



Gross anatomical studies on the pelvic limb bones of white cockatoo (*Cacatua alba*)

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Citation: Sreeranjini, A. R., Ashok, N., Maya, S., Lucy, K. M., Indu, V. R., Sunilkumar, N. S. and Sumena, K. B. 2020. Gross anatomical studies on the pelvic limb bones of white cockatoo (*Cacatua alba*). *J. Vet. Anim. Sci.* **51**(1): 86-90.

Received : 18.09.2019

Accepted : 07.11.2019

Published : 01-01-2020

Abstract

The present study was conducted on the pelvic limb bones of a five year old male umbrella cockatoo. The femur was light in weight and presented a straight shaft, two extremities and four surfaces. The proximal extremity had a head with distinct fovea capitis, neck and indistinct trochanter major, while the distal extremity had a trochlea, two condyles and a wide intercondyloid groove. Patella was a small pea-sized sesamoid bone. The tibiotarsus was the largest of the leg bones and was one third longer than femur. It presented a long shaft with distinct fibular crest and two extremities. Both extremities showed medial and lateral condyles. From proximal extremity, the straight cnemial crest extended ventrally. The condyles of distal extremity were separated by intercondyloid fossa and continued caudally to wide grooved trochlea. Instead of extensor canal in other birds, a deep groove was observed. The fibula was with small head and rudimentary shaft and terminated near the middle of the shaft of tibiotarsus. The tarsometatarsus was extremely short. Its shaft presented convex dorsal surface whereas the plantar surface was concave without ridges. The distal extremity presented three articular trochleae. Between the trochlea for third and fourth digits, a bony canal was noticed. The spur core seen in cockerel was not observed in the present study. Four digits from one to four showed zygodactyl type of arrangement and contained two, three, four and five phalanges, respectively. Distal phalanx in each digit was a claw. The light femur and highly reduced fibula in umbrella cockatoo showed adaptations for flight whereas the positioning of the digits showed adaptation for climbing and grasping.

Key words: Gross anatomy, Hind limb, Pelvic limb, Umbrella cockatoo, White cockatoo

Birds have bipedal locomotion and have diverse anatomy of legs and feet in order to suit their habitat and feeding habit. According to Abourachid (2006), the osteological differences between birds are more adjustments than deep disruptions and the limb shows adaptations like functioning as shock absorbers during landing, or thrusters during taking off. Zeffer *et al.* (2003)

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reported that increase in length of femur helps to increase the step-length and speed in ground species of birds, to decrease the time between last visual contact and impact in the birds of prey and to increase the forward reaching-distance of the feet in tree species of birds. The length of tibia is an indicator of a bird's perching habit.

The white cockatoo or umbrella cockatoo, endemic to tropical rainforests of Indonesia are medium-sized, naturally acrobatic birds with majority of white feathers and pale yellow or lemon colored feathers on the ventral sides of wings. Since they are very affectionate, highly intelligent and easily trained, they have been used in zoos, amusement parks and live animal shows. In the wild, their numbers have been declining due to habitat loss and capture for pet-bird trade. Gross anatomical features of the pelvic limb bones of white cockatoo have not been studied. Hence the present study was conducted to investigate the anatomical features of the pelvic limb bones of white cockatoo and to compare the differentiating features with that of other birds.

Materials and Methods

The present study was conducted on the pelvic limb bones of a five year old, male white cockatoo, brought for post mortem examination to the Department of Veterinary Pathology at College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India. The bird was reported to have anorexia, dyspnoea, melaena and was unresponsive to therapy for seven days. Post mortem examination revealed severe hemorrhagic enteritis, pneumonia, severe haemorrhage in caecal tonsils and congestion in kidneys. From the carcass, the pelvic limb bones were separated by maceration method, 10% to 15% sodium bicarbonate was added for whitening and were dried. Gross anatomical features of the bones were studied and were compared with that of other birds.

