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Comparative gross anatomical studies on tibia-fibula of Cattle, Horse and Dog

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Abstract
The present study was undertaken on tibia-fibula of Cattle, Horse, Dog. The long prismatic tibia has shaft with proximal and distal extremities. The Shaft was broad towards the proximal extremity and narrow towards the distal extremity in cattle and horse. The shaft of dog was prismatic towards the proximal extremity and cylindrical towards the distal extremity. Tibial crest was short and very prominent in dog. The nutrient foramina were observed posterior surface near the lateral border in cattle, popliteal line in horse and upper third of the lateral border in dog. Proximal extremity has three tuberosity and two condyles. Sulcus muscularis was deeper in horse than cattle. The lateral condyle was attached with small sesamoid bone fabella at posterior aspect of tibia in dog. The two articular surfaces for corresponding tarsal bones in distal extremity and separated by articular ridge. Lateral malleolus was separate peace of bone in cattle, whereas in horse both malleoli were attached to tibia and medial malleolus prominent then lateral. The fibula was rudimentary in cattle. Whereas better develop in horse. In the dog, the fibula was long cylindrical, parallel to the length of tibia. The fibula of dog was consisted with body and two extremities.

Keywords: Gross, tibia-fibula, Cattle, Horse and Dog

Introduction
Cattle play an important role in the life and prosperity of the people in India, where 70% of the population depends on agriculture for their livelihood (DADF, 2019) [3]. Cattle is one of the most significant livestock species in the country, providing sustenance as well as a source of additional revenue. In India, livestock offers a consistent, supplemental income to farmers involved in secondary and tertiary economic activities connected to the livestock industry (Khan & Parashari, 2018) [5]. Horses are among the most significant animals in human history, as they have been utilized in warfare, as a mode of transportation, and even to facilitate work in quarries (Lonker *et al*., 2020) [9]. Due to their roles as companions, working, and amusement animals, dogs occupy an important role in Indian society. In addition, they serve as essential animal models for research that has contributed to advancements in human and animal health. (NRC, 2009) [11]. The tibia is one of the two bones (Along with the fibula) of the hind limb of the skeleton, but the tibia is the only one that supports the animal's weight, which is reflected by a thickening of this bone (Anonymous, 2023) [2]. The fibula, unlike the tibia, is not a weight-bearing bone. Its primary function is to fuse with the tibia to stabilize the ankle joint. There has been limited scientific work carried out on the comparative gross anatomical studies on the tibia-fibula of cattle, horse, and dog hence, the present study was undertaken to elucidate the various features of femur bone of cattle, horse, and dog.

Materials and Methods
The gross comparative anatomical study was conducted on four Tibia-fibula of each cattle, horse, and dog preserved for academic purposes in the Museum of Department of Veterinary, College of Veterinary and Animal Sciences, Bikaner (RAJUVAS, Bikaner) Rajasthan. Photographs were taken using Phone 14 Pro max. All descriptions were according to Nomina Anatomica Veterinaria, 2005 [16].

Result and Discussion
The lower region of the hind limb skeleton of cattle, horses, and dogs involved two long bones viz. tibia and fibula.

The tibia was observed fully developed in cattle, horses, and dogs (Fig. 1) as reported by Raghavan, 1964 [12]. The tibia of cattle, horse and dog was observed prismatic and long with a shaft and two extremities viz. proximal and distal extremities (Fig. 1 & 2). A similar finding was reported by Yadav (2011) [15] in Chital.

The shaft of the tibia consisted of three surfaces viz. medial, lateral, and posterior. The shaft was observed broad towards the proximal extremities; however, it narrows towards the distal extremity in cattle and horse (Fig. 1 & 2A and 1 & 2B). A similar finding was reported by Yadav (2011) [15] in Chital. Whereas, in dog the shaft of the tibia was convex medially and laterally at the upper and lower part respectively. The shaft of dog was prismatic towards the proximal extremity and cylindrical towards the distal extremity for the attachment with the fibula (Fig. 1C & 2C). Similar findings were reported by Abdulrahman and Abubakar (2021) [1] in local domestic dog.

The shaft consisted of three borders viz. anterior, medial, and lateral which were present three surfaces viz. medial, lateral, and posterior surface. The upper part of the anterior border was prominent and formed a tibial crest which was indistinct at the lower part (Fig. 1A & B), which conforms with the findings of Yadav, (2011) [15] in chital. However, in dog tibial crest was short but very prominent. Abdulrahman and Abubakar (2021) [1] reported similar findings in local domestic dog. The medial aspect of the tibial crest was more prominent which was for the insertion of semitendinosus and some parts of biceps femoris muscles (Fig. 1C). The lateral border was concave and attached to the fibrous cord of the fibula. Whereas in horse, the tibiofibular arch was formed with fibula. The medial border was rounded and with posterior surface gives attachment to the popliteal muscle. Whereas in horse a small tubercle was present on the medial border of the tibia, which conforms with the findings of Raghavan, (1964) [12].

