



ANATOMICAL STUDIES ON THE BONES OF THE PELVIC LIMB IN INDIAN MUNTJAC (*Muntiacus muntjak*)

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Abstract

Anatomical studies on the bones of the pelvic limb of three Indian muntjac were carried out. The long axis of ilium and ischium were in the same line and the pelvic floor had a caudal slope. The elliptical pelvic inlet was obliquely placed. The gluteal line was a rounded crest. The iliopubic eminence was a small ridge. The ischiatic spine was tall and sharp. The tuber ischii was large and trituberculate. The rim of acetabulum presented a narrow deep notch. The shaft of femur was curved cranially in the distal third. The trochanter major projected above the level of the head of femur. The medial trochlear ridge was more prominent than the lateral. The supracondyloid fossa was well-developed and the patella was long, narrow and triangular with pointed apex. The popliteal line and the muscular ridges on tibia were less prominent. The medial intercondylar tubercle of tibia was taller. Lateral malleolus was a small quadrilateral bone. The tarsus comprised of tibial tarsal, fibular tarsal, central and fourth fused tarsal, first tarsal and second and third fused tarsal. The shaft of the large metatarsal was distinctly four-sided. The small metatarsal was a quadrilateral sesamoid bone. Two chief digits each with three phalanges and three sesamoids were present. The proximal and middle phalanges were more slender than that of the pectoral limb. The middle phalanx was one-third shorter than the proximal one and the distal phalanx had the shape of a hoof.

Key words: Morphology, pelvic limb, Indian muntjac

The Indian muntjac or barking deer is the most numerous one among the various muntjac deer species. The male Indian muntjac has small, unbranched antlers and tusk-like upper canine teeth. Information about the anatomical peculiarities of the pelvic limb in Indian muntjac is scanty. Hence this study was undertaken to elucidate the anatomical features of the pelvic limb in Indian muntjac.

Materials and Methods

Pelvic limb bones were collected from three Indian muntjac died of natural causes and brought for post-mortem examination to the Department of Pathology, College of Veterinary and Animal Sciences, Pookode. Bones were processed (Young, 1980) for studying the anatomical features.

Results and Discussion

The pelvic girdle comprised of two os coxae each had three bones: ilium, pubis and ischium (Fig. 1). The bone was 16.1 cm long. The pelvic floor formed by pubis and ischium sloped a little caudally as in small ruminants (Getty, 1975). The long axis of ilium and ischium were placed in the same line. The elliptical pelvic inlet was obliquely positioned. The middle transverse diameter of the pelvic inlet and transverse diameter of outlet were 3.8 cm and 2.4 cm respectively. The ilia of both sides were almost parallel and comprised of a broad wing and an elongated shaft as in goat (Nickel *et al.*, 1986). The sacropelvic surface consisted of an extensive rough articular area and a narrow elongated smooth

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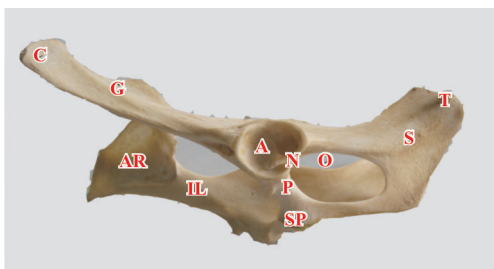


Fig.1. Ventrolateral view of pelvic girdle of Indian muntjac

C- Coxal tuber of ilium, G- Gluteal line, AR- Articular surface, P- Pubis, IL- Iliopubic eminence, SP- Pubic symphysis, S- Ischium, A- Acetabulum, N- Notch of acetabulum, T- Tuber ischii, O- obturator foramen

iliac surface. The gluteal line was a rounded crest parallel to the lateral border of wing of ilium. This concurred with the reports of Nickel *et al.* (1986) in small ruminants where the gluteal line was a rounded crest but disagreed with the observations in cattle where it was indistinct. The arcuate line and the psoas tubercle on the shaft were indistinct. The crest of ilium was thin, concave and sharp. The coxal tuber was thick while the sacral tuber was thin with a wide gap separating it from the opposite side. The greater ischiatic notch was deep. These features agreed with observations made by Dyce *et al.* (1996) in large animals.

The pubis consisted of a body and two rami- a cranial ramus and a caudal ramus. The cranial border of pubis showed laterally iliopubic eminence as a small ridge similar to that in sheep (Getty, 1975). But in cattle, it was a large roughened tubercle. The transverse groove on the cranial border was very faint that faded before reaching the acetabular notch. The ischium made up of a body, a ramus and a tabula. The ventral surface of ischium had a rough ridge for the muscles. The ischiatic spine located caudal to the greater ischiatic notch was tall and sharp which showed vertical rough lines laterally. The large tuber ischii presented three tubercles of

which the lateral tubercle was more prominent as recorded in goat (Fig. 1). However it disagreed from sheep where the lateral tubercle of the tuber ischii was much longer (Nickel *et al.*, 1986) and the ischiatic spine was low and everted (Getty, 1975). The lesser ischiatic notch was very shallow. The depth and articular circumference of the rim of acetabulum were 1 cm and 5.3 cm respectively. Caudomedially it had a narrow deep notch as seen in small ruminants (Nickel *et al.* 1986). Nevertheless the additional cranial notch observed in cattle was absent. The ischiatic arch was narrow and deep with an angle of about 52° . The pelvic floor presented large elliptical obturator foramen of 3.8 cm long and 1.8 cm wide.

