Physiological and haematological findings in immobilized free-ranging African elephants

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Abstract

Fifty-six elephants (*Loxodonta africana*) of mixed ages and of both sexes were immobilized to translocate them in Laikipia District, Kenya, in July 2001. The animals were immobilized with etorphine hydrochloride mixed with hyaluronidase through an intramuscular dart. The range, mean and standard deviations were analysed for all physiological and haematological parameters collected for each age group. The body temperature, mean corpuscular volume and total protein showed significant difference ($P < 0.05$) between adults and subadults while respiratory rate, pulse rate and total protein showed significant difference ($P < 0.05$) between subadults and juveniles. In addition to white blood cell counts, all the above-stated parameters showed significant difference ($P < 0.05$) between adults and juveniles. The range for haematological parameters compared well with those reported by other authors except for the white blood cell counts. These data from healthy free-ranging African elephants provide baseline information on parameters for monitoring during immobilization and in haematological analysis during disease investigation.

Résumé

On a immobilisé 65 éléphants (*Loxodonta africana*) d'âge divers et des deux sexes pour les transporter vers le District de Laikipia, au Kenya, en juillet 2001. Les animaux ont été immobilisés au moyen d'une seringue intramusculaire contenant de l'étorphine mélangée à de l'hyaluronidase. On a étudié l'étendue, les déviations standards et moyennes pour tous les paramètres physiologiques et hématologiques récoltés pour chaque groupe d'âge. La température corporelle, le volume corpuspulaire moyen et le total des protéines montraient des différences significatives ($P < 0,05$) entre les adultes et les subadultes, tandis que le rythme respiratoire, le pouls, et le total des protéines présentaient des différences significatives ($P < 0,05$) entre les subadultes et les juvéniles. La gamme des paramètres hématologiques était comparable à celle rapportée par d'autres auteurs sauf en ce qui concerne le comptage des globules blancs. Ces données, qui proviennent d'éléphants africains libres et en bonne santé, apportent des informations de base sur les paramètres à contrôler lors de l'immobilisation et dans les analyses hématologiques en cas de maladies.

Introduction

Elephants (*Loxodonta africana*) have been routinely immobilized for various purposes. These include ecological and behavioural research (Thouless 1995; Elkan et al. 1998; Whyte and Grobler 1998) and translocation (Puterill 1993; Njumbi et al. 1996). They have also been immobilized for clinical examination and treatment, minor surgical procedures such as suturing wounds and removing snares as well as reproductive procedures such as electroejaculation (Kock RA et al. 1993).

Improvements in veterinary and other technology have encouraged intervention for diagnosis and treatment of diseases as well as for ecological monitoring and behavioural research. To successfully implement these interventions, elephants must be immobilized. Understanding the physiological dynamics in elephants during immobilization will help to minimize mortalities. In managing elephant health, understanding the normal range of haematological parameters is useful.

The literature available on these parameters in free-ranging East African elephants is limited. Some data are available from southern Africa and from captive elephants (Brown and White 1980; Allen et al. 1985; Kock MD et al. 1993; Kock RA et al. 1993; Olsen and Byron 1993; Still 1996; Osofsky 1997; Whyte and Grobler 1998). This paper provides data from 56 African elephants immobilized for translocation in Laikipia District, Kenya, and compares the physiological and haematological parameters among the various age groups.

Materials and methods

The study was conducted during the capture of 56 African elephants for translocation from Laikipia District to Meru National Park, Kenya. The capture and release sites are 250 km apart. The translocation was undertaken to resolve a long-standing human–elephant conflict and to decrease habitat pressure in Ol Pejeta Ranch. Another objective was to restock Meru National Park, whose elephant population had been almost annihilated by poaching in the 1970s. Pretranslocation monitoring was done to identify suitable family groups and individual bulls for translocation.

