International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(11): 202-205
www.biochemjournal.com
Received: 22-08-2025
Accepted: 25-09-2025

Jasvinder Singh Sasan
Assistant Professor, Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Suraj Amrutkar
Assistant Professor, Division of Livestock Farm Complex, SKUAST-J, Jammu and Kashmir, India

Shalini Suri
Professor, Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Kamal Sarma
Professor and Head, Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Lovish Sethi
Ph.D. Scholar, Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Haneet Singh
M.V.Sc., Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Corresponding Author:
Jasvinder Singh Sasan
Assistant Professor, Division of Veterinary Anatomy, SKUAST-J, Jammu and Kashmir, India

Morphometrical studies on the pelvic bones in guinea fowl (*Numida meleagris*)

Jasvinder Singh Sasan, Suraj Amrutkar, Shalini Suri, Kamal Sarma, Lovish Sethi and Haneet Singh

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i11c.6214

Abstract
The present study investigated the gross anatomical structures of the pelvic bones in the guinea fowl (*Numida meleagris*), focusing on the ilium, ischium, and pubis, all of which were fused with the synsacrum to form a rigid support structure. This fusion, consistent with adaptations for bipedal locomotion, was similar to that observed in several avian species including the chicken, bar-headed goose, and cattle egret. The ilium was the largest bone, divided into pre-and post-acetabular parts, both articulating firmly with the synsacrum. The pubic bones remained unfused ventrally, without forming pubic symphysis, an adaptation related to egg-laying and visceral protection. The ischium formed the ilio-ischiatic and obturator foramina in conjunction with the ilium and pubis, respectively. Morphometric data was recorded for the ilium, ischium, pubis, and associated foramina, revealing interspecies variations. The acetabulum was circular and supported by an anti-trochanter, facilitating hip joint stability during locomotion. Overall, the pelvic morphology of the guinea fowl reflects evolutionary specializations for terrestrial bipedalism and internal organ protection, contributing to the broader understanding of avian pelvic anatomy and offering valuable reference data for veterinary and comparative anatomical studies.

Keywords: Guinea fowl, ilium, ischium, pubis, synsacrum

Introduction

The pelvic bones in birds is a complex structure composed of three fused bones: the ilium, ischium, and pubis. This composite structure is rigidly fused to the synsacrum-a specialized vertebral complex formed by the fusion of thoracic, lumbar, sacral, and caudal vertebrae-resulting in a stiff and supportive framework [1]. This rigid articulation is crucial for supporting body weight during bipedal locomotion and for providing a stable base for the attachment of hindlimb muscles and support of visceral organs.

Previous studies have documented the gross anatomy of the pelvic bones in various avian species, providing insights into species-specific morphological adaptations. Notable contributions included investigations on the bar-headed goose (*Anser indicus*) [2], owl [3], crested serpent eagle and brown wood owl [4] and common hawk cuckoo and yellow-billed babbler [5]. These studies highlighted the diversity in pelvic morphology related to ecological niches and locomotor behavior among bird species.

However, there is lack of documented anatomical information on the pelvic bones of guinea fowl (*Numida meleagris*). Therefore, this study was undertaken with the aim of generating baseline data that may be useful for anatomical reference, comparative studies, and regional avian biodiversity documentation.

Materials and Methods

The present study was conducted on pelvic bones along with synsacrum of guinea fowl. Carcass was obtained from Division of Livestock Farm Complex, F.V.Sc & A.H., SKUAST-Jammu. Immediately after collection, the bones were processed as per the standard techniques and used for recording various morphological characteristics and biometrical parameters.