Results and Discussion

On each pelvic limb, femur, patella, tibiotarsus, fibula, tarsometatarsus and phalanges with claws constituted the pelvic



Fig.1. Femur of white cockatoo- cranial view

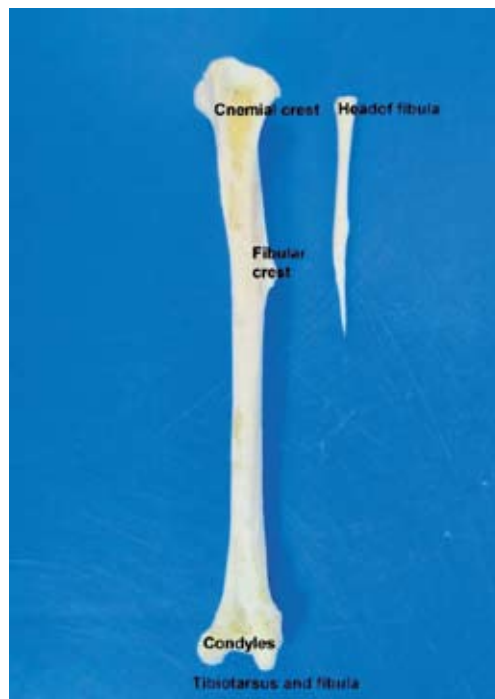


Fig. 2. Tibiotarsus and fibula of white cockatoo - craniolateral view

limb bones.

Femur and Patella: The femur was 5.7cm long and it presented a straight shaft unlike in fowl with two extremities and four surfaces (Fig. 1). The proximal extremity

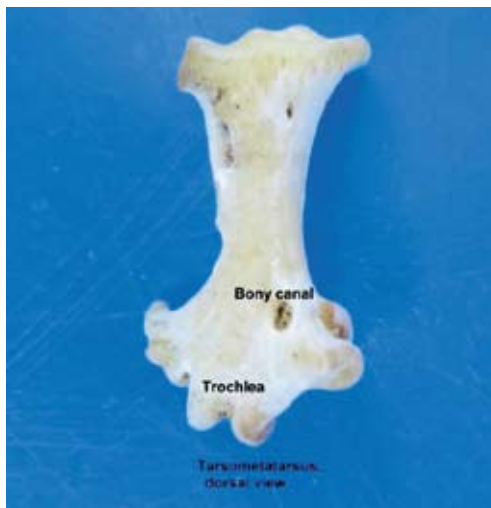


Fig. 3. Tarsometatarsus of white cockatoo - dorsal view



Fig. 4. Phalanges of white cockatoo

presented large head with distinct fovea capitis and neck. Compared to that of fowl, the trochanter major was indistinct but was placed at a higher level than that of head. Distal extremity furnished a trochlea and two condyles separated by a wide intercondyloid groove. But in peacock, the condyles were separated by a shallow intercondyloid groove (Sreeranjini *et al.*, 2013). The medial condyle was placed at a lower level than the larger lateral condyle unlike in fowl which has a larger lateral condyle that

is placed at a lower level (Nickel *et al.*, 1977). Medial division of the latter articulated with tibia while its caudolateral part furnished a facet for fibula. The lateral ridge of trochlea was slightly larger as in chicken and duck. As in peacock, the proximal and distal extremities showed several pneumatic foramina which contributed to the light weight of the bone compared to that of chicken and duck. Compared to the length of the limb, length of femur in white parrot was more. This finding was in agreement with the observations of Gatesy (1991) who noticed that there was negative allometry between total limb length and the length of avian femora. Patella was a small pea-sized sesamoid bone with articular facet for tibia ventrally and femur caudally.