The animals were darted from a helicopter after herding them to a low-canopy area. Small calves were darted from the ground. One calf that was about 1 m in height was physically restrained and sedated with 40 mg azaperone (Stresnil® 40 mg/ml, Jansen Phamaceutica (Pty) Ltd, South Africa). Darting was carried out using the Palmer Cap Chur® Long-Range projector (Palmer Cap-Chur Equipment, Inc., Douglasville, Georgia 30133 USA) with 3-ml darts. A side-bore collared elephant needle (Palmer Cap-Chur Equipment) was used, 5 mm wide and either 65 mm or 55 mm long, depending on animal size. A mixture of etorphine HCl (M99 9.8 mg/ml, Logos Agvet (Pty) Ltd, South Africa) and hyaluronidase (Kryon Laboratories, Benrose 2011, South Africa) was used. Dosage was 18 mg etorphine HCl and 5000 IU hyaluronidase for adults, 15 mg etorphine HCl and 3500 IU hyaluronidase for subadults, and 5 mg etorphine HCl and 1500 IU hyaluronidase for juveniles. Etorphine HCl at a quarter of the original dose was administered intravenously when anaesthesia became light. Neuroleptoanalgesia was judged to be ineffective when frequency and strength of trunk and ear movements increased.

Induction time was considered as the time from darting to the time when the animal became recumbent. Once the animal was recumbent, the trunk was straightened to ensure that airways were unobstructed. The pulse rate was obtained by palpating the middle ear artery for one minute. Respiratory rate was determined by counting for one minute the number of chest movements and expiratory movements at the tip of the trunk. Body temperature was determined by inserting a digital thermometer deep into the rectum. The three parameters were determined and recorded every 5 min. Blood for haematology was collected in ethylenediaminetetra-acetic acid (EDTA) bottles from the middle ear vein. It was then placed in a cool box and analysed within 6 hours with the use of a CBC-5 Coulter Counter (Coulter Electronics, Hialeah, Florida 88666, USA). The dart wound was treated with 1% tetracycline ophthalmic ointment (Sarabhai Chemicals, Wadi Wadi, Baroda, India). An intramuscular injection of oxytetracycline hydrochloride (Oxy-kel 20 L.A., Kela Laboratories, B-2320 Hoogstraten, Belgium) was given, 40,000 mg to adults, 20,000 mg to subadults and 10,000 mg to juveniles. Animal age was estimated as described by Laws (1966).

Etorphine HCl was reversed by diprenorphine HCl (M5050 12 mg/ml, Logos Agvet) intravenously at three times the dosage of etorphine used for each category of elephants.

Student's *t*-test was used to compare the means. Outliers were corrected by plotting normal distribution curves for the various age groups. In all statistical analysis a significant level of $P < 0.05$ was applied.

Results

Of the 56 elephants that were captured, 51 were successfully translocated and 5 (8.9%) died. Four died during transportation, two having manifested pink foam syndrome, a condition caused by lung oedema after prolonged recumbency. One died of suffocation due to obstruction of its trunk when it fell in the family crate and its tusks got locked into the sliding partition. The fourth died from pyloric obstruction present before immobilization and exacerbated by the capture stress. The fifth, a small calf, lay on its trunk after it was darted and suffocated before the veterinary team arrived.

The captured elephants comprised nine bulls and seven family groups of between four and seven individuals. The age groups were divided into less than 3 years (juveniles), 3–10 years (subadults) and over 10 years (adults). There were 26 adults (10 males and 16 females), 14 subadults (5 females and 9 males) and 16 juveniles (7 males and 9 females).

Table 1 summarizes the range, mean and standard deviation of the various parameters in the three age groups, and any significant difference in the mean.

Discussion

The results of this study show that most physiologic parameters are different in the three age groups of elephants. The differences are statistically significant in some parameters and not in others.

The average induction time of 9.1 minutes in all age groups compares well with that previously reported (Kock MD et al. 1993; Osofsky 1997) at similar or slightly lower etorphine HCl and hyaluronidase dosages. However, when compared with the induction time reported by other authors (Kock RA et al. 1993), the time in this study was higher at equivalent drug dosages.

