

Gross anatomical studies on hind limb of African Lion (*Panthera leo*)

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Received on: 16/07/2021

Accepted on: 13/10/2021

Published on: 15/10/2021

ABSTRACT

Aim: The study was aimed to investigate the unique morphological features and number of bones making up the region of the animal's skeleton.

Method and Materials: Two (2) adult African lions were obtained as carcass after post-mortem examination at different times for study and cold water maceration was used to extract the bones.

Results: Each Os Coxae presented ilio-pubic eminence immediately lateral to the median pubic tubercle; an iliac tubercle cranial to the acetabulum and a large ellipsoidal obturator foramen. Articular surfaces for fabella articulation, lateral and medial supracondyloid tubercles and shallow supracondyloid fossa were all observed above the distal condyles. The internal articular surface of the patella was restricted to the proximal third while the extensive interosseous space between the tibia and fibula spanned the entire shaft length. The Pes composed of 6 tarsals and 4 long metatarsals which anchored 3 digits with 3 phalanges each. The 3rd phalanx had a unique appearance with a crescent plate projecting from the ventral opening. The total number of bones making up the forelimbs was counted to be 65.

Conclusion: In the study, it was concluded baseline data for future biomedical, archaeological and comparative anatomical studies.

Keywords: African lion, bone, hind limb, phalanx, skeleton.

Cite This Article as: Onwuama KT, Salami SO, Kigir ES and Jaji AZ (2021). Gross anatomical studies on hind limb of African Lion (*Panthera leo*). J. Vet. Res. Adv. 03(02): 07-12.

Introduction

The African lion (*Panthera leo*) is a representative of the family Felidae of the order Carnivora and suborder Feliformia (Wozencraft, 2005). It is closely related to the leopard, tiger and jaguar which are in the same genus *Panthera* (Tseng *et al.*, 2014). It is the largest carnivore and best studied mammalian species in African ecosystem (Bygott, *et al.*, 1979; Packer, *et al.*, 2005; Schaller, 2009) having been in existence for almost 3 million years in Laetoli, Tanzania. (Werdelin *et al.*, 2011). The African Lion (*Panthera leo*) has cultural significance in entertainment; national flag symbols and literatures because of its recognition in Human culture (Hogarth and Butler, 2004; Pinch, 2004). Lions have been kept in exhibition since the time of the Roman Empire and have been kept in zoos worldwide since the late 18th century (Guggisberg, 1975).

Its characteristics, significance and behaviour further increases its interests in scientific investigations with anatomy not excluded; which exposes adaptive features of this species to its feeding and behavioural habits. There is the need to study the shape and size of its forelimb in order to differentiate normal from abnormal and help in designing prosthesis. To this end, this study on the appendicular skeleton (hind limb) has been conducted to establish normal gross features and number of bones making up this region of the animal skeleton. It also serves to enhance better understanding of its features when comparing with other species of felidae.

Materials and Methods

Two adult African lions (*Panthera leo*) weighing 173kg and 112kg were obtained as post-mortem carcasses at different periods from the Department of Veterinary Pathology, University of Ilorin and transported to the Department of Veterinary Anatomy gross laboratory, University of Ilorin, Nigeria for bone preparation as museum specimens. They were carefully de-fleshed using

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sharp knife and scalpel blade to remove the skin and tease out muscle leaving the bones with minimal soft tissue attachment before being transferred to a large container of cold water at room temperature enough to submerge the bones. The container was then covered airtight and placed under shade throughout the period of maceration with a change of water regularly. After completion, the water was drained, the Hind limb bones were recovered, and sun dried. Photographs of bones recovered were taken individually and segmentally after articulation with glue.

Ethical approval

Ethical institutional guidelines were followed to conduct the study.

Results and Discussion

The Hind limb comprised bones of the Ossa coxarum (Ilium, Pubis and Ischium), Thigh (Femur), Leg (Tibia and Fibula) and Pes (tarsals, metatarsals and phalanges). They exhibited general and peculiar features similar to and different from other domestic animals studied. The average number of bones of the forelimb was found to be 65 as given (Table 1).