Tibiotarsus and Fibula: It constituted the largest of the leg bones with 8.2cm length (Fig. 2) and was almost one third longer than femur similar to that of fowl and pigeon (Nickel *et al.*, 1977). But in peacock, duck and goose it was almost twice longer than the femur (Sreeranjini *et al.*, 2013). Lateral surface of the shaft furnished a distinct fibular crest in the proximal one third. However, the crest was moderately developed in fowl and coturnix quail, and not well developed in peacock (Sreeranjini *et al.*, 2013). The proximal extremity presented larger medial and smaller lateral condyles similar to that of fowl and the straight cnemial crest extended ventrally. Since it was located more towards the middle of the anterior aspect, the extensor groove was wider as in the peahen (Sreeranjini *et al.*, 2013). The cnemial crest on which the main extensor muscle of the knee joint attaches (Mc Lelland, 1990) extended down up to the proximal one fourth of the shaft unlike in fowl. But in peahen the crest was short and stump compared to that of the domestic fowl and it ended abruptly in the proximal extremity itself (Sreeranjini *et al.*, 2013). Al- Sadi (2012) reported the presence of two cnemial crests in turkey; cranial larger and caudal smaller.

The distal extremity presented large lateral and small medial condyles separated by intercondyloid fossa. The extensor canal seen on the dorsal aspect of the shaft of tibiotarsus near its distal extremity in fowl, peahen (Sreeranjini *et al.*, 2013) and in coturnix quail

(Fitzgerald, 1969) was not observed in white parrot and in its place, a deep groove was noticed. The extensor canal is for the passage of the tendon of extensor muscles of the toes (Mc Lelland, 1990). The condyles continued caudally to constitute a wide grooved trochlea. According to Fitzgerald (1969), the extensive articular surface provided by condyles and trochlea permits great deal of movement of the hock joint.

Fibula was 3.5cm long and presented a small head and rudimentary shaft (Fig. 2). It terminated near the middle of the shaft of tibiotarsus as in coturnix quail and peahen (Sreeranjini *et al.*, 2013). But in fowl, the shaft of fibula extends up to the distal one third of the shaft of tibiotarsus. The shaft of the fibula showed attachment to the fibular crest of tibia. The highly reduced fibula and fusion of tibia with proximal row of tarsals to form tibiotarsus are indicative of adaptations for flight.

Tarsometatarsus: Tarsometatarsus, formed by the fusion of metatarsals II, III and IV, and the distal row of tarsals was extremely short with only 2.6cm length, compared to the fowl (Fig. 3). According to Nickel *et al.* (1977), the length of tarsometatarsus determines the ground clearance of a bird in standing position. So, the short metatarsus of umbrella cockatoo substantiates its very little ground clearance. According to Zeffer *et al.* (2003) in perching birds, stability may be increased by reduction of the length of the legs, especially the tarsometatarsus due to positioning of the centre of mass closer to the substrate. Two concave articular surfaces in proximal extremity articulated with the trochlea of tibiotarsus. Dorsal surface of the shaft was convex whereas the plantar surface was concave and smooth. In fowl, dorsal surface of tarsometatarsus just below the proximal extremity showed a deep groove and plantar surface presented ridges (Nickel *et al.*, 1977). The distal extremity furnished three articular trochleae separated by grooves as in fowl. Each trochlea was divided by a groove and a bony canal was noticed between the trochlea for third and fourth digits as in fowl (Getty, 1975). The spur core seen in cockerel was not observed in the present study.

Phalanges: The umbrella cockatoo presented zygodactyl foot with four digits from one to four and contained two, three, four and five phalanges respectively (Fig. 4). The distal phalanx in each digit was a slender claw and was covered by horny skin in life as in fowl (Getty, 1975). These slender and sharp claws are typical of birds which perch and climb. The first and fourth digits faced backward while the second and third digits were directed forward. When alive, the former are used by the birds to grip the rear of the perch whereas the latter are used to grip the front of the perch. The positioning of the digits in white cockatoo is adaptive for climbing and grasping and is the second most common toe arrangement among birds. Due to zygodactyl foot, they are able to grasp food in one foot and bring it to its beak and can move around branches. From the present study, it could be concluded that the pelvic limb bones of white cockatoo showed adaptations for flight, perching, climbing and grasping.

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