The respiratory and pulse rates were significantly different between adults and juveniles, and between subadults and juveniles. They are highest in juveniles and lowest in adults. This is attributed to the higher metabolic rate in younger animals. The average respiratory rate of 7.1 breaths per minute and pulse rate of 67.0 beats per minute in all age groups compares well with other reported work (Kock RA et al. 1993; Olsen and Byron 1993; Still et al. 1996).

The body temperature was significantly different between adults and subadults as well as between adults and juveniles. The difference between subadults and juveniles was not statistically significant. The average body temperature of the three age groups of 37.2°C compares well with previously reported work (Kock MD et al. 1993; Kock RA et al. 1993; Olsen and Byron 1993). Osofsky (1997) reported slightly higher value than the present study. This difference could have resulted from different environment conditions and elephant populations.

The packed cell volume (PCV) was significantly different between adults and juveniles. The juveniles had higher PCV than subadults and subadults higher than adults, but the differences were not statistically significant. The same trend was observed in red blood

Table 1. Anaesthesiologic and haematologic results of different age groups of free-ranging African elephants

Variables	Juveniles *n* = 16		Subadults *n* = 14		Adults *n* = 26	
	Range	Mean ± SD	Range	Mean ±SD	Range	Mean ± SD
Induction time	5.0 – 14.0	9.5 ± 6.36[a]	8.0–10.0	9.0 ± 1.41[a]	5.0 – 25.0	8.9 ± 2.34[a]
Respiratory rate	3.0 – 13.0	8.9 ± 3.09[a]	3.0–8.0	6.3 ± 1.38[b]	3.0 – 10.0	6.0 ± 1.45[b]
Pulse/min	51.0 – 97.0	74.3 ± 3.26[a]	52.0–79.0	65.4 ± 8.81[b]	44.0 – 79.0	61.5 ± 8.29[b]
Temperature (°C)	36.0 – 38.4	37.5 ± 0.77[a]	36.0–38.6	37.3 ± 0.75[a]	39.0 – 38.8	36.7 ± 0.65[b]
PCV (%)	30.9 – 46.7	39.7 ± 4.80[a]	27.6–46.1	36.4 ± 5.22[a,b]	27.0 – 46.5	36.1 ± 4.46[b]
RBC x 10^6/ml	2.2 – 4.0	3.3 ± 0.60[a]	2.5–4.0	3.2 ± 0.40[a]	2.2 – 3.7	3.0 ± 0.38[a]
MCV (fl)	111.0 – 21.0	111.8 ± 5.87[a]	102.0–118.0	111.8 ± 5.33[a]	102.0 – 126.0	117.9 ± 6.36[b]
Hb (g/dl)	10.7 – 14.1	12.0 ± 1.08[a]	11.0–14.1	12.2 ± 1.14[a]	10.6 – 16.7	13.0 ± 1.36[a]
WBC x 10^3/ml	8.6 – 40.1	20.1 ± 8.56[a]	9.7–23.5	17.3 ± 4.1[a,b]	4.1 – 21.4	15.4 ± 4.55[b]
Plasma proteins (g)	7.6 – 8.9	8.2 ± 0.47[a]	8.0–9.6	8.9 ± 0.44[b]	8.6 – 10.6	9.4 ± 0.64[c]
Neutrophils (%)	15.0 – 42.0	27.0 ± 9.32[a]	15.0–36.0	26.5 ± 6.83[a]	14.0 – 37.0	28.6 ± 7.76[a]
Band neutrophils (%)	0.0 – 2.0	0.3 ± 0.78[a]	0.0–2.0	0.57± 0.94[a]	0.0 – 2.0	0.25± 0.53[a]
Lymphocytes (%)	58.0 – 85.0	72.1 ± 9.49[a]	64.0–81.0	70.1 ± 5.22[a]	56.0 – 84.0	69.8 ± 7.60[a]
Eosinophils (%)	0.0 – 3.0	1.0 ± 1.04[a]	0.0–6.0	1.64± 2.20[a]	0.0 – 3.0	0.75± 1.03[a]
Monocytes (%)	0.0 – 2.0	0.33± 0.65[a]	0.0–1.0	0.09± 0.3[a]	0.0 – 2.0	0.2 ± 0.51[a]
Basophils (%)	0.0 – 1.0	0.2 ± 0.40[a]	0.0–2.0	0.21± 0.58[a]	0.0 – 3.0	0.3 ± 0.70[a]