Table 1: Number of bones of the Hind limb of the Lion (*Pantheraleo*)

Bones	Number
Ossa coxarum	1
Femur	2
Patella	2
Fabella	2
Tibia	2
Fibula	2
Tarsals	12
Metatarsals	8
First phalanx	8
Second phalanx	8
Third phalanx	8
Sessamoid	12
Total average:	65

The ossa coxarum presented two halves joined at the pelvic symphysis. It consisted of 3 different fused bones; ilium cranially, ischium caudally and pubis medially all presenting parts that formed the acetabulum for articulation with the head of femur. The *ilium* was positioned perpendicularly having a lateral smooth concave surface crossed vertically by the gluteal line and a medial rough convex surface with an auricular surface distally for attachment of the wings of sacrum. Its cranial border formed a curved crest. An arcuate line extended from the medial surface of the ilium to

the cranial border of pubis. The psoas tubercle was not visible. The lateral surface of the shaft of ilium presented a large iliac tubercle on its distal third that ended on the acetabulum. The *pubis* presented arms that fused with the ilium cranially and ischium caudally. Its cranial border bore prominent pubic tubercle on each side. A small elevation, the pubic eminence was placed lateral to the pubic tubercle. The *ischium* extended caudoventrally to form the ischial tuber and with its opposite, formed a shallow v-shaped ischial arch caudally. Separating the ischium from the pubis was the large ellipsoidal obturator foramen. The laterally placed acetabulum presented a cotyloid cavity with a single notch.

The Femur was a long bone with a body and two extremities. The proximal extremity presented the head (having a fovea), a well-defined neck medially and the greater trochanter laterally. The greater trochanter divided into a small cranial part and a large caudal part from which the trochanteric crest emanated (creating the trochanteric fossa) curving obliquely to end at the middle adjacent to the lesser trochanter; a rounded projection. Another crest arose laterally from the cranial part of the greater trochanter before terminating laterally on the middle of the shaft. The shaft presented a rather cylindrical shape with a small nutrient foramen on its one third. It presented a shallow supracondyloid fossa and a lateral and medial supracondylar tubercle with the lateral more distinct on its caudal surface. The distal extremity presented the trochlea cranially, the medial and lateral condyles enclosing the intercondylar fossa caudally. The patella presented a cone-like structure with convex dorsal base and lateral and medial borders that converge to form the ventral convex apex. The inner articular surface was smooth and concave occupying most of the proximal part while the external surface was convex and roughened.

The tibia and fibula presented long bones fused at the proximal and distal extremities creating an extensive interosseus space that ran throughout the length. The *tibia* was larger and presented lateral, medial and caudal surfaces at the proximal third of the body while the distal third presented cranial and caudal surfaces. Proximally, the tibia presented lateral and medial condyles each having equal intercondyloid eminences enclosing a depression cranial to the condyles. The tibia tuberosity continued distally as a ridge before terminating at the proximal one third. An extensor groove having

