Measurement of the cardiac silhouette in psittacines

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Objective—To determine reference values for size of the radiographic cardiac silhouette in healthy adult medium-sized psittacines.

Design—Prospective case series.

Animals—46 African grey parrots (Psittacus erythacus), 7 Senegal parrots (Poicephalus senegalus), and 6 orange-winged Amazon parrots (Amazona araus).

Procedure—Birds were anesthetized, and ventrodorsal radiographic projections were obtained. Maximum width of the cardiac silhouette, width of the thorax at the level of the maximum width of the cardiac silhouette, and width of the coracoid were measured on the radiographs. Sternum length was directly measured on individual birds. Results of physical examination, electrocardiography, and echocardiography were normal in all birds.

Results—Mean cardiac silhouette width-to-sternum length ratio was 38%, mean cardiac silhouette width-to-thorax width ratio was 55%, and mean cardiac silhouette width-to-coracoid width ratio was 600%. Width of the cardiac silhouette was strongly correlated with length of the sternum, width of the coracoid, and width of the thorax. No significant differences between species were detected.

Conclusions and Clinical Relevance—Results suggest that in healthy adult medium-sized psittacines, the cardiac silhouette on a ventrodorsal radiographic projection should be 35 to 41% of the length of the sternum, 51 to 61% of the width of the thorax, and 545 to 672% of the width of the coracoid. (J Am Vet Med Assoc 2002;221:76–79)

In birds, cardiomegaly may be a result of primary (eg, congenital defects) or secondary (eg, poxvirus infection, myxomatous valvular degeneration, endocarditis, hemochromatosis, chronic anemia, and compression by extrinsic masses) cardiac disease. However, little has been published on the antemortem diagnosis of cardiac disease in pet birds. Thus, the question has been raised as to whether cardiac disease is rare in pet birds or simply not diagnosed.

For various physiologic and anatomic reasons, physical examination is limited in birds, compared with dogs and cats. Thus, radiology is commonly performed in avian medicine. However, appropriate evaluation of radiographs depends on knowledge of the normal size and position of the internal organs. Information on variations in size and position of the abdominal organs of birds has been published, but surprisingly little is known about the size of the avian heart, even though reference values for cardiac size in humans and mammalian pets have been available for several years. Standard values for measurements of cardiac size in red-tailed hawks (Buteo jamaicensis), screech owls (Otus asio), and Canadian geese (Branta canadensis) have been published, but these birds are rarely examined by veterinarians in private practice. One author has suggested that in Amazon parrots, the width of the cardiac silhouette measured on a ventrodorsal radiograph projection at the level of the atria should be approximately 50% of the width of the coelom cavity measured at the level of the fifth thoracic vertebra. However, because of the lack of data on the normal size of the cardiac silhouette on thoracic radiographs of pet birds, the diagnosis of cardiomegaly is often subjective and based on individual experience. The purpose of the study reported here, therefore, was to determine reference values for size of the radiographic cardiac silhouette in psittacines commonly examined by veterinarians in private practice.

Materials and Methods

Fifty-nine adult psittacines were used in the study, including 46 African grey parrots (Psittacus erythacus), 7 Senegal parrots (Poicephalus senegalus), and 6 orange-winged Amazon parrots (Amazona araus). For all birds, results of a physical examination and electrocardiogram-triggered echocardiography, performed as described, were normal. None of the birds had any signs of cardiovascular disease.

Birds were anesthetized with isoflurane in oxygen (flow rate, 1 L/min), and ventrodorsal and lateral radiographic projections were obtained, as described, with a commercial x-ray unit and film (45 kV; 10.0 mAs). The focus-film distance was 80 cm.

Positioning for the ventrodorsal radiographic view was considered to be adequate if the sternum and spine were superimposed and the wings were symmetrical; radiographs were used only if positioning was adequate. On the ventrodorsal radiographic projection, the maximum width of the cardiac silhouette, the width of the thorax at the level of the maximum width of the cardiac silhouette, and the width of the coracoid just caudal to the facies articularis humeralis were measured with a vernier calliper (Fig 1). The length of the cardiac silhouette could not be measured on this projection because positioning of the cardiac apex between the left and right lobes of the liver made it impossible to distinguish the cardiac apex.

