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Gross Anatomical features and Osteometric measurements of the Humerus of Indigenous Poultry of Poonch Region

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ABSTRACT

The present study revealed the gross morphology and osteometric parameters of the humerus in indigenous poultry of the Poonch region (N=06). The humerus was a long pneumatic bone with broad, cranio-caudally flattened proximal extremity. It presented transversely elongated head with two distinct tubercles. Ventral tubercle was larger than the dorsal one and was separated from the head by a distinct bicipital groove. The pneumatic foramen was located below the ventral tubercle. The dorsal tubercle continued as a prominent lateral delto-pectoral crest, whereas the bicipital crest originated from the ventral tubercle. The shaft was cylindrical and slightly S-shaped. The distal extremity consisted of a larger lateral ulnar condyle and a smaller medial radial condyle separated by inter-condylar groove. The ulnar epicondyle was larger than the radial one. The caudal aspect of distal extremity presented olecranon fossa whereas brachial fossa was located cranially. Osteometric data revealed consistent bilateral symmetry. The proximal extremity exhibited the greatest width, while the shaft showed the least. The humeral head exhibited an elongated shape, as indicated by an eccentricity value close to 1. Correlation analysis revealed a strong positive relationship between humeral length and midshaft width. A significant negative correlation was observed between the smaller diameter of the humeral head and the e-value. These findings provided baseline anatomical and morphometric data that will be valuable for comparative anatomy, breed characterization, and functional adaptation studies in indigenous poultry, contributing to veterinary education and avian skeletal research.

Keywords: Humerus, osteometry, morphology, poultry, supra-condyloid fossa

INTRODUCTION

The Union Territory of J&K belongs to the greater Himalayan mountain range which exerts significant influence on its agro-climatic conditions. District Poonch has a humid, subtropical climate which is much cooler than rest of India due to its moderately high elevation and northerly position. Indigenous poultry rearing provides sustainability to the local people. The indigenous poultry of Poonch region weighs about 2.1-2.5 kg (cock) and 1.6-1.8 kg (hen). Females are combless whereas males present red coloured comb and can survive well in temperature of 0° C. The avian forelimb is specialized for flight, with its bones modified to form the wings that articulate with the body at the glenoid cavity supported by the junction of three bones namely, scapula, coracoid and the clavicle (Vistro *et al.*, 2015). Humerus forms an important part of wing skeleton which at one end is attached to the main thorax via the scapula, and at the other end to both ulna and the radius (Hilderbrand and Goslow, 2001). Previous studies by Middleton and Gatesy (2000) highlighted the functional and evolutionary significance of the humerus, particularly its relative proportion within the forelimb with flightless birds exhibiting comparatively longer humeri. Despite such insights, detailed anatomical descriptions of the humerus in indigenous poultry breeds of Poonch region remained limited. Therefore, the present study was undertaken to provide a detailed investigation on the structure of the humerus bone, offering baseline data for further anatomical and functional studies.

MATERIALS AND METHODS

The present study was conducted on the left and right humerus bones of indigenous poultry of Poonch region. Carcasses of 06 birds were obtained from Division of Animal Genetics and Breeding, F.V.Sc & A.H., SKUAST-Jammu. Immediately

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after collection, the bones were processed as per the standard techniques (Raghavan, 1964) and used for recording various morphological characteristics and biometrical parameters. The following biometrical parameters were recorded: 1.Maximum length (cm), 2.Width (cm) at proximal extremity, mid of the shaft and distal extremity,3.Length (cm) of delto-pectoral crest 4. Greater and lesser diameter (cm) of head, 5. Eccentricity of head was calculated as per Zedda *et al* (2016). The lesser diameter was considered as minor semiaxis of ellipse (b) and greater diameter was considered as major semiaxis of ellipse (a). The degree of eccentricity was calculated according to the following mathematical formula: e = $\sqrt{1-b^2/a^2}$ The value of eccentricity lies between 0 and 1 (0 < e < 1). When the eccentricity is 0, the figure is round and when the value of eccentricity is towards 1, the figure becomes more elongated. All the data was subjected to standard statistical analysis (Snedecor and Cochran, 2004). Pearson Correlation was used to determine the association between different parameters.