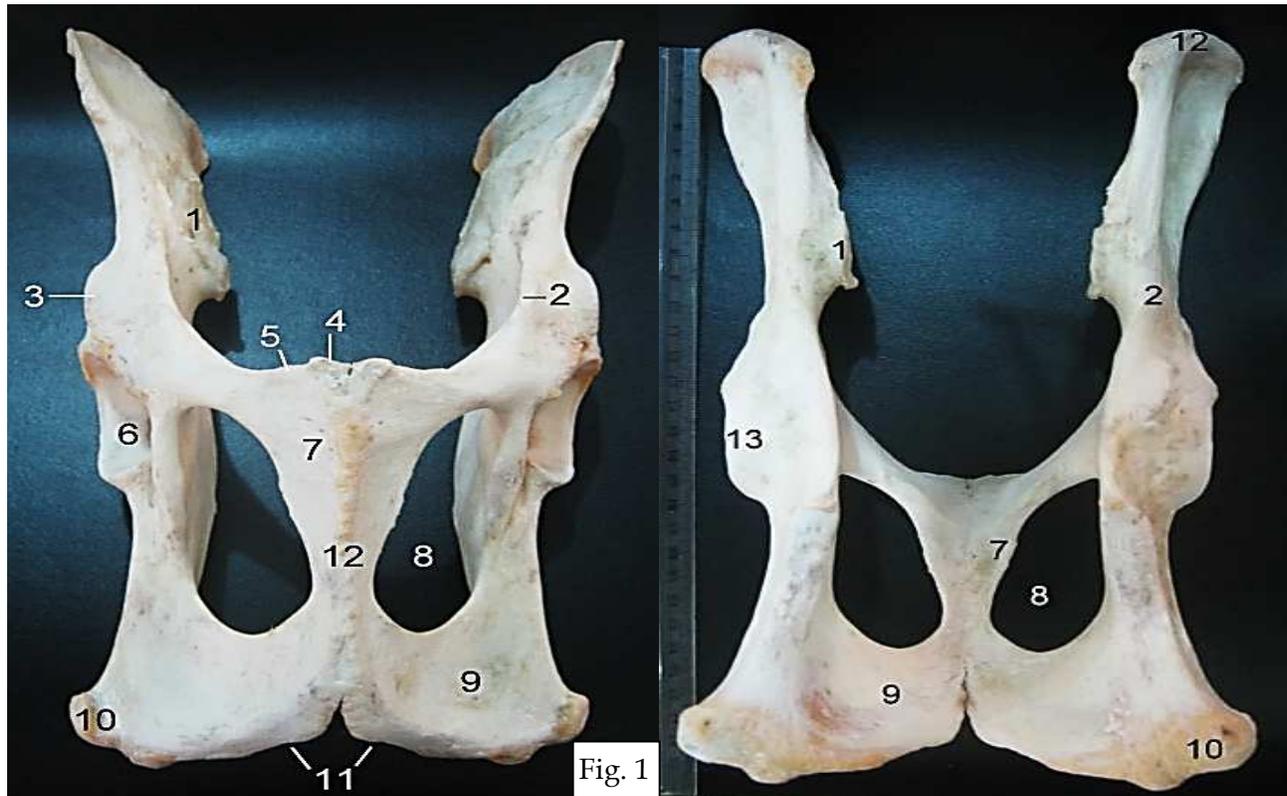


Fig 1: Lion Ossa coxarum (ventral and dorsal views). 1, Auricular surface; 2, Arcuate line; 3, Iliac tubercle; 4, pubic tubercle; 5, ilio-pubic eminence; 6, Cotyloid cavity of acetabulum; 7, Pubis; 8, Obturator foramen; 9, Ischium; 10, Ischial tuber; 11, Ischial arch; 12, iliac crest; 13, Acetabulum.



Fig 2: Lion Femur (cranial and caudal views). 1, head; 2, neck; 3, greater trochanter; 4, shaft; 5, trochlea; 6, trochanteric fossa; 7, trochanteric crest; 8, lesser trochanter; 9, supracondyloid fossa; 10, 11, Medial and lateral supracondyloid tubercles; 12, intercondyloid fossa; 13, medial condyle; 14, lateral condyle.



Fig. 3

Fig 3: Lion Patella (caudal and cranial views). 1, Base; 2, Internal articular surface; 3, Apex;



Fig 4: Lion tibia and fibula (cranial and caudal views). 1, lateral condyle; 2, medial condyle; 3, tibial tuberosity; 4, fibula head; 5, shaft of fibula; 6, shaft of tibia; 7, lateral malleolus; 8, medial malleolus; 9, interosseous space; 10, intercondyloid fossa; 11, extensor groove; 12, popliteal line. **Fig 5:** Lion pes (dorsal and plantar views). I-IV, first to fourth metatarsals; 1, calcaneus; 2, talus; 3, central tarsal; 4, second tarsal; 5, third tarsal; 6, fourth tarsal; 7, first phalanx; 8, second phalanx; 9, third phalanx.



