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Comparative Gross Anatomical Features of the Sternum of Black Swan (*Cygnus atratus*) and the Domestic Fowl (*Gallus gallus*)

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Abstract

The present study was undertaken to provide a reference for the comparative gross anatomy of the sternum of the Black swan and the domestic fowl. The sternums of Black swan and fowl were procured from the postmortem room of the Department of Veterinary Pathology, College of Veterinary Science, Rajendranagar, Hyderabad and was macerated by wet method of maceration. The sternum showed two surfaces, two extremities and two borders. The anterior border of the sternum of swan was thick and convex while it was thin and triangular in the domestic fowl. The lateral border was concave and was seen with seven articular cylinders for the sternal ribs in swan while in fowl there were four articular facets. Craniolateral process was a short, flat and irregularly quadrilateral in Swan while it was large in the domestic fowl. The posterior extremity or metasternum also showed an irregularly quadrilateral plate with a notch in its middle while such notch was not seen in the domestic fowl. The two caudolateral processes were found in the fowl and single caudolateral process was noticed in the swan. The width to height ratio in swan was 1.57 mm in swan and 0.6mm in fowl.

Keywords: Black Swan, Domestic Fowl, Keel

Introduction

The anatomy of the sternum in avian species differs according to their movement and particularly flight capability, as well as species and habitat. Flight ability is a key feature of the evolutionary diversification of birds. However, it also places various constraints on their anatomy and physiology which may lead to morphological specializations. The family Anatidae (ducks, geese, swans, and allies) is characterized by the frequent loss of flight ability. Among ~160 modern species of Anatidae, 5 species are known to be flightless (Junya W., 2017). Ample information is available on the gross anatomy of sternum of domestic fowl but it is lacking on comparative aspects of sternum of aquatic birds such as the swan. A study was undertaken to provide a reference for the gross anatomy of the sternum of the Black swan and also to compare the structural differences with the sternum of fowl.

Materials and Methods

The study was conducted on two adult Black swan and four adult domestic fowl. The sternum along with pectoral muscles were procured from the postmortem room of the Department of Veterinary Pathology, College of Veterinary Science, Rajendranagar, Hyderabad and were macerated by wet method of maceration. The disarticulated sternum was cleaned and utilized to study the gross anatomical features. Morphometrical measurements were obtained using a vernier callipers.

Results and Discussion

Sternum of swan was an irregularly quadrilateral bone positioned at the antero ventral aspect of the body. The sternum was rectangular with very shallow dorsal surface in duck (Kumar and Singh, 2014) and bowl shaped in emu (Jayachithra *et.al.,* 2015). Fowler (1991) described soup plate like sternum in emu. The sternum showed two surfaces, two extremities and two borders. The dorsal surface was concave and the ventral surface was convex which gave a broad surface for attachment to the breast muscles. Further the dorsal surface showed numerous small pneumatic foramen in the middle and lateral aspects of dorsal surface of sternum nearer to its anterior border. Anterior two third of the dorsal (visceral) surface presented numerous pneumatic foramina in the green winged Macaw among which three near the anterior border were prominent (Sreeranjini *et.al.,* 2015). Nickel *et al*. (1977) reported the presence of a single large pneumatic foramen behind the cranial border of sternum in the domestic fowl. Pneumatisation was comparatively more in swan than in the domestic fowl which were similar to the observations of Hogg (1984) who reported low incidence of pneumatisation in the adult domestic fowl (Fig. 1). These foramina were also observed in turkey and duck but were absent in emu (Jayachithra *et al.,* 2015). Pneumatic foramina communicated with clavicular air sac and helped to lower the wing load without loss of strength.

Figure 1: Photograph showing the dorsal surface of sternum of Black swan (a) and domestic fowl (b) 1. Craniolateral process 2. Caudolateral process 3. Anterior extremity 4. Posterior extremity

The ventral surface was encroached by keel which was in agreement to the observations in duck and turkey (Nickel *et al*., 1977). However, the keel/sternal crest was prominent just beneath the anterior extremity in swan but started way behind the anterior extremity in the domestic fowl. On either side of the sternal crest, a low ridge extending obliquely from anterior end to the posterior one third on the ventral surface of sternum was observed in swan which

was not observed in fowl. The sternal crest gradually decreased in size towards the metasternum in both the species but not to the end of the metasternum in swan. Ventral border of sternal crest was convex, thick anteriorly and thereafter uniform in thickness posteriorly. The ventral border of the sternal crest was concave and thick and presented a ridge in the middle extending halfway in the middle and divided into two which were continuous with the ridge on either side of the sternal crest in swan. In the anterior end just above the articular areas of coracoid bone a small blunt triangular projection was found on either side (Fig. 2).

