine. No complications were observed in any of the cases and all cases displayed smooth anaesthesia induction. The pace and depth of ventilation continued calmly and regularly, similar to other avian species. The cases were then intubated and connected to a semi-closed circuit anaesthesia machine. Anaesthesia was established at 4% and maintained at 2% isoflurane.

The third group displayed noticeable convulsions and anxiety within 15-20 min of IV injection of tiletamine-zolazepam combination. Anaesthesia induction was established with difficulty. Cases showed anxious behaviour and those that were intubated were attached to

Table 2: Mean values for heart and respiratory rate and body temperature during anesthesia

		During anesthesia (x vs. Sx)		
Groups (n = 12)	Mean values for adults	A (X+K+I)	B (D+K+I)	C (Z+T+I)
Respiratory rate (min)	12-36/min	23.2±0.8^{c}	21.8±0.7^{b}	18.6±0.6^{a}
Body temperature (°C)	38-40°C	51.2±0.8	50.7±0.8	49.5±0.7
Heart rate (min)	30-60/min	40.2±0.7^{b}	38.5±0.7^{a}	38.9±0.6^{a}

$^{a-c}$Means in a column that are not followed by a common letter are different ($p<0.05$); Mean±standard deviation; n = 12; Group 1 (A): Xylazin+Ketamine+Isoflurane; Group 2 (B): Diazepam+Ketamine+Isoflurane; Group 3 (C): Tiletamin-Zolazepam+Isoflurane

a semi-closed circuit anaesthesia machine. Isoflurane was given at 4% at the start and 2% for maintenance of anaesthesia.

Mean values for heart and respiratory rate and body temperature during anesthesia are shown in Table 2. Data were compared by using the Analysis of Variance (ANOVA, Duncan's multiple range test) between the groups and in each group for the number of inhalation, body temperature and heart beat. Results are presented as mean±standard deviation. All statistical analyses were performed using Software Package Program (SPSS for Windows, Standard Version 10.0, 1999, SPSS Inc., Headquarters, Chicago, IL, USA). A significance level of $p<0.05$ was employed in the analysis of data from groups.

Increasing in number everyday, ostriches may be exposed to many diseases. While some of these can be treated by conservative therapy, others require surgical treatment. Various anaesthesia combinations are considered for surgical interventions (Al-Sobayil *et al*., 2009; Skadhauge and Dawson, 1999).

Xylazine HCl is used for minor surgical manipulations and diagnostic procedures such as x-rays. Some researchers attempted to use pre-anaesthetic drugs with strong sedative effects, however, they reported that the desired sedation could not be achieved due to the patient exhibiting excessive convulsions, excitation and respiratory depression (Linn *et al*., 1987; Cullen *et al*., 1995). Also, since xylazine HCl produces excessive cardiovascular depression in ill birds, pre-operative assessment is important. In this study, respiratory rate, heart rate and body temperature mean values were above normal during anaesthesia in cases given premedication with xylazine HCl. These findings were compatable with literature (Perelman, 1999; Schmidt-Nielsen *et al*., 1969). Researchers are of the opinion that this is due to the difference in responses given by ostriches to xylazine HCl. Therefore, the researchers think that since the drug can cause serious problems when used on its own, pre-operative assessment and dosage calculations should be carried out carefully.

It has been reported that in ostriches diazepam is used as a myorelaxant and anti-convulsant in the recovery period and since its absorption through the muscle structure is slow and painful IV administration is considered to be more suitable (Sanli and Kaya, 1991; Koc and Saritas, 2004). Researchers administered the drug to four of the cases for premedication via the right jugular vein or the brachial vein after restraining the patient. While administration was easier in the right side due to the fact that the right jugular vein was more prominent than the left one, it also aided diazepam in taking effect. Diazepam also enables ostriches to have a smooth recovery and provides ease of administration for the general anaesthetic to be used. It helps in the smooth recovery of patients. Therefore, in the researchers' opinion, it may be administered to both healthy and unwell animals for premedication.

Due to its excellent tranquilising effect in ostriches, it has been expressed that diazepam may be used on its own mostly for catching and restraining (Perk and Gulanber, 2003; Sanli and Kaya, 1991). When used on its own, diazepam was seen to provide sufficient restraint during x-ray examinations of some cases and was seen to be particularly effective in ill or frail birds and in providing controlled restraint of the patient. Researcher's findings support literature. In the group to which diazepam was administered in accordance with literature (Perelman, 1999; Schmidt-Nielsen *et al*., 1969), respiratory rate, heart rate and body temperature mean values were seen to remain close to normal limits during anaesthesia. In researcher's opinion, when premedicated with diazepam, general anaesthesia is established in patients very comfortably and controlled general anaesthesia can be achieved in serious cases.

Ketamine HCl was administered to the first two groups to establish general anaesthesia. The ostriches were observed as they went under general anaesthesia following the pre-anaesthetic drugs given to both groups. In the anaesthesia of the first group, following IV ketamine injection, convulsions, excitation and respiratory depression was seen in patients and the desired tranquilisation was achieved with difficulty. These findings were compatible with literature (Lin, 1996; Hall, 1976). Therefore, this combination was considered to carry a high risk. In the anaesthesia of the second group, IV ketamine injection did not produce any convulsions, excitation or respiratory depression and catching and restraining was achieved with ease. These findings support literature (Sanli and Kaya, 1991; Koc and Saritas, 2004). The immobilization effect and compatibility of diazepam with ketamine showed it to produce a very

smooth anaesthesia in ostriches. Since, no side effects of this combination were observed, it was concluded that it would also be suitable for anaesthesia.

It has been stated in literature that, immediately after tiletamine-zolazepam injection, ostriches exhibit noticeable convulsion and anxiety lasting for 15-20 min (Lin, 1996; Hall, 1976). It was observed that, in ostriches of a calm nature, this period was shorter when entering anaesthesia and that sometimes no anxiety was observed. In ostriches with a tougher temperament, this period was long.

Researchers also think that the difficulty of IV administration of the drug and the prolonged state of anxiety it produces cause the patients not to enter the anaesthesia comfortably and therefore harm themselves.

With this combination, respiratory rate, heart rate and body temperature mean values were seen to be close to normal range throughout anaesthesia which is compatable with literature (Perelman, 1999; Schmidt-Nielsen *et al*., 1969).

CONCLUSION

As a result, in researcher's opinion, due to its ease of administration in the clinical manipulations of patients requiring only conservative treatment, its minimal complications depending on duration of anaesthesia in surgical treatment, its excellent muscle relaxant property and its safe and rapid recovery properties, subsequent to diazepam application and ketamin induction, isoflurane anesthesia combination is the best combination to use in ostriches in the present day.

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