On the lateral radiographic projection, the heart was superimposed on the sternum and proventriculus, making it impossible to measure the width of the cardiac silhouette. Similarly, the cardiac apex was superimposed on the liver, making it impossible to measure the length of the cardiac silhouette. Therefore, no measurements were made on the lateral radiographic projections.

On each bird, the length of the sternum was directly measured from the palpable apex of the carina to the palpable caudal end of the sternum.
Data analysis—Variables analyzed included width of the cardiac silhouette, width of the thorax, width of the coracoid, and length of the sternum, along with the ratio of the width of the cardiac silhouette to the width of the thorax, the ratio of the width of the cardiac silhouette to the width of the coracoid, and the ratio of the width of the cardiac silhouette to the length of the sternum. The Kolmogorov-Smirnov test was used to test for normal distribution, and the SD and coefficient of variation were calculated. The Mann-Whitney test for paired samples was used to test for correlations between width of the cardiac silhouette and width of the thorax, between width of the cardiac silhouette and width of the coracoid, and between width of the cardiac silhouette and length of the sternum; scatterplots were created and linear regression analysis was performed. Analysis of variance was used to test for differences between species. All analyses were performed with standard software. Values of $P < 0.05$ were considered significant.

Results

For all birds, mean cardiac silhouette width-to-sternum length ratio was 38%, mean cardiac silhouette width-to-thorax width ratio was 55%, and mean cardiac silhouette width-to-coracoid width ratio was 600% (Table 1). Width of the cardiac silhouette was strongly correlated with length of the sternum ($r = 0.92$; Fig 2), width of the coracoid ($r = 0.84$; Fig 3), and width of the thorax ($r = 0.85$; Fig 4). Regression equations were as follows: cardiac silhouette width (mm) = 0.18 + 0.38$ \times$ sternum length (mm); cardiac silhouette width (mm) = 6.24 + 4.51$ \times$ coracoid width (mm); and cardiac silhouette width (mm) = 5.96 + 0.43$ \times$ thorax width (mm). No significant differences between species could be found for any of the variables examined.

Discussion

Results of the present study suggest that in healthy medium-sized psittacines, the cardiac silhouette, measured on the ventrodorsal radiographic projection, should be 35 to 41% of the length of the sternum (measured on the bird), 51 to 61% of the width of the thorax (measured on the ventrodorsal radiographic projection), and 545 to 672% of the width of the coracoid.

Table 1—Measurements obtained for evaluating cardiac size in 59 healthy adult medium-sized psittacines (46 African grey parrots [Psittacus erythacus], 7 Senegal parrots [Poicephalus senegalis], and 6 orange-winged Amazon parrots [Amazona amazonica])

<table>
<thead>
<tr>
<th>Variable</th>
<th>African grey parrots</th>
<th>Senegal parrots</th>
<th>Amazon parrots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>95% CI</td>
</tr>
<tr>
<td>Body mass (g)</td>
<td>501</td>
<td>45</td>
<td>487–514</td>
</tr>
<tr>
<td>Cardiac silhouette width (mm)</td>
<td>27</td>
<td>2</td>
<td>27–28</td>
</tr>
<tr>
<td>Sternum length (mm)</td>
<td>71</td>
<td>3</td>
<td>70–71</td>
</tr>
<tr>
<td>Coracoid width (mm)</td>
<td>4.6</td>
<td>0.3</td>
<td>4.5–4.7</td>
</tr>
<tr>
<td>Thorax width (mm)</td>
<td>49</td>
<td>4</td>
<td>48–50</td>
</tr>
<tr>
<td>CSW:SL (%)</td>
<td>39</td>
<td>2</td>
<td>38–39</td>
</tr>
<tr>
<td>CSW:CW (%)</td>
<td>593</td>
<td>48</td>
<td>578–607</td>
</tr>
<tr>
<td>CSW:TW (%)</td>
<td>56</td>
<td>4</td>
<td>54–57</td>
</tr>
</tbody>
</table>