Figure 2: Photograph showing keel (arrow) on the ventral surface of sternum of *(a)* Black swan and *(b)* domestic fowl

According to Mc Lelland (1990), keel was prominent in birds with well-developed powers of flight and it gave attachment to the two important flight muscles namely pectoral and supracoracoideus. So, the extent of development of the keel bears direct relation with the extent to which a bird moves its wings, whether in flight or in swimming. Birds that fly by stroke of wings had large breast muscles and correspondingly large sternum. This explained the larger size of the sternum of swan while birds like the domestic fowl requiring greater muscle power to take off quickly or to fly at low speeds have large keels. The anterior border in the sternum of swan was thick and convex similar to that of duck and goose (Nickel *et al*., 1977). Nevertheless, it was thin and triangular in the domestic fowl which were similar to the observations in pigeon and Pariah Kite by Tomar *et al.* (2011). The facets for coracoid were deeply concave with thin edges and were located immediately below the anterior border in swan (Fig. 3)

Figure 3: Photograph showing facets for coracoid (1) in the anterior border of sternum of Black swan (a) and domestic fowl (b).

The lateral border was concave and had seven articular cylinders for the sternal ribs in swan. The lateral border was comparatively smaller and presented four depressions for the sternal ribs in fowl. The sternum of goose bears 6-7 facets and that of Ostrich and Rhea contains six and four facets respectively (Predoi *et al*., 2009). Between these articular areas, pneumatic foramina which led into the sternum were noticed (Jagapathi *et al*., 2007) which was in similar to our findings. At the junction of anterior and lateral border on either side, a short, flat irregularly

quadrilateral craniolateral process was noticed (Fig. 4). In fowl the craniolateral process was very large. This process was very short in pigeon and small in duck and goose (Nickel *et al*., 1977). Craniolateral processes in emu were short, wide and flattened (Jagapathi *et al*., 2007). The posterior extremity or metasternum also showed an irregularly quadrilateral plate with a notch in its middle. On either side of the junction of caudal border with the lateral border a long caudally directed caudolateral process, inclining medially was present. The two caudolateral processes were found in the fowl and single caudolateral process was found in the swan (Fig.1).

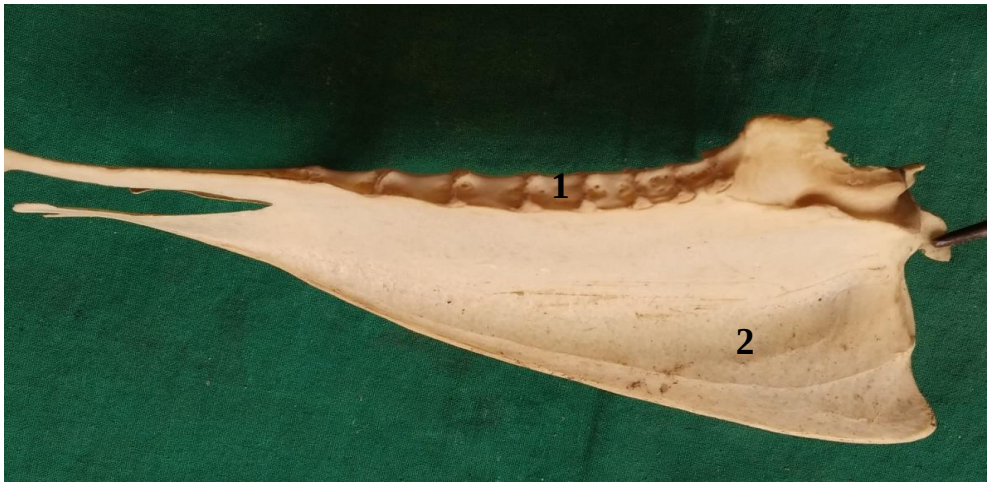

Figure 4: Photograph showing facets for ribs (1) and keel (2) in the lateral border of sternum of Black swan

According to Ahyan *et al.*, 2006 the width to height ratio was reported as 1.56-1.95 mm in the swimming group, 0.96-1.35 mm in the flying group, and 0.50-0.68 mm in the walking group. In the present study the width to height ratio was1.57 in swan and 0.69 in the fowl which coincides with their findings that swan belongs to the swimming group and fowl to the walking group.

Conclusion

Present study showed that the sternum of swan can be differentiated from the sternum of fowl by differences in size, seven articular facets, broader keel, shorter craniolateral process and presence of a single undivided caudolateral process.

Conflict of Interests

There is no conflict of interest.

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