

RADIOGRAPHIC EVALUATION OF THE CARDIAC SIZE IN FALCONRY RAPTORS

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Abstract: The objective of this study was to establish reference values for the cardiac size during radiographic examination in four species of Falconiformes used for falconry purposes. Lateral and ventrodorsal radiographs were examined from healthy birds of 4 species: Harris' hawk (*Parabuteo unicinctus*) n=48, Peregrine falcon (*Falco peregrinus*) n=35, Saker falcon (*Falco cherrug*) n=19, Lanner falcon (*Falco biarmicus*) n=13. Ratios were established between the length of the heart from its base to the apex and the total length of the carina in the lateral view. In the ventrodorsal views ratios were calculated between the width of the heart at its widest point and the distance between the ribs at the same level. Ratios between the width of the coracoid immediately caudal to the humerus articular surface in the shoulder joint and width of the heart and the distance between the ribs were established too. No differences were found between species in the length of the heart/length of the carina ratio, differences were found in the width of the heart/distance between ribs and width of the heart/coracoid width between hawks and falcons, but not between the different falcon species.

Key words: cardiac measurements, heart, radiograph, lanner falcon, peregrine falcon, harris hawk, saker falcon.

INTRODUCTION

Previous studies have established reference values for the radiographical evaluation of the heart size in avian species^{1,2}, including birds of prey such as red tailed hawks²

However no previous studies have been performed in the species described in this study.

The objective of this study was to establish reference values for the cardiac silhouette in these species. It may also prove to be a useful preliminary study to examine how different factors may affect the cardiac size in falconry birds.

Materials and methods

Four species were evaluated, Harris hawk (*Parabuteo unicinctus*) n=48 (33 females, 15 males) Peregrine falcon (*Falco peregrinus*) n=35 (22 females, 13 males) Saker falcon (*Falco cherrug*) n=19 (12 females, 7 males) Lanner falcon (*Falco biarmicus*) n=13 (9 females, 4 males). The criteria for inclusion in the study were flying birds used for falconry purposes, captive bred, between 1-5 years old, fed with day old chicks mainly but supplementation with other types of food such as quail, partridge and rabbit was offered, pure birds excluding hybrids, flying training started between 3-5 months of age, method of training was traditional free flying, hawks were flown 1-2 times

weekly while falcons were flown daily for a similar period of time between one and two hours. The birds selected did not have any prior medical problems and were presented for routine health checks where faecal flotation exams, haematology, biochemistry and radiographs were found to be within normal limits, or were found to have traumatic injuries related to orthopaedic conditions. Birds with other medical problems were excluded. Sex was considered for the study, due to the differences in size in the species evaluated.

The radiographs were taken under anaesthesia with isoflurane (Isoba; Abbotts) in oxygen, no consideration was given if the radiographs were taken in expiration or inspiration.

Only well positioned lateral and ventrodorsal views were examined. For the ventrodorsal views the carina and the vertebral spine were superimposed and wings were symmetrical. For the lateral views and both coxofemoral joints were overlapped. The radiographs were taken with a commercial x-ray unit (MX.2 SEC Medical) using a 75 cm focal distance and mammography film (HDC-M, Photon imaging systems, Ashton Keynes, United Kingdom)

The radiographs were placed on an illuminated radiograph viewer and the following measurements were taken using a millimetre graduated ruler:

- A: sternum length from the most cranial point of the carina to the most caudal point in the lateral view
- B: length of the heart between the base and the apex (figure X – *and then you can explain the perpendicular there*), in certain radiographs where the apex was difficult to visualize due to the overlapping with the liver, pictures were taken using a digital camera (Cannon Ixus 60) from the film in the viewer at a 30 cm distance, and the contrast manipulated with a photographic software (GIMP 2.4) allowing to visualize clearer the cardiac silhouette.
- C: width of the chest at the same level where the width of the heart (measurement C) was measured.
- D: width of the heart, in the ventrodorsal view at its widest point.
- E: width of the coracoid immediately caudal to the articular surface with the humerus

The following ratios were calculated B/A, D/C, D/E, in order to be able to compare cardiac parameters across different sexes and species.