The lateral surface was slightly concave and attached with a rudimentary fibula; however, in dog well-developed fibula was attached parallel to the shaft with interosseous space. The medial surface was rough and gives attachment to the sartorius, gracilis, and semi-membranous muscles. The posterior surface was rough ridges for the attachment of the popliteal muscle named the popliteal line (Fig. 2A & C). Whereas in horse popliteal lines extended from the lateral border to the medial border and do not extend upward as in cattle (Fig. 2B). Similar findings were reported by as reported by Konig & Bragulla (2007) and Raghavan, (1964) [7].

The nutritional foramina were found on the posterior surface near the lateral border; in a horse, they were found on the popliteal line, and in a dog, they were found on the upper third of the lateral border (Fig. 5). The nutrition foramen plays an important role in bone grafting, diaphyseal transplantation, microvascular bone surgery, and the healing and repair of bone fractures. (Kizilkanat *et al*., 2007 and Wavreille *et al*., 2006) [6, 14]. Anatomical investigations like this one serve as critical for ensuring that surgical operations don't endanger the nutrition veins located inside this foramen. (Kumar *et al*., 2013) [8].

The proximal extremity was consisted of three tuberosity viz. anterior, medial and lateral tuberosity and two condyles viz. lateral and medial (Fig. 1 & 3), which conforms with the findings of Sarma *et al*., (2022), Yadav, (2011) and Meena, (2017) [13, 15, 10] in monkey, chital and blue bull, respectively. The lateral and medial condyles of tibia attached to the corresponding condyles of femur. The non-articular anterior tuberosity above the tibial crest were gives attachment to medial, middle, and lateral ligament of patella. Whereas in horse tuberosity was grooved, whereas in dog the tuberosity was not grooved but only one patellar straight ligament was attached unlike cattle (Fig. 1B). Between the anterior tuberosity and lateral condyle, a semilunar notch was found which was passage for tendons of muscles in anterolateral aspects termed as sulcus muscularis (Fig. 3A & C and 6A & C), whereas, in horse the sulcus muscularis was deeper than cattle (Fig. 3B & 6B). The medial lateral condyles were saddling shape with flat surfaces for corresponding menisci were present in stifle joint. Articular eminence in-between condyles which was tibial spine was higher towards the medial condyles. Similar findings were reported by Yadav, (2011) and Meena, (2017) [15, 10] in chital and blue bull, respectively. In dog lateral condyle was attached with small sesamoid bone fabella at posterior aspect of tibia.

The two articular surfaces for corresponding tarsal bones in distal extremity and these surfaces were separated by articular ridge (Fig. 4). Malleolus bone was small bone present on the medial and lateral aspects. The similar findings were reported by Sarma *et al*., (2022), Yadav, (2011) and Meena, (2017) [13, 15, 10] in monkey, chital and blue bull, respectively. Lateral malleolus was separate peace of bone in cattle, whereas in horse both malleoli were attached to tibia and medial malleolus prominent then lateral (Fig. 2B). In the dog, the similar findings as cattle, which conforms with the findings of Raghavan, (1964) [12]. In cattle synovial fossa was runs with the lateral margin of groove. The articular bones of distal extremity join with fibular and tibial tarsal, lateral and medial respectively. These surfaces were deep and directed anteroposterior. Whereas in horse these surfaces and ridges was directed outward obliquely. In the dog, the similar findings as cattle, which conforms with the findings of Raghavan, (1964) [12].

The fibula was observed rudimentary in cattle. Whereas better develop in horse. In the dog, the fibula was long cylindrical, parallel to the length of tibia (Fig. 6C). Proximal end of fibula was fused with lateral condyle of tibia in cattle. The distal extremity was formed lateral malleolus as separate peace. Whereas in horse, the head of fibula was thickened and forms articular surface with lateral condyles. In dog, fibula was presented with body and two extremities. Fibula was articulated with tibia at proximal extremities and leaving interosseous space proximally distal end of fibula articulates with tarsal bone medially (Fig. 6C), which conforms with the findings of Raghavan, (1964) [12].

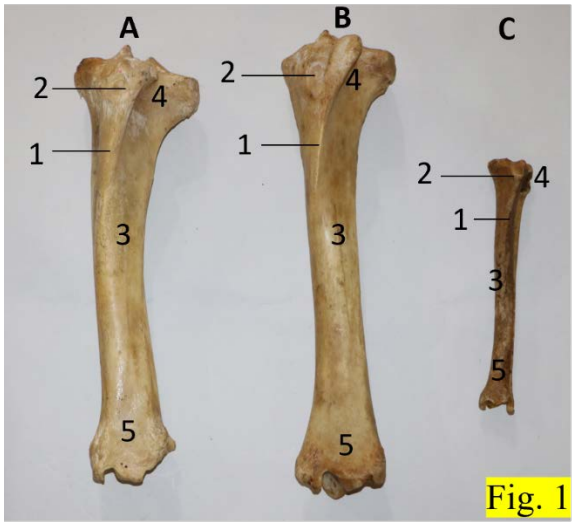

Fig 1: A-Tibia and fibula of Cattle, B-Tibia and fibula of horse C-Tibia and fibula of dog (Anterior view), 1-Tibial crest, 2-Anterior tuberosity, 3-Shaft of tibia, 4-proximal extremity, 5- distal extremity.