Results and Discussion

In present study, the pelvic bones in guinea fowl included three bones, namely the ilium, ischium, and pubis, all of which were fused with the synsacrum (Fig. 1). This configuration aligns with observations in the bar-headed goose (*Anser indicus*) [2], chicken [6] and cattle egret [7]. The rigid union between the pelvic bones and synsacrum formed a strong support structure for the body, an adaptation to bipedal posture [1]. The large size of the hip bones in birds is correlated with their erect, bipedal stance [8]. The pubic bones remained separated ventrally and, therefore, did not formed a pubic symphysis. This absence of a pubic symphysis has been documented in literature and was interpreted as an evolutionary adaptation possibly to facilitate the passage of eggs through the pelvic canal [9]. It was also suggested to facilitate protection of underlying visceral organs [10, 11]. The ostrich (*Struthio camelus*) was one of the few birds that retained a pubic symphysis [12], likely as an adaptation to support the weight of large visceral organs though at the cost of constraining egg size.

The ilium was the largest component, consistent with findings in peafowl [13]. It was elongated and divided into a pre-acetabular and post-acetabular part (Fig. 1), as also reported in the Indian eagle owl [3]. Both parts articulated firmly with the synsacrum, a condition also observed in crested serpent eagle and brown wood owl [4]. However, such fusion was absent in the coturnix quail [14] and pigeon [15], indicating species-specific variation.

The dorsal surface of the pre-acetabular part was concave, bounded dorsally by the dorsal iliac crest, which connected to the fused spinous processes of the synsacrum anteriorly to form the ilio-synsacral crest (Fig. 1). In pigeons, this ridge was formed solely by dorsal spinous processes and extends the entire length of the synsacrum [15]. The lateral crest formed the lateral margin of the pre-acetabular part (Fig. 1). Cranially, the ilium presented a strongly convex border, as similarly observed in peafowl [13].

The post-acetabular part had a slightly convex dorsal surface, with clearly distinguishable dorsal and lateral surfaces, separated by the dorso-lateral iliac crest (Fig. 2). The lateral surface merged with the ischium without distinct demarcation.

The total length of ilium was 10 cm. The pre-acetabular part measured 5.5 cm, was longer than the post-acetabular part at 4.5 cm. In Japanese quail, these parts measured 2.20±0.11 cm and 1.50±0.06 cm respectively [16], indicating substantial interspecies size differences. Longer pre-acetabular parts were reported in peacock (7.5±0.058 cm) and peahen (8.0±0.058 cm) [13]. The distance between the two ilia was 1.1 cm cranially which increased to maximum of 2.56 cm at the level of the acetabulum, then decreased to 1.45 cm at the level of the caudal margin of the ilio-ischiatic foramen.

Ventrally, the ilium was flat anteriorly and fused to the synsacrum. Posteriorly, it formed a distinct renal fossa (Fig. 3) for kidney lodgment, similar to the findings in Indian eagle owl [3] and crested serpent eagle [4]. In contrast, such a depression was absent in emu [17] and bar-headed goose [2], likely due to species variation. The renal fossa was elongated, consistent with reports in yellow-billed babbler, though an oval fossa was noted in the common hawk cuckoo [5]. In the emu, the kidneys rested ventral to the synsacrum and thus were more exposed to trauma [18]. The presence of a renal fossa in the guinea fowl may thus reflect improved protection of the kidneys relative to these other birds.

The ischium was a flat, triangular bone located beneath the post-acetabular part of the ilium (Fig. 2). Similar morphology was reported in the Indian-eagle owl [3] and duck and domestic fowl [12]. By contrast, the ischium of the emu was a long and broad rod-like structure [12, 19], and in ostrich as long but narrow [20], again underscoring species-specific variation. It was thickest at the acetabular region and became thinner and broader caudally, with an oblique convex caudal border, similar to the Japanese quail [16]. The maximum length of the ischium was 4.5 cm, shorter than that reported in peacock (6.2±0.058 cm) and peahen (7.5±0.058 cm) [13], likely due to species-specific factors.

Caudal to the acetabulum, the ischium formed an oval ilio-ischiatic foramen with the ilium (Fig. 2). This foramen transmits the ischiatic nerve [8]. The measured antero-posterior length was 1.89 cm, nearly double its dorso-ventral width of 0.94 cm. In Japanese quail, the corresponding values were 0.8±0.05 cm and 0.4±0.01 cm [16]. In peacock and peahen, the length and width measured 2.0±0.058 cm and 1.25±0.028 cm, and 2.2±0.079 cm and 1.5±0.058 cm, respectively [13].