Cardiac silhouette width, coracoid width, and thorax width were measured on ventrodorsal radiographic projections; sternum length was measured on the individual birds. CI = Confidence interval. CSW:SL = Ratio of the width of the cardiac silhouette to the length of the sternum. CSW:CW = Ratio of the width of the cardiac silhouette to the width of the coracoid. CSW:TW = Ratio of the width of the cardiac silhouette to the width of the thorax.
We found the width of the cardiac silhouette could reliably be measured on the ventrodorsal projection but could not reliably be measured on the lateral projection because of superimposition of the sternum and proventriculus. Length of the cardiac silhouette could not reliably be measured on either projection, because the cardiac apex could not be differentiated from the left and right lobes of the liver. In a previous study involving measurement of the cardiac silhouette in birds, all measurements were also done on the ventrodorsal radiographic projection. Unfortunately, the length of the sternum is not always clearly evident on the ventrodorsal and lateral radiographic projections; therefore, we elected to measure sternum length directly on each bird.

In the first part of this study, we evaluated 46 African grey parrots (mean body mass, 501 g), because this species is often kept by private owners and frequently examined by veterinarians in private practice. We next studied slightly smaller birds (orange-winged Amazon parrots; mean body mass, 357 g) and, in comparing results for these birds with results for the African grey parrots, found no significant differences between these 2 species. Therefore, representatives of an even smaller species (Senegal parrots; mean body mass, 143 g) were evaluated to determine whether reference values for medium-sized psittacines could be developed. Once again, no significant differences between species were found.

Because cardiac disease is more frequent in cage and aviary birds than previously thought, it is not easy to select healthy birds for evaluation of reference values. Therefore, an echocardiographic examination was performed in addition to a detailed physical examination in all birds. Furthermore, in all birds, an electrocardiogram was recorded during echocardiography. None of the birds used in this study had any signs of cardiovascular disorders.

Significant correlations between width of the cardiac silhouette and length of the sternum, width of the coracoid, and width of the thorax were found in the present study. Therefore, these values should be useful when evaluating cardiac size in birds. Because width of the coracoid was the smallest value measured, measurement errors became most evident for this value. Thus, length of the sternum and width of the thorax should preferentially be used.

Results of the present study suggest that a cardiac silhouette width-to-sternum length ratio of 35 to 41% and a cardiac silhouette width-to-thorax width ratio of 51 to 61% can be used as reference values when examining ventrodorsal radiographic projections of medium-sized psittacines. According to Hanley et al. the width of the cardiac silhouette should be 47 to 57% of the width of the thorax in Canadian geese. Thus, our findings support the hypothesis that smaller birds have a relatively bigger heart than do larger ones.

Currently, little is known about the effect of various factors on measurements of cardiac size in birds. Further examination is needed to determine to what extent the amount of pericardial fat and the degree of distension of the digestive tract and air sacs might influence the measurements. In the present study, the coefficient of variation for the ratio of cardiac silhouette width to thorax width was < 7.1%, even though we did not attempt to standardize phase of the respiratory cycle when performing radiographic exposures. Thus, the influence of thoracic movements associated with respiration may not have as big an influence on measured ratios as might be suspected.

Further studies are needed to determine to what extent ratios measured in the present study can be used to discriminate between normal cardiac size and cardiomegaly in birds. Reference values for results of echocardiography in psittacines have been established, and these values may be helpful in determining the clinical usefulness of cardiac radiography in cage and aviary birds. Nevertheless, practitioners should not use radiographic measurements alone to determine whether cardiac size is normal or abnormal in birds. Aberrations in these ratios, however, may be an indication that further cardiac examinations should be performed.
References

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