Fig 6: Lion third phalanx (A), with second phalanx articulation (B), with comma shaped claw (C). Lateral views. 1, Cranial extremity; 2, Caudal tubercle; 3, Ventral plate; 4, Third phalanx; 5, Claw.

a popliteal line and was observed on the caudal surface of the proximal one third of the tibia shaft. Distal extremity presented an articular surface marked with two depressions for articulation with the tibia tarsal bone. Laterally it presented a medial malleolus marked with two ridges. The *fibula* was a thin slender bone with the proximal extremity articulating with the lateral condyle of tibia, a twisted body and a lateral malleolus at its distal extremity.

The pes presented three segments; the tarsal, metatarsal and phalangeal bones. The tarsal bones included; The calcaneus, talus, second tarsal, third tarsal, central tarsal and fourth tarsal. The calcaneus was largest of the tarsals bearing the calcaneal tuber at its caudal extremity. The talus bore one condyle on its caudal extremity, it articulated with the calcaneus creating a tiny space between them. The caudal surface of the central tarsal attached to the cranial extremity of the talus. The caudal extremity

of the fourth tarsal attached to the cranial extremity of the calcaneus. The second tarsal bone did not articulate with the third tarsal bone but attached directly with the proximal extremity of the first tarsal bone. The third tarsal was placed between the first and fourth tarsals. Four long metatarsal bones presented proximal and distal extremities that articulated with the distal carpals and proximal phalanges respectively. Three phalanges (proximal, middle and distal) were seen, with the third Phalanx having a characteristic appearance of a capsized boat with a wide convex cranial extremity and a caudal tubercle. The dorsal border was convex cranially before becoming concave caudally upon which the second phalanx articulates. A flat crescent plate (covered by a comma shaped claw in the live animal) projected ventrally from the open ventral border. Two sesamoid bones were located on the ventral surface and one on the dorsal surface of each Metacarpophalangeal joint.

This study presented unique morphological features of the African Lion's hind limb that fell between the feline and canine species. The perpendicular orientation and general features of the Ilium, pubis and ischium of the Ossa coxarum (Pelvic bone) was similar to that reported in cat (Sebastiani and Fisbeck, 2006) and dog (Evans and DeLahunta, 2013). However, slight differences were observed in the position of the ilio-pubic eminence immediately lateral to the pubic tubercle; the presence of an iliac tubercle cranial to the acetabulum and a larger ellipsoidal obturator foramen.

The Femur was also typical of cat and dog presentation having features such as articular surfaces for fabella articulation and lateral and medial supracondyloid tubercles, which may act as areas for muscle attachment or re-enforcement (Konig and Liebich, 2004). However, the presence of a shallow supracondyloid fossa which is absent in the dog was the only slight difference. The Patella was unique with its triangular shape and smooth articular surface restricted to the proximal half only. This particular surface differs from other canine species where the inner surface of the apex also presented a smooth surface for trochlea articulation (Dyce *et al.*, 2010).

The Tibia and Fibula were also typical of the cat and dog. However, the only difference was the extensive interosseous space that spans the entire length. The interosseous space of the dog's tibio-

fibula bone was limited to the proximal third (Adams, 2004).

The number and arrangement of the Pes was also similar to the cat and dog (Adams and Crabtree, 2012). However, unlike the dog the presentation of the last phalanx with a retractile claw as shown in plate 6 was unique and characteristic of the felidae family. Its morphology is an adaptive feature that aids in capturing and holding of its prey (Sebastiani and Fisbeck, 2006). The position and articulation of the second phalanx on the dorsal articular depression of the last phalanx helps in movements such as pronation and supination of this bone.

Conclusions

The study on the gross anatomy of the African Lion's (*Panthera leo*) hind limb bones presented numerical and morphological information on the bones of this animal highlighting specific features, similarities and differences when compared to the canine and feline species.

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