The ventral border of the ischium along with pubis formed the obturator foramen which was incomplete (Fig. 2). This foramen was smaller than the ilio-ischiatic foramen and acetabulum and was located caudo-ventral to the acetabulum. In emu and duck, the caudal border of the obturator foramen was formed by connective tissue rather than bone, rather than by the pubis as in other birds [12]. The obturator foramen accommodates the obturator nerve and obturator medialis muscle [21], and thus this anatomical variation may reflect differences in locomotor or pelvic musculature adaptations. An ischio-pubic incisure was observed (Fig. 2) similar to the findings in Indian eagle owl [3] and ostrich [20]. The obturator foramen measured 0.67 cm in diameter, values lesser than in peahen (0.95±0.028 cm and 0.5±0.028 cm) [13].

The pubis was a slender, rod-like bone situated along the ventral border of the ischium and extended beyond the level of the ilium and ischium (Fig. 2). The curved length of pubis was 7.5 cm. In contrast, in emu, the pubis does not extend beyond these levels [17]. The pubic tubercle was pointed, projecting downward and forward from the acetabulum (Fig. 2). In peafowl, the tubercle was rudimentary [13], while in the common hawk cuckoo, it was absent [5]. Such differences in pubic projection likely reflect variations in pelvic architecture associated with body size, posture, and locomotive style.

In present study, the ilium, ischium and pubis together contributed to the formation of the acetabular foramen which was circular (Fig. 2), serving as the articulation site for the femoral head, and was closed by a translucent acetabular membrane, consistent with previous observations in Japanese quail [16] and birds in general [1]. An anti-trochanter was present on the caudo-dorsal aspect of the acetabulum, forming a facet for articulation with the greater trochanter of the femur. This articulation enables perching on one leg and helps distribute mechanical stress, limiting excessive hip joint motion [1, 3, 7, 22]. A prominent antitrochanter was observed in pelicans [23], cattle egret [7] and owl [3]. The maximum diameter of the acetabulum was 1.05 cm, close to that observed in peacock (1.15±0.029 cm) [13], and considerably larger than in Japanese quail (0.40±0.02 cm) [16].

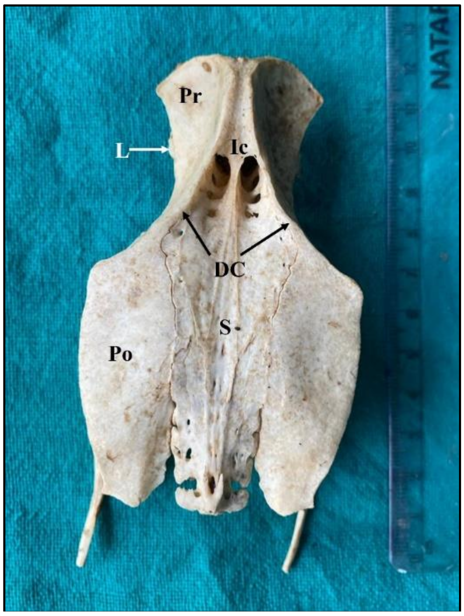

Fig 1: Photograph of dorsal aspect of os-coxae showing pre-acetabular (Pr) and post-acetabular part (Po) of ilium, synsacrum (S), dorsal iliac crest (DC), lateral crest (L) and ilio-synsacral crest (Ic)