RESULTS AND DISCUSSION

Gross morphology

In present study, humerus was a strong, cylindrical long bone forming a major structural component of the wing. When the wing was at rest, the humerus was oriented parallel to the thoracic vertebrae whereas during functional positioning, humerus was directed obliquely downward and backward, extending between the scapula proximally and the radius and ulna distally as observed by Rajalakshmi *et al.* (2020). In present study, the humerus consisted of a well-defined shaft and two expanded extremities consistent with the observations by Tiwari *et al.* (2011) in Pariah kite and Vistro *et al.* (2015) in commercial broiler and desi chicken.

Proximal extremity presented transversely elongated head with two distinct tubercles (Fig. 1). Ventral tubercle was larger than the dorsal one and was separated from the head by a distinct bicipital groove as earlier reported by Nickel *et al.* (1977) in domestic fowl. However, Rajalakshmi *et al.* (2020) in emu reported shallow depression separating head and tubercle. The dorsal tubercle continued as a prominent lateral delto-pectoral crest, whereas the bicipital crest originated from the ventral tubercle.The shaft was cylindrical and slightly S-shaped (Fig. 1). Mayr and Mourer (2000) reported slightly curved shaft of humerus in Rollers (Aves: Coraciiformes s.s.) whereas Tiwari *et al.* (2011) reported that the shaft of the humerus of Parah kite was long and semicylindrical in shape. In present study, the shaft exhibited four distinct surfaces corroborating with the observations by Vistro *et al.* (2015) in commercial broiler and desi chicken and Rajalakshmi *et al.* (2020) in emu. The anterior surface was characterized by presence of delto-pectoral crest in its proximal region (Fig. 2), indicating the site of muscle attachment. This observation was consistent with the findings of Kumar and Singh (2014) and Rajalakshmi *et al.* (2020) in emu, who also reported a well-developed crest in a similar location. Konig *et al.* (2009) in domestic fowl reported two flattened surfaces, termed cranial and caudal. The posterior surface presented a large pneumatic foramen towards proximal extremity below the ventral tubercle (Fig. 1) similar to the findings of Nickel *et al.* (1977) in domestic fowl. However, Rajalakshmi *et al.* (2020) in emu reported a small pneumatic foramen.

The distal extremity consisted of a larger lateral ulnar condyle and a smaller medial radial condyle separated by inter-condylar groove (Fig. 3). These findings were in agreement with earlier observations in domestic fowl by McLelland (1990). The ulnar epicondyle was larger than the radial one. The caudal aspect of distal extremity presented olecranon fossa whereas brachial fossa was located cranially.

Biometry

The biometrical observations of the left and right humerus revealed a high degree of bilateral symmetry (Table 1), as evidenced by the close similarity in all measured parameters and the non-significant p-values ($p > 0.05$). The overall length of the humerus was recorded as 8.74 ± 0.057 cm on the left side and 8.71 ± 0.045 cm on the right side. This suggested uniform growth and development of the humerus on both sides of the body. In comparison, the humeral length has been reported as 12 cm in Pariah kite (Tiwari *et al.*, 2011) and 10 cm in emu (Rajalakshmi *et al.*, 2020). Similarly, the width at different regions of the bone showed consistent values between the left and right humerus. At the proximal extremity, the width was 2.23 ± 0.034 cm on the left and 2.22 ± 0.036 cm on the right. At the midshaft, it measured 0.84 ± 0.016 cm on the left and 0.86 ± 0.016 cm on the right, while at the distal extremity, it was 1.69 ± 0.009 cm on the left and 1.70 ± 0.058 cm on the right. These findings indicated slight narrowing at the shaft and expansion at both ends, a characteristic feature of long bones adapted for strength and mobility. Comparable morphometric trends were reported by Tiwari *et al.* (2011) in Pariah kite, he recorded humeral circumferences of 4.50 cm at the proximal end, 2.30 cm at the midshaft, and 3.90 cm at the distal end. Similarly, Rajalakshmi *et al*. (2020) in emu documented widths of 1.9 cm at both proximal and distal extremities and 0.8 cm at the midshaft. In present study, the length of the delto-pectoral crest, an important site for muscle attachment, was nearly identical on both sides, measuring 1.55 ± 0.015 cm on the left and 1.54 ± 0.025 cm on the right.

Measurements of the humeral head further supported this bilateral uniformity. The smaller diameter of the head was 0.99 ± 0.007 cm on the left and 0.99 ± 0.011 cm on the right, while the greater diameter was 1.46 ± 0.013 cm and 1.46 ± 0.009 cm, respectively.