Induction time; in minutes; respiratory rate – in breaths/min; PCV – packed cell volume; RBC – red blood cells; MCV – mean corpuscular volume; Hb – haemoglobin concentration; WBC – white blood cells

a, b, c – means with different superscripts are significantly different ($P < 0.05$).

cell (RBC) counts, in which the counts decreased from juveniles to subadults and to adults, but the differences were not statistically significant. The average value of PCV in the three age groups of 37.4% compares well with that previously reported (Kock MD et al. 1993) but is slightly higher than other reported work (Woodford 1979). However, the value is lower than that reported by other authors (White and Brown 1978; Brown and White 1980; Whyte and Grobler 1998). The average RBC count of 3.2 x 10^6 cells/µl in this study compares well with that previously reported (White and Brown 1978; Woodford 1979; Allen et al. 1985).

The mean corpuscular volume (MCV) showed significant differences between adults and subadults as well as between adults and juveniles. The difference between subadults and adults was not significant. The values were highest in adults and lowest in juveniles. The same trend is seen in haemoglobin (Hb) concentration that increases with age. The differences of Hb concentration between the age groups are statistically significant. The average MCV of 114.9 fl in the three age groups compares well with that previously reported (Woodford 1979; Allen et al. 1985). However, it differs from that reported by other authors (Young and Ombard 1967; Brown and White 1980). The average Hb concentration of 12.4 g/dl compares well with that previously reported (Woodford 1979; Brown and White 1980; Allen et al. 1985). However, it differs from that reported by another author (Young and Ombard 1967).

The white blood cell (WBC) count declines from juveniles through subadults to adults but the only significant difference occurs between juveniles and adults. In differential WBC counts no significant differences were observed among the different age groups and no clear pattern of increase or decrease could be seen across the age groups. The percentage of lymphocytes was highest followed by neutrophils, eosinophils, basophils, monocytes and band neutrophils, in that order. The average WBC count of 17.6 x 10^3 cells/µl for the three age groups was higher than those previously reported (White and Brown 1978; Woodford 1979; Brown and White 1980; Allen et al. 1985). Further, the range of WBC count was also lower than that reported by other authors. This is the only parameter where such a disparity in range was noted. These differences between the results in this study and those of the authors listed above could have arisen from bias caused by low numbers of animals sampled in these studies. However, some differential count results agreed with those reported by these authors: lymphocyte, neutrophil and monocyte counts, (White and Brown 1978), eosinophil counts (Brown and White 1980) and basophil counts (Woodford 1979; Allen et al. 1985). The differential counts differed from those reported by the rest of the authors.

The total plasma protein value showed significant differences between all age groups and was the only parameter that showed such a trend. It was highest in adults and lowest in juveniles. The average total plasma protein value of 8.8 g/ml in the three age groups agrees with that previously reported (Hill and Smith 1990) but is higher than that reported by Allen et al. (1985). Further, Hill and Smith (1990) categorized the values according to age groups and their reported values agreed with those observed in this study with the exception of juvenile values, which were higher in this study. These authors also reported significant differences in total plasma protein values between adults and calves, which were also observed in this study.

The results of this study compare well with other published work. However, most of the previously reported work involved a small number of sampled animals and no categorization was made according to age. This study has shown that major differences do occur in physiological parameters among different age groups. Therefore, pooling physiologic data of animals of different ages can complicate data interpretation and result in bias. The present study, like all studies previously reported, concentrated on collecting data from a population of elephants in the same geographic area. This could cause some bias in the findings. A study on comparison of physiologic parameters of elephants in different geographic areas and seasons should be undertaken in future.

The results in this study provide baseline data for reference of physiological and haematological parameters of different ages of immobilized free-ranging African elephants using etorphine HCl. The differences in various parameters in different age groups of elephants should be taken into consideration when monitoring neuroanalgesia during immobilization and during health assessment.

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