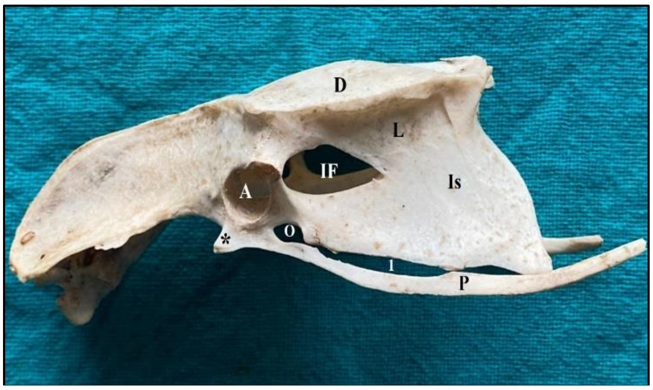

Fig 2: Photograph of lateral aspect of os-coxae showing dorsal (D) and lateral (L) surfaces of post-acetabular part of ilium, ischium (Is), obturator foramen (O), acetabulum (A), ilio-ischiatic foramen (IF), pubis (P), pubic tubercle (*) and ischio-pubic incisure (1)

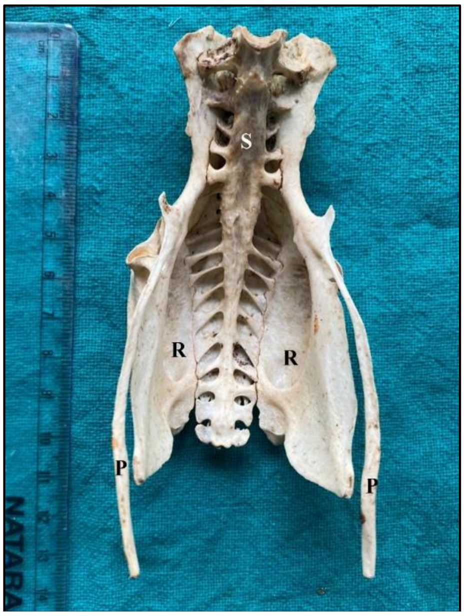

Fig 3: Photograph of ventral aspect of os-coxae showing synsacrum (S), renal fossa (R) and elongated pubis (P)

Conclusion

In conclusion, the gross anatomical structure of the pelvic bones in the guinea fowl demonstrated significant adaptations for terrestrial locomotion and body support. The extensive fusion of vertebrae in the synsacrum, in conjunction with the broad, firmly articulated pelvic bones, offered a rigid framework essential for weight-bearing and movement. The distinct morphology of the ilium, ischium, and pubis reflects the bird's evolutionary specialization for bipedal gait and internal organ protection. These findings contributed to the broader understanding of avian pelvic anatomy and may serve as a reference for veterinary anatomy and avian functional morphology.

References

1. Konig HE, Korbel R, Liebich HG. Avian anatomy: textbook and colour atlas. 2nd ed. 5m Publishing; 2016. p. 62-64.
2. Sasan JS, Suri S, Sarma K. Gross anatomical studies on the os-coxae of Bar-headed goose (*Anser indicus*). Indian Veterinary Journal. 2017;94(5):9-10.
3. Sarma K, Suri S, Sasan JS. Gross anatomical studies on os-coxae of Indian eagle owl (*Bubo bengalensis*). Exploratory Animal and Medical Research. 2018;8(2):208-210.
4. Keneisenuo, Choudhary OP, Arya RS, Kalita PC, Doley PJ, Rajkhowa TK, Kalita A. Comparative gross morphological studies on the os-coxae of crested serpent eagle (*Spilornis cheela*) and brown wood owl (*Strix leptogrammica*). Journal of Animal Research. 2019;9(3):439-442.
5. Supriya B, Bharath Kumar ML, Jamuna KV. Comparative morphological study of os coxae and synsacrum bones of common hawk cuckoo (*Hierococcyx varius*) and yellow-billed babbler (*Argya affinis*). International Journal of Current Microbiology and Applied Sciences. 2020;9(10):1284-1288.
6. Tahon RR, Ragab SA, Abdel Hamid MA, Rezk HM. Some anatomical studies on the skeleton of chickens [PhD thesis]. Cairo: Faculty of Veterinary Medicine, Cairo University; 2013. p. 43-80.
7. Resk HM. Anatomical investigation on the appendicular skeleton of the cattle egret (*Bubulcus ibis*). Journal of Experimental and Clinical Anatomy. 2015;14(1):5-12.
8. McLelland J. A colour atlas of avian anatomy. London: Wolf Publishing Ltd.; 1990. p. 26.
9. King G, Custance DR. Colour atlas of vertebrate anatomy: the pigeon. Oxford: Blackwell Science Publications; 1982. p. 5.1-6.1.
10. Kumar P, Singh G. Gross anatomy of wing and pelvic limb bones in emu (*Dromaius novaehollandiae*). Indian Journal of Veterinary Anatomy. 2014;26(2):82-86.
11. Santhilakshmi M, Chandra S, Rao TS, Jagapathi RP, Ravindrareddy Y. Gross anatomical studies on the os coxae and femur of emu (*Dromaius novaehollandiae*). Indian Journal of Poultry Science. 2007;42(1):61-63.
12. Chukkath R, Harshad P, Helna W, Kalaripparambath S. Comparative morphological studies of the pelvic limb bones in ostrich (*Struthio camelus*), emu (*Dromaius novaehollandiae*), domestic fowl (*Gallus gallus domesticus*) and duck (*Anas platyrhynchos domesticus*). Indian Journal of Animal Research. 2019;53(11):1445-1449.