Variables were analyzed, including A, B, C, D, E and the ratios calculated, separating males from females. The Kolmogorov-Smirnov test was used to test for normal distribution, and the SD and coefficient of variation were calculated. The Pearson test was used to test for correlation between length of the heart and the length of the carina, between the width of the heart and the width of the chest and between the width of the heart and the width of the coracoid, linear regression analysis were performed and analysis of variance was used to test for differences between the species and sexes. Values of $P < 0.05$ were considered significant.

Analysis was performed using commercial software (SPSS 16.0).

Results

Mean ratios for the different species can be observed in the following tables

Harris hawks

	N	Minimum %	Maximum %	Mean %	Std. Deviation %
Ratio heart/carina (B/A)	48	53	60	56	1
Ratio chest/heart (C/D)	48	54	60	57	1
Ratio heart/choracoid (D/E)	48	575	900	706	71

Peregrine falcons

	N	Minimum %	Maximum %	Mean %	Std. Deviation %
Ratio heart/carina (B/A)	35	55	64	57	2
Ratio chest/heart (C/D)	35	66	74	68	1
Ratio heart/choracoid (D/E)	35	725	967	863	55

Saker falcons

	N	Minimum %	Maximum %	Mean %	Std. Deviation %
Ratio heart/carina (B/A)	19	52	59	56	2
Ratio chest/heart (C/D)	19	66	72	68	1
Ratio heart/choracoid (D/E)	19	780	1000	905	74

Lanner falcons

	N	Minimum %	Maximum %	Mean %	Std. Deviation %
Ratio heart/carina (B/A)	13	56	61	58	1
Ratio chest/heart (C/D)	13	65	72	68	2
Ratio heart/choracoid (D/E)	13	725	925	839	71

Correlation (Pearson correlation, 2 tailed)

The correlation between the width of the heart and width of the chest and the correlation between the length of the carina and the length of the heart were strong in all species. The correlation between width of heart and width of coracoid was moderate. This was the case for all 4 species examined.

Harris hawk

Length of the sternum, length of the heart correlation: $r=0.97$, width of the chest, width of the heart: $r=0.95$, width of the heart, width of the coracoid $r=0.61$

Peregrine falcon

Length of the sternum, length of the heart correlation: $r=0.97$, width of the chest, width of the heart: $r=0.94$, width of the heart, width of the coracoid $r=0.72$

Saker falcon

Length of the sternum, length of the heart correlation: $r=0.93$, width of the chest, width of the heart: $r=0.92$, width of the heart, width of the coracoid $r=0.58$

Lanner falcon

Length of the sternum, length of the heart correlation: $r=0.91$, width of the chest, width of the heart: $r=0.97$, width of the heart, width of the coracoid $r=0.61$

Regression equation

Harris hawk

Length of the heart= $-8.00 + 0.67 \times$ length of the sternum

Width of the heart= $-2.57 + 0.62 \times$ width of the chest

Width of the heart= $15.57 + 3.19 \times$ width of the coracoid

Peregrine falcon

Length of the heart= $17.18 + 0.35 \times$ length of the sternum

Width of the heart= $3.87 + 0.61 \times$ width of the chest

Width of the heart= $16.5 + 4.5 \times$ width of the coracoid

Saker falcon

Length of the heart= $27.12 + 0.21 \times$ length of the sternum

Width of the heart= $-2.39 + 0.73 \times \text{width of the chest}$
Width of the heart= $25.45 + 3.02 \times \text{width of the coracoid}$

Lanner falcon

Length of the heart= $4.2 + 0.53 \times \text{length of the sternum}$
Width of the heart= $7.13 + 0.54 \times \text{width of the chest}$
Width of the heart= $21.58 + 3.08 \times \text{width of the coracoid}$

Analysis of variance showed no significant differences were found between sexes in the same species for any of the parameters, or in the length of the heart/length of the sternum ratio ($P < 0.05$). However significant differences were found in the width of heart/width of the chest ratio and between the width of the heart/width of the coracoid ratios between falcons and hawks ($P > 0.05$), although no significant difference was found in these ratios within falcon species

Discussion

This study demonstrates a useful method for evaluating cardiac silhouette size in relation to carina length, thorax width and coracoid width in healthy Falconiformes used for falconry.