These identical values indicate a consistent shape and articulation surface on both sides, which is essential for smooth and coordinated joint movement at the shoulder. The e-value was also similar on both sides, recorded as 0.74 ± 0.004 on the left and 0.74 ± 0.007 on the right, further reinforcing the absence of any significant asymmetry. Overall, the biometry demonstrated that there was no statistically significant difference between the left and right humerus for any of the measured parameters. This bilateral symmetry highlighted normal anatomical development and suggested that both the wings were equally adapted for function.

Correlation

Correlation analysis (Table 2) revealed that among all measured parameters, the only strong and statistically significant relationship ($P<0.01$) was observed between the total length of the humerus and the midshaft width ($r=0.813$), indicating coordinated growth and structural reinforcement of the bone. All other correlations among humeral measurements were weak to moderate and statistically non-significant, suggesting limited interdependence among these parameters. In the humeral head measurements (Table 3), a statistically significant negative correlation ($r = 0.701$, $P < 0.05$) was observed between the smaller diameter of the head and the e-value, indicating its influence on overall head morphology. The relationships between the greater diameter and other parameters were weak and not statistically significant. Due to the scarcity of comparable literature, detailed discussion of the observed correlations was not undertaken.

CONCLUSION

The present study concluded that the humerus was a well-developed, cylindrical long bone showing typical avian adaptations with distinct structural features that support wing function. The biometrical analysis revealed a high degree of bilateral symmetry, indicating uniform growth and equal functional adaptation of both wings. Correlation studies demonstrated a strong positive association between humeral length and midshaft width, emphasizing the importance of shaft robustness in maintaining mechanical strength. Additionally, the significant negative relationship between the smaller diameter of the head and the e-value highlighted its role in determining head morphology. Overall, the study provided baseline anatomical and morphometrical data for indigenous poultry, contributing to the limited existing literature.

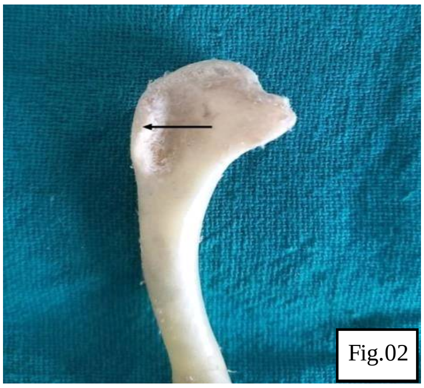

Fig. 1 Photograph of humerus of indigenous poultry showing head (1), ventral tubercle (2), pneumatic foramen (arrow head), shaft (3); **Fig. 2** Photograph of humerus of indigenous poultry showing delto-pectoral crest (arrow); **Fig.3** Photograph of distal extremity of humerus of indigenous poultry showing ulnar (u) and radial (r) condyle

Table 1 Gross biometrical parameters of left and right humerus bone of indigenous poultry

Parameter		Left humerus	Right humerus	P-value
Length		8.74 ± 0.057	8.71 ± 0.045	0.642
Width	**Proximal extremity**	2.23 ± 0.034	2.22 ± 0.036	0.792
	Mid of the shaft	0.84 ± 0.016	0.86 ± 0.016	0.616
	Distal extremity	1.69 ± 0.009	1.70 ± 0.058	0.847
Length of delto-pectoral crest		1.55 ± 0.015	1.54 ± 0.025	0.655
Antero-posterior diameter of head		0.99 ± 0.007	0.99 ± 0.011	0.618
Transverse diameter of head		1.46 ± 0.013	1.46 ± 0.009	0.917
e-value		0.74 ± 0.004	0.74 ± 0.007	0.687

Table 2 Correlations of different parameters of humerus bone

	Length	**Width Proximal extremity**	**Width Mid-shaft**	**Width Distal extremity**	**Length of Delto-pectoral crest**
Length	-	0.00746	0.813**	0.213	-0.409
Width Proximal extremity		-	-0.446	-0.56	0.406
Width Mid-shaft			-	0.469	-0.545
Width Distal extremity				-	-0.567

$**P<0.01$

Table 3 Correlations of different parameters of head of humerus bone

	Greater diameter of head	**Smaller diameter of head**	**e-value**
Greater diameter of head	-	0.377	-0.701*
Smaller diameter of head		-	0.374

$*P<0.05$

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