Fig 2: A-Tibia and fibula of Cattle, B- Tibia and fibula of horse C-Tibia and fibula of dog (Posterior surface), 1-Tibial spine, 2- Popliteal line, 3-Articular grooves for tarsal bones, 4-Fused medial malleolus; 5&6-Fused lateral and medial malleolus.

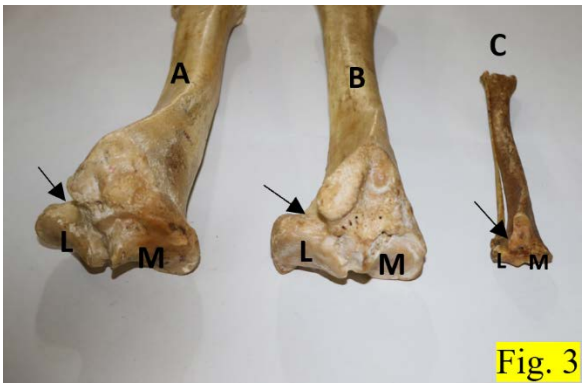

Fig 3: A-Tibia and fibula of Cattle, B- Tibia and fibula of horse, C-Tibia and fibula of dog (Proximal extremity), M-Medial condyle, L-Lateral condyle, Arrow- Sulcus muscularis.

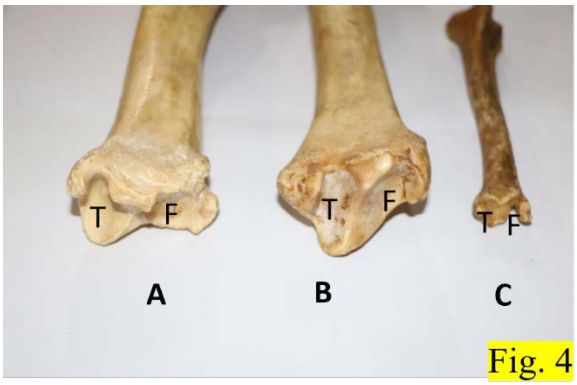

Fig 4: A-Tibia and fibula of Cattle, B-Tibia and fibula of horse, C-Tibia and fibula of dog (Distal extremity), T-Articular groove for tibial tarsal bone, F- Articular groove for fibular tarsal bone.

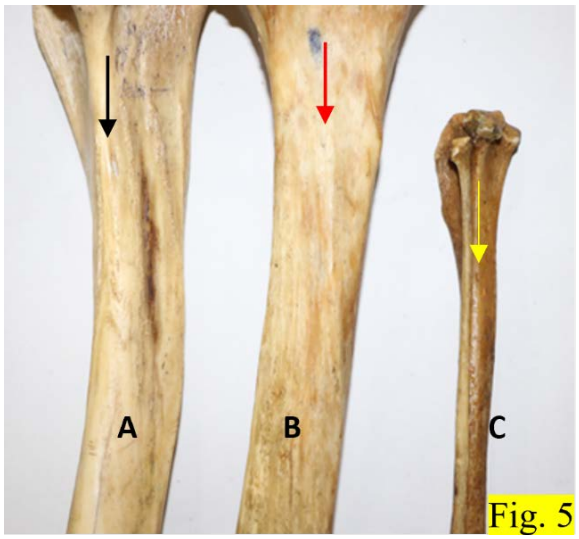

Fig 5: A-Tibia and fibula of Cattle, B-Tibia and fibula of horse, C-Tibia and fibula of dog (Posterior view) showing nutrient foramen.

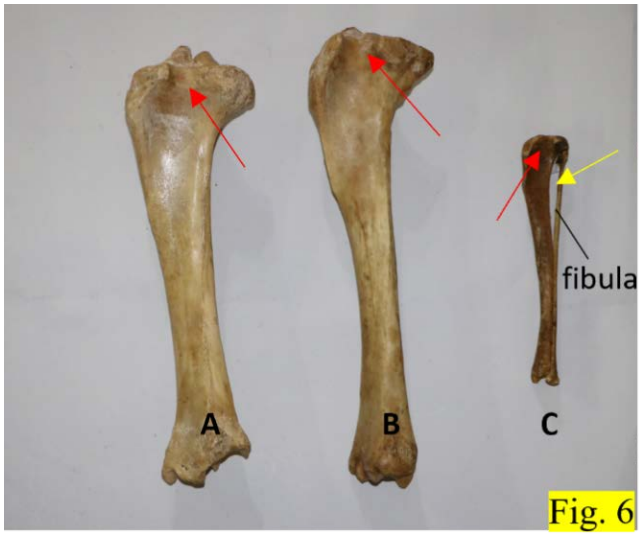

Fig 6: A-Tibia and fibula of Cattle, B-Tibia and fibula of horse, C-Tibia and fibula of dog (lateral surface) Red Arrow showing sulcus muscularis, Yellow Arrow showing Proximal interosseous space in between tibia and fibula of dog.

Conclusions

According to the findings of this research, there are distinct anatomical distinctions between cattle, horses, and dogs, all of which must be considered while planning and performing orthopaedic surgeries.

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