The measurements were easily performed, although some radiographs have to be manipulated through image software to visualize the heart apex clearly in the lateral view. Using computerised or digital imaging techniques would eliminate this problem.

The species examined are birds commonly used for falconry purposes in the United Kingdom, especially Harris hawks and Peregrine falcons. Only pure-bred falcon species were chosen for the study to prevent any effects that hybridisation might have on the size of the structures measured.

The criteria for inclusion in the study were intentionally restrictive to prevent variation due factors such age, age when training commenced and medical illness.

The health status of the birds was assessed by physical exam, faecal flotation, haematology, biochemistry and radiographs. , Electrocardiography and echocardiography were not routinely performed in all cases but none of the included cases presented any signs of cardiac disease, nor did the owners report any decrease in the performance or exercise intolerance. In any case, although normal ECG values have been recorded in peregrine falcons³ lack of reference values for electrocardiography in the other species and echocardiography make further assessment of the cardiac function limited.

The coracoid width measurement was evaluated as a rigid skeletal component since the stage of inspiration or expiration was not considered and may have influenced the thoracic width measurements. Other studies have suggested that this variation may not be significant^{1,2} . Although the ratios of heart width to coracoid measurement support the ratio results with the width of

the thorax, the correlation is only moderate suggesting variation of coracoids size across species may be minimal in the context of this study.

The results show that there is no significance difference in ratio between the length of the heart and the length of the carina in these four species of birds of prey. Further evaluation in other falconiform species would be useful. A significant difference was found when comparing heart width/chest width ratio between the hawks and the falcons. The ratio in falcons was higher which could potentially be due to the fact that falcons in the UK tend to be flown more frequently than hawks and therefore the heart may be slightly wider in comparison with the chest width. The ratio found in hawks was similar to that found in other species¹.

For interest the ratios established in this study were compared with some radiographs of patients with known cardiac pathology. When evaluating a 13 year old, female, Harris hawk who presented with severe ascites and was diagnosed with congestive heart failure based on the clinical signs and the echo-cardiographic study, the ratio of length of the heart/length of the keel was within the normal range while the ratio of width of the heart/width of the chest was 71%, higher than the reference values obtained in the study. Another comparison evaluated a 1 year old, female Gyr falcon (*Falco rusticolus*) with severe pericardial effusion. This showed the opposite to the Harris hawk with heart failure; while the ratio of width of the heart/width of the chest was within normal range the ratio of length of the heart/length of the keel was 76%, much higher in the sick bird. Although these two cases may illustrate the potential clinical use of this study, further work using larger numbers of birds with confirmed cardiac pathology is required to evaluate these measurements as a useful diagnostic aid when evaluating radiographs of raptors with suspected heart disease.

References

1.- Straub J, Pees M, Krautwald-Junghanns M-E. Measurement of the cardiac silhouette in psittacines. JAVMA, 2002; 221:76-79

2.- Hanley SH, Helen GM, Torry S et al. Establishing cardiac measurement standards in three avian species. J. Avian Med Surg 1997; 11:15-19

3.- Rodriguez R, et al, The normal electrocardiogram of the unanaesthetized peregrine falcon. Avian diseases, 2004; 48(2):405-9

Naldo JL, Samour JH. Radiographic findings in captive falcons in Saudi Arabia, 2004; 18:242-256

Gardner A, Thompson MS, Fontenot D, Gibson N, Heard DJ. Radiographic evaluation of cardiac size in flying fox species (*Pteropus rodricensis*, *P hypomelanus* and *P vampyrus*). J Zoo and Wild Med 2007; 38:192-200

Samour JH, Naldo JL, Anatomical and clinical radiology of birds of prey, Philadelphia, Saunders Elsevier; 2007