The shaft of femur was slender, cylindrical and was curved cranially in the distal third as reported in Sambar deer (Rajani *et al.*, 2012). But the shaft was almost straight in cattle. A nutrient foramen was located in the proximal third of cranial surface as recorded by Peters (1988) in domestic cattle. The caudal surface was narrow, longitudinally concave and showed in its middle third the *facies aspera* bounded by the prominent lateral and faint medial femoral lips. The distal extremity showed a well-developed supracondyloid fossa. These features corroborated with Rajani *et al.* (2012) in Sambar deer. On the other hand, Nickel *et al.* (1986) recorded a shallow supracondyloid fossa in large ruminants and supracondyloid tuberosity in small ruminants.

The proximal extremity of femur comprised of a head, neck and two trochanters (Fig. 2). The stout convex head projected more medially. It presented a shallow fovea capitis in the middle. Medially, the neck was distinct as in smaller species (Dyce *et al.*, 1996). The undivided trochanter major was massive (Hyman, 2004) whose summit

Table Mean morphometrical parameters of the pelvic limb bones of Indian muntjac

Parameters (cm)	Femur	Tibia	Large metatarsal
Length	15.9	17.9	11.6
Circumference At the proximal end	5.4	7.8	5
At middle end	4.7	4.8	3.8
At distal end	7.7	5.4	4.8



Fig.2. Caudal and cranial view of femur and patella of Indian muntjac

H- Head, TM- Trochanter Major, T- Trochanteric fossa, I- Inter trochanteric crest, M- Trochanter minor, S- Shaft, M- Medialcondyle, R- Trochlea, P- Patella, ML- Medial condyle

projected 0.7 cm above the level of the head. This finding concurs with the observations made by Nickel *et al.* (1986) in large ruminants but disagreed with that made by Rajani *et al.* (2012) in Sambar deer where the trochanter major was in level with the head. A prominent trochanter minor was located at the caudomedial aspect of proximal third of shaft. The extensive trochanteric fossa was 1.2 cm deep and the intertrochanteric crest was well developed. The distal extremity consisted of sagittally oblique, caudodistally projected two large condyles and a cranial trochlea (Fig. 2). The trochlear groove had a length of 3.1 cm and breadth of 1.5 cm. It was bounded by medial and the lateral trochlear ridges, of which the medial one was more prominent. This feature was similar to that of domestic cattle (Peters, 1988) and Sambar deer (Rajani *et al.*, 2012) where the medial ridge was more prominent, but disagreed with the appearance in small ruminants where both the ridges were equal (Nickel *et al.*, 1986). The lateral condyle and epicondyle were bigger than the medial one. The inter-condyloid fossa was rough,

oblique and wide.

The patella was long and simulated a narrow triangle with pointed apex (Fig. 2) as recorded by Getty (1975) in cattle. It had a length and breadth of 2.7 cm and 1.7 cm respectively. Conversely, Rajani *et al.* (2012) reported it as ovoid, long and narrow in Sambar deer. The base was broader in Spotted deer, whereas in the cattle it was in the form of a thick transverse ridge (Nickel *et al.*, 1986). The rough cranial surface was convex while the caudal articular surface was smooth. The caudal articular surface showed a blunt sagittal ridge which divided it into a medial smaller and a lateral larger area as in large ruminants (Nickel *et al.*, 1986) and Sambar deer (Rajani *et al.*, 2012). But the caudal surface of patella was concave transversely in small ruminants as opined by Nickel *et al.* (1986).

The tibia was moderately curved as in cattle. The proximal third of the shaft was triangular in cross section with the distal end oval (Fig. 3). Medial and lateral surfaces were longitudinally convex and concave respectively. The caudal surface was flat; but the popliteal line and the muscular ridges were less prominent. But Getty (1975) described more prominent ridges in this area in cattle. The cranial border was blunt and laterally curved as in cattle. The proximal extremity consisted of two condyles separated caudally by the popliteal notch. The medial intercondylar tubercle was taller than the lateral one as recorded in cattle but, in small ruminants both the tubercles were equal (Nickel *et al.*, 1986). The lateral condyle showed cranially an extensor sulcus for the passage of tendons.

