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Anatomical Studies on the Femorotibial Joint in Buffalo

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ABSTRACT

Results obtained in this work reveals significant differences in the dimensions of the medial and lateral condyles of the femur. The condyles are convex in both directions. The cranoicaudal convexity of the medial condyle (115.83±0.88 mm) is stronger than that of the lateral one (111.65±2.3 mm). The mediolateral dimension of the medial condyle (69.43±1.03 mm) is smaller than that of the lateral condyle (83.25 ±1.79 mm). However the articular surface of the medial condyle of the tibia is larger than the lateral one.

The present finding reveals that the axial border of the menisci is thin and concave forming a U- shaped notch. Through this notch there is a communication between the proximal and distal compartments of the medial and lateral sacs of the femorotibial joint. The area of communication is large at the medial side. The cruciate ligaments are two strong bands, cranial and caudal, situated mainly in the intercondyloid area of the femur between the two femorotibial synovial sacs. The cranial cruciate ligaments are represented by two bands; the cranial and caudal.

The collateral ligaments of the femorotibial joint are long as they extend more distally from the margin of the articular surfaces, the medial one is longer than the lateral this leads to instability of movement.

KEY WORDS:-Femorotibial joint - Buffalo – upward fixation of patella – femur – tibia

INTRODUCTION

The femorotibial jointis the largest joint in the body, and iscomprised oftwo condyloid articulations. The medial and lateral femoral condyles articulate with the corresponding tibial plateau. Intervening medial and lateral menisci serve to enhance the conformity of the joint **(Goldblatt** and **Richmond, 2003).** The meniscus and cruciate ligaments play an important role in weight bearing and stability of the stifle joint.

The available literature show that the incidence of upward fixation of the patella is higher in buffalo than incattle **(Semieka**and**Misk, 1997)**. This fact may be referred to anatomical structures of this joint in this animal. The aim of this work is to study the anatomical features and morphometry of the different structures of the femorotibial jointto indicate the causes of this fact and their role in induction of upward fixation of the patella in buffalo.

MATERIALS AND METHODS

This study was carried out on fivefresh stifle regions adult buffalo*(Bus Bubulis)* of local breeds. The specimens were collected from Assiut slaughterhouse. The studied specimens were clinically healthy and showed no evidence of marked bony abnormalities or degenerative diseases.

So the gross anatomical study of the femorotibial joint included:-

I-Morphological study:

The morphological features of different structures of the stifle jointwere studied as:

1- Shape and extension of the articular surfaces of the condyles of the femur and tibia as well as the menisci.
2- The line of attachment of the joint capsule and its pouches.
3- Shape, density, extension and area of attachment of the meniscal, cruciateand collateral ligaments.
4- The attachment of the muscles related to the joint and their relations to theunderlying pouchesof the joint.

II-Morphometricalstudy:

-Different measurements including the length, the width and thickness were carried out on the articular surfaces and ligaments of the tibiofemoraljoint as follow:

1- Length and width of the articular surfaces of the femoral and tibialcondyles.
2- Length, width and thickness of the menisci.
3- Length, width and thickness of the ligaments.

- All the anatomical components were photographed and the dimensions were recorded using a digital caliper.

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- All measurements were statistically analysed using a one way-ANOVA. Descriptive statistics are given as means ± SD (standard deviation). The statisticanalysis was carried out with Microsoft® Excel 2007 program.

The data given in the form of tables.

- The nomenclature used in the present work was adapted to the NominaAnatomicaVeterinaria (2005) as well as the available literature.

RESULTS

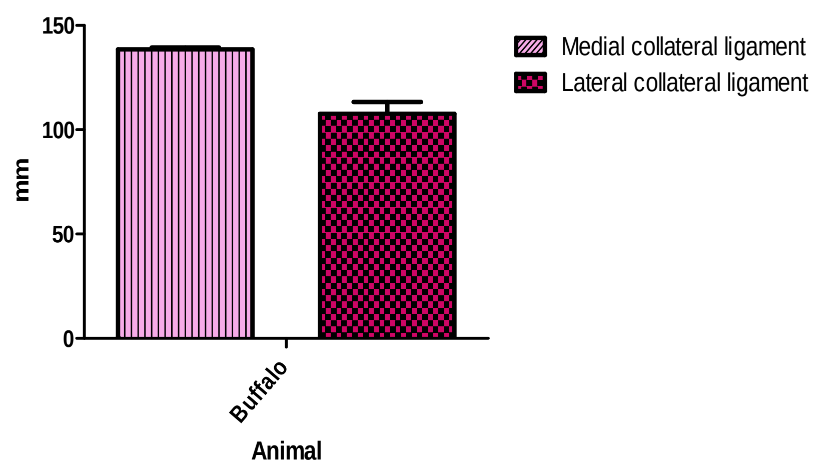
I-Articular surfaces:

The articular surfaces of the femorotibial j(10930 the condyles of the femur, the condyles of the tibia and the intervening menisci.

a- Condyles of the femur:(Table 1;Fig. 1)

Table (1): Showing the dimensions of the articular surfaces of the femorotibial joint of buffalo in mm. (Mean & S. E).

Items	Mean	S. E
A- Condyles of the femur		
a -Medial condyle		
- Craniocaudal dimension		
- Mediolateral dimension	115.83	± 0.88
b-Lateral condyle	69.43	± 1.03
-Craniocaudal dimension		
-Mediolateral dimension	111.65	± 2.30
B- Condyