

ANATOMY OF THE FEMOROTIBIAL JOINT OF STIFLE OF BUFFALO CALVES (*BUBALUS BUBALIS*)

B. Supriya^{1,*}, T.S. Chandrasekhara Rao² and P. Jagapathi Ramayya³

ABSTRACT

The present study aims at identifying the anatomical aspects of the femorotibial joint of stifle which are specific to buffaloes and vary with those of ox. The study was conducted at Department of Veterinary Anatomy and Histology, College of Veterinary Science, Tirupati. Fifteen apparently healthy 1 to 1½ year old buffalo calves irrespective of breed, sex and nutritional status were utilized for gross anatomical studies of stifle articulation of buffalo calves after embalming with 10% formalin. The gross morphology of joints and relations were studied by careful dissection. The dissection was also carried out in some unpreserved fresh specimens to study the movements and also certain aspects of the joints. In femorotibial joint of buffalo an additional ligament was found. That ligament had tibial attachment on the central part of area intercondylaris close to tuberculum intercondylare mediale of eminentia intercondylaris blended with attachment of cranial cruciate ligament and extended proximally and caudally to a depression in the middle of the medial wall of intercondylar fossa. This ligament was thin but strong gives additional stability to the articulation during extreme flexion. It was loose in normal position

and stretched in extreme flexed condition. Such ligament was not reported earlier in white cattle or in buffalo.

Keywords: stifle joint, buffalo calf, cruciate ligament, femorotibial joint, meniscus

INTRODUCTION

From the clinical point of view the stifle joint is very important. For proper diagnosis and treatment of disturbances in stifle joint, a thorough knowledge of the normal structures at the site is indispensable. Buffaloes were more hardy, resistant and also economic producers of milk than cows (Singh *et al.*, 1963). Extensive information was available on the anatomy of the joints of horse, dogs, pig and the cattle in standard text books dealing with anatomy and clinical anatomy (Chauveau, 1891; Raghavan, 1964; Sisson, 1975; Nickel *et al.*, 1986; Shivley, 1987; Dyce, 2002; Konig *et al.*, 2004). Hence the present study was undertaken to through light on special morphological features of femorotibial joint of buffalo stifle.

¹Department of Veterinary Anatomy, College of Veterinary Science, Tirupati, Andhra Pradesh, India,
*E mail: supriyabotlagunta@gmail.com

²Faculty of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India

³College of Veterinary Science, Proddatur, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India

MATERIALS AND METHODS

A total number of fifteen apparently healthy 1 to 1½ year old buffalo calves irrespective of breed, sex and nutritional status were utilized. The animals were procured in and around Tirupati and the age of the animal was determined based on the dentition (Chandrasekhara Rao, 2007). 10% xylazine 0.05 mg/kg body weight was given to sedate the animal. The animal was secured in lateral recumbence and the carotid artery was punctured to bleed the animal. Embalming fluid (10% formalin) was injected through the same puncture. The limbs were separated from the trunk of the embalmed calves and preserved in formalin for subsequent study on joints. The gross morphology of joints and relations were studied by careful dissection. The dissection was also carried out in four unpreserved fresh specimens to study the movements and also certain aspects of the joints. Nomina Anatomica Veterinaria (2005) was followed for nomenclature.

RESULTS AND DISCUSSION

The femorotibial articulation was hinge joint formed by the condyles of the femur and the proximal articular surface of the tibia. In accordance with the findings of Hifny *et al.* (2012) the condyles of the femur were obliquely placed with their long axes directed distally, cranially and medially. This obliquity was more pronounced in the medial condyle than in the lateral condyle. The intercondyloid fossa was deep and wide than that of ox. The articular surface of the tibia consists of two condyles separated by the intercondyloid eminence. Each condyle was gently saddle shape, concave transversely and convex craniocaudally. The medial condyle was smaller than the lateral

one. Incongruence of the articular surface of tibia and that of femur was compensated by the fibrocartilaginous menisci (Figure 1, 2 and 3). The menisci were semilunar with a thick and convex peripheral border and a central thin and concave border with notch (Figure 2). Through this notch there is a communication between the proximal and distal compartments of the medial and lateral sacs of the femorotibial joint. The proximal surface facing towards the femoral condyles was concave (Figure 2) while the distal surface facing towards the tibia was flat. The posteriolateral part of the lateral meniscus did not cover the tibial condyle, over which the tendon of M. popliteus plays (Figure 4). The general morphological features of the menisci entering in the formation of the femorotibial joint of buffalo showed great resemblance to those of the ox (Raghavan, 1964). Besides weight transmission, the menisci increased the concavity of the tibial condyles and helped in complex mechanism of gliding and angular movements.

The fibrous layer of articular capsule was attached to the margins of the articular surfaces and the convex border of menisci. The synovial membrane of articular capsule was partitioned by the cruciate ligaments into medial and lateral femorotibial sacs. This partition was incomplete. The femorotibial joint sacs were further separated by menisci into freely communicating proximal and distal compartments, which were communicated at the thin medial border of the menisci. The medial synovial sac communicated dorsally with patellar synovial sac. These findings were in accordance with those of Sisson (1975) in horse and Nickel *et al.* (1986) and Konig *et al.* (2004) in ox. Raghavan (1964) stated that the lateral and medial femorotibial sacs usually do not communicate with each other in ox.

The ligaments of the femorotibial

articulation included the ligaments of the menisci and the ligaments of the femorotibial joint. The cranial ligament of lateral meniscus and the cranial ligament of medial meniscus extended from the cranial angle of the respective menisci to the area intercondylaris of the tibia (Figure 1, 2 and 3). The caudal ligament of lateral meniscus and caudal ligament of medial meniscus arose on the caudal angle of menisci, the one from the lateral meniscus terminated on the popliteal notch of tibia (Figure 4) and the one from the medial meniscus ended in the intercondylar area of the tibia (Figure 2). The meniscofemoral ligament extended from the superior aspect of the caudal angle of lateral meniscus to the intercondylar surface of femur towards the medial side (Figure 4). The transverse ligament connected the cranial angles of the two menisci (Figure 1).

The femur and the tibia were connected by the ligaments of the femorotibial joint. The lateral collateral ligament extended from lateral epicondyle of the femur with one branch attaching to the lateral condyle of the tibia and another strong branch ending on the head of the fibula. It was separated from the lateral meniscus by the tendon of origin of muscle popliteus (Figure 4). The medial collateral ligament extended between the medial epicondyle of femur and a roughened area distal to the margin of medial condyle of tibia. It was fused with the medial meniscus and the joint capsule (Figure 2). The lateral collateral ligament was shorter and narrower but thicker and stronger than medial collateral ligament as observed by Gupta and Sharma (1989) in yak.

The cranial cruciate ligament extended from the intercondylar surface of the lateral condyle of femur, directed craniodistally and attached on the central intercondylar area of the tibia (Figure 1 and 3). Abdalla Hifny *et al.* (2012)

reported that the cranial cruciate ligament arises by two parts; cranial and caudal in buffalo. Such division of cranial cruciate ligament was not observed in the present investigation. In humans it composed of two bundles that are named based on their relative attachments on the femur and tibia: an anteromedial which is tight in flexion, and a posterolateral bundle, which was more convex and tight in extension (Kweon *et al.*, 2013). The caudal cruciate ligament was longer than cranial cruciate ligament. It was attached to the cranial part of the intercondylar area of femur extended caudodistally and ended on the popliteal tubercle of the tibia (Figure 1 and 4). The cruciate ligaments were twisted across each other (Figure 1). Dyce *et al.* (2002) in domestic animals suggested that the cruciate ligaments assist the collateral ligaments in opposing rotation as well as medial and lateral deviation of the leg.

The newly found ligament had tibial attachment to the central part of intercondylar area close to tuberculum intercondylare mediale of eminentia intercondylaris blended with attachment of cranial cruciate ligament and extended proximally and caudally to a depression in the middle of the medial wall of intercondyloid fossa. The ligament was thin but strong. It was loose in normal position and stretched in extreme flexed condition (Figures 1 and 3). These findings were in accordance with the findings of Chandrasekhara Rao *et al.* (2009). This provided additional stability to the cruciate ligaments during extreme flexion.

This joint showed flexion, extension and limited rotation. When the stifle joint was flexed the menisci move caudally. The meniscofemoral ligament and the tendon of muscle popliteus prevented the lateral menisci from extreme posterior motility. Such kind of protection not available for the medial meniscus. In flexion the

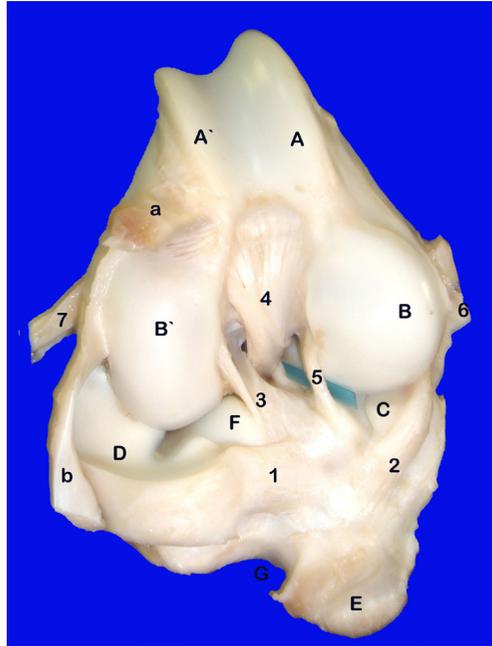


Figure 1. Photograph showing femorotibial articulation anterior aspect in extreme flexed condition.

- A, A'. Medial and lateral trochlea of femur
- B, B'. Medial and lateral condyles
- C. Medial meniscus
- D. Lateral meniscus
- E. Tibial tuberosity
- F. Tibial spine
- G. Sulcus extensorius
- 1. Cranial ligament of lateral meniscus
- 2. Cranial ligament of medial meniscus
- 3. Cranial cruciate ligament
- 4. Caudal cruciate ligament
- 5. Newly found ligament
- 6. Medial collateral ligament
- 7. Lateral collateral ligament

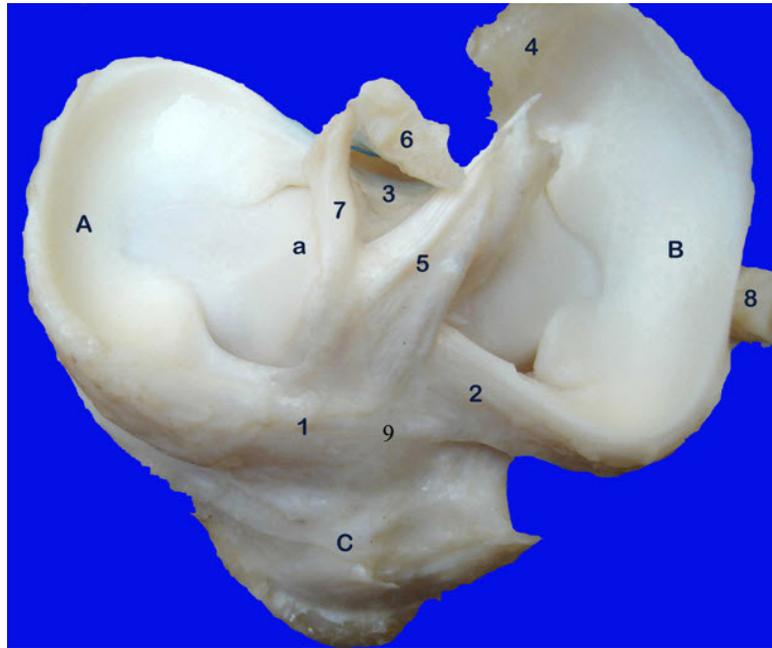


Figure 2. Photograph showing proximal articular surfaces of menisci with femur, patella and capsula articularis removed.

- A. Medial meniscus
- B. Lateral meniscus
- C. Tibial tuberosity
- 1. Cranial ligament of medial meniscus
- 2. Cranial ligament of lateral meniscus
- 3. Caudal ligament of medial meniscus
- 4. Menisiofemoral ligament
- 5. Cranial cruciate ligament
- 6. Caudal cruciate ligament
- 7. Newly found ligament
- 8. Lateral collateral ligament
- 9. Transverse ligament

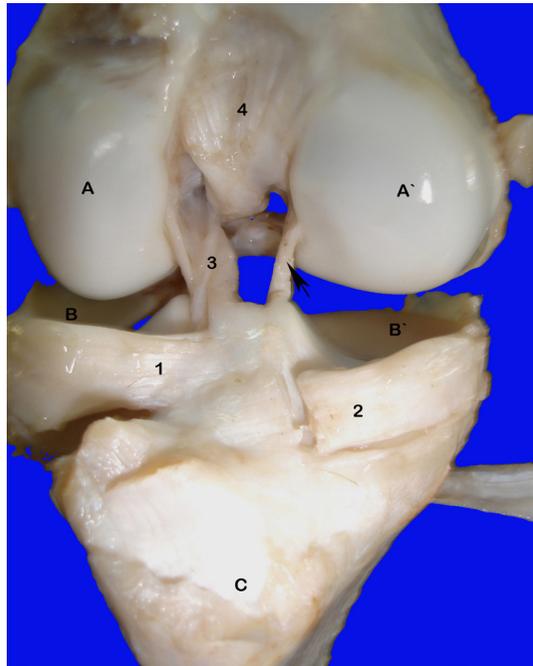


Figure 3. Photograph showing newly found additional ligament (arrow).

- A, A'. Lateral condyle and medial condyle
- B. Lateral meniscus, B'. Medial meniscus
- C. Tibial tuberosity
- 1. Cranial ligament of lateral meniscus
- 2. Cranial ligament of medial meniscus
- 3. Cranial cruciate ligament
- 4. Caudal cruciate ligament

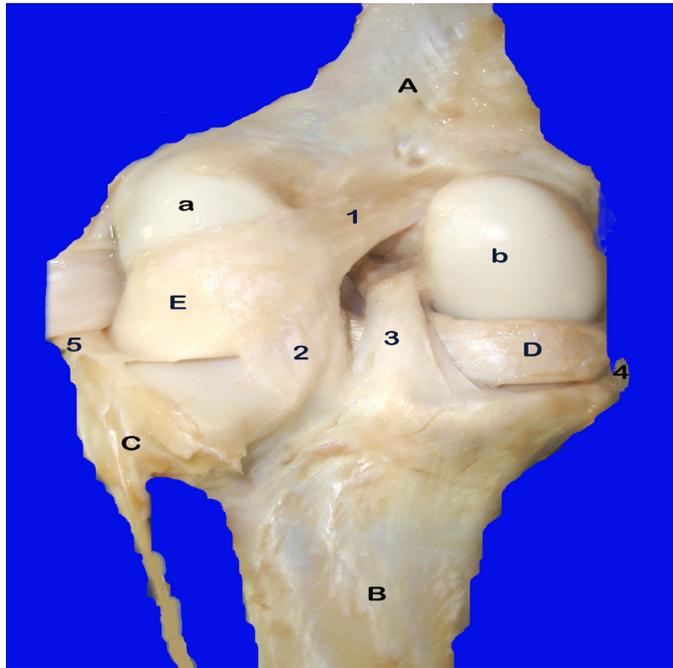


Figure 4. Photograph showing posterior aspect of femorotibial articulation with capsula articularis removed.

- C. Fibula
- D. Medial meniscus
- E. Lateral meniscus
- a, b. Lateral condyle et medialis
- 1. Menisofemoral ligament
- 2. caudale ligament of lateral menisci
- 3. Caudal cruciate ligament
- 4. Medial collateral ligament,
- 5. Lateral collateral ligament,
- 6. Tendon of muscle Popliteus,

cruciate ligaments stabilize the internal rotation of the tibia. In bovine the menisci glide forwards over the tibia as the femoral condyles roll upon them in extension and the restriction of their movement imposed by the meniscal ligaments is important brake upon straightening the joint (Dyce *et al.*, 2002).

REFERENCES

- Chandrasekhara Rao, T.S. 2007. Pre and postnatal development of the buffalo skull. *Report on Indian Council of Agricultural Research Ad-hoc Scheme*, Indian Council of Agricultural Research.
- Chandrasekhara Rao, T.S., A.K. Gautam and A.P. Babu. 2009. Presence of an additional ligament in femorotibial joint of buffalo (*Bubalus bubalis*). In *Proceedings of 24th IAVA Convention*, Lucknow, India.
- Chauveau, A. 1891. *The Comparative Anatomy of the Domestic Animals*, 2nd ed. Appleton Company, New York. p. 194-225.
- Dyce, K.M., W.O. Sack and C.J.G. Wensing. 2002. *Text Book of Veterinary Anatomy*, 3rd ed. Philadelphia, London. p. 732-759.
- Gupta, S.K. and D.N. Sharma. 1989. Anatomy of the stifle joint of Yak., *Indian Journal of Veterinary Anatomy*, **1-2**: 47-48.
- Hifny, A., K.E.H. Abdalla, Y.A.A. Rahman, K. Aly and R.A. Elhanbaly. 2012. Anatomical studies on the femorotibial joint in buffalo. *J. Basic. Appl. Sci. Res.*, **2**(11): 10930-10944.
- Konig, H.E., H.G. Leibich and J. Maierl. 2004. *Text Book and Color Atlas of Veterinary Anatomy of Domestic Mammals*, p. 148-165. and 218-228. In Konig, H.E. and H.G. Leibich (eds). Schattauer Publisher, Stuttgart, Newyork.
- Kweon, C., E.S. Lederman and A. Chhabra. 2013. Anatomy and biomechanics of the cruciate ligaments and their surgical implications, p. 17-27. In *The Multiple Ligament Injured Knee: A Practical Guide to Management*, Springer Science and Business Media, New York.
- Nickel, R., A. Schummer and E. Seiferle 1986. The locomotor system of domestic mammals. In Nickel, R., A. Schummer, E. Seiferle, H. Wilkens, K.H. Wille and J. Frewin (eds.) *The Anatomy of the Domestic Animals*,. Verlag Paularey, Berlin.
- Nomina Anatomica Veterinaria. 2005. *International Committee on Veterinary Gross Anatomical Nomenclatur*, 5th ed. Published by Editorial Committee Hannover, Columbia, Gent, Sapporo. p. 1-52.
- Raghavan, D. 1964. *Anatomy of The Ox*. Indian Council of Agricultural Research, New Delhi. p. 163-190.
- Shively, M.J. 1987. *Text Book of Basic, Comparative and Clinical Veterinary Anatomy*. Texas and A M University press. p. 167-198.
- Singh, S., O.P.S. Sengar and S.N. Singh. 1963. Prenatal development of buffalo (*Bos bubalis*). *Agra University Journal of Research.*, **12**: 197-246.
- Sisson, S. 1975. *Ruminant Syndesmology*, 5th ed. In Getty, R. *The Anatomy of the Domestic Animals*. W.B. Saunders Company, Philadelphia. **1**: 787-790.