13. Deshmukh SK, Karmore SK, Gupta SK, Kodape S, Prakash R. Comparative biometrical studies on the os-coxae and synsacrum of peacock and peahen. Veterinary Practitioner. 2016;17(1):41-42.
14. Fitzgerald TC. The *Coturnix* quail: anatomy and physiology. Ames (IA): Iowa State University Press; 1969. p. 26-27.
15. Lavanya C, Jayachitra S, Iniyah K, Balasundaram K. Comparative anatomy of os coxae in guinea fowl and pigeon. International Journal of Current Microbiology and Applied Sciences. 2017;6(9):3655-3659.
16. Mehta S, Guha K, Shalini S, Kumar C. Gross anatomical studies on the os-coxae and synsacrum of Japanese quail (*Coturnix coturnix japonica*). Indian Journal of Veterinary Anatomy. 2014;26(2):126-127.
17. Mehta S, Guha K, Singh KK. Gross anatomical studies on the os-coxae and synsacrum of emu (*Dromaius novaehollandiae*). Indian Veterinary Journal. 2013;90(9):79-81.
18. Venkatesan S, Muthukrishnan S, Basha SH, Kannan A, Ramesh G. Gross anatomy of the pelvic girdle of emu. Indian Veterinary Journal. 2008;85:1094-1096.
19. Sridevi P, Rajalakshmi K, Sivakumar M. Gross morphological and morphometrical studies on the pelvic girdle of emu (*Dromaius novaehollandiae*). Journal of Entomology and Zoology Studies. 2020;8(2):271-274.
20. Tamilselvan S, Iniyah K, Jayachitra S, Sivagnanam S, Balasundaram S, Lavanya C. Gross anatomy of os coxae of ostrich (*Struthio camelus*). International Journal of Current Microbiology and Applied Sciences. 2015;4(4):201-205.
21. Maierl J, Liebich H, König HE, Korbel R. Pelvic limb (membrum pelvinum). In: König HE, Korbel R, Liebich HG, editors. Avian anatomy: textbook and colour atlas. 2nd ed. Sheffield (UK): 5M Publishing Ltd.; 2016. p. 62-82.
22. Maina JN. Perspectives on the structure and function of birds. In: Rosskopf W, Woerpel R, editors. Dissection of cage and aviary birds. 3rd ed. Baltimore: Williams & Wilkins; 1996. p. 163-217.
23. Sathyamoorthy OR, Thirumurugan R, Kumar KS, Jayathangaraj MG. Gross morphological studies on the pelvic girdle of spot-billed pelicans (*Pelecanus philippensis*). Indian Journal of Veterinary Anatomy. 2012;24:109-110