The distal extremity had two sagittal oblique grooves and an intermediate ridge. The medial malleolus had a pointed end. Laterally, distal extremity articulated with the lateral malleolus. The fibula comprised of only two extremities (Fig. 3). The head was fused with the tibia in the form of a small prominence on the lateral condyle of the tibia. Lateral malleolus was a small, quadrilateral and side to side compressed bone of about 1.1 cm long.

The tarsus comprised of five bones arranged in three rows: tibial and fibular tarsals in the proximal row, central and fourth fused tarsal in the middle row and the first and the second and third fused tarsals in the distal row (Fig. 4). The tuber calcis of fibular tarsal was



Fig.3. Medial view of tibia; dorsal view of metatarsus of Indian muntjac

L- Lateral malleolus, T- Tibial tuberosity, LC- Lateral condyle, F- Fibula, C- Crest of tibia, S- Shaft, D- Dorsal longitudinal groove of large metatarsus, C- condyle of large metatarsus

marked by a wide shallow groove. Central and fourth fused tarsal showed a medioplantar hook like projection directed proximally. The lateral plantar tuberosity of central and fourth fused tarsal was more prominent than the medial one. This differed from cattle (Getty, 1975) wherein the medial tuberosity was more prominent. The first tarsal was a small quadrilateral bone while second and third fused tarsal was broad and flat.

The metatarsals were two in number: a large metatarsal and a small medial metatarsal. The shaft of large metatarsal was four-sided in the proximal 2/3rd, while distally it was almost oval. It was longer than the large metacarpal. The dorsal longitudinal sulcus was wide, deep and distinct (Fig. 3). The plantar longitudinal sulcus was distinct in the proximal 2/3rd. The proximal perforating foramen of the plantar surface opened on the plantar aspect of the proximal extremity. The small metatarsal bone was a small quadrilateral sesamoid bone.

Two chief digits (III) and (IV), each with three phalanges and three sesamoids

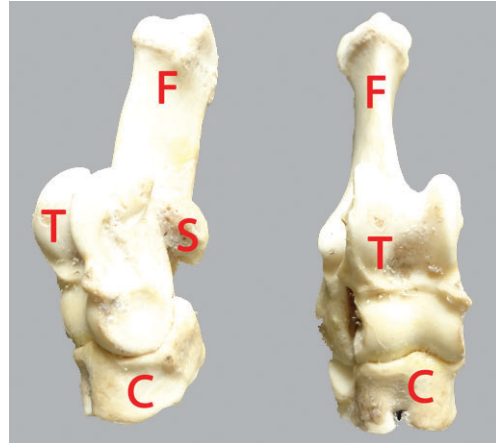


Fig.4. Dorsal and lateral views of tarsus of Indian muntjac

T- Tibial tarsal, F- fibular tarsal, S-Sustentaculum tali, C- fused Central and fourth tarsal, S- sustentaculum tali

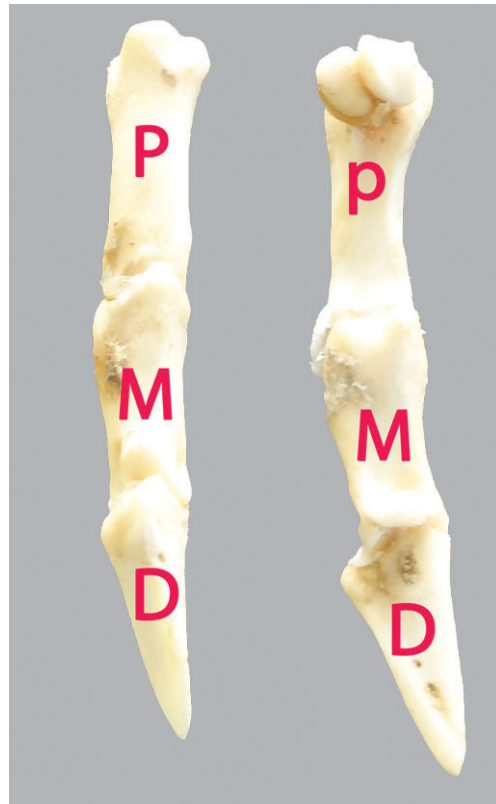


Fig.5. Dorsal and palmar views of chief digits of Indian muntjac

P-Proximal phalanx, M- middle phalanx, D- Distal phalanx

were observed (Fig. 5). Second and fifth digits were dewclaws. The proximal and middle phalanges were more slender than that of pectoral limb. The flexor tubercles of proximal phalanx were positioned more proximally as

recorded by Nickel *et al.* (1986) in small ruminants. The three sided middle phalanx was one-third shorter than the proximal phalanx as reported by Getty (1975) in cattle. The distal phalanx resembled the shape of a hoof. The dorsal border was narrow and sharp. This was similar to the observations in small ruminants where the dorsal border was narrow but differed from the features in cattle where it was broader (Nickel *et al.*, 1986). The extensor process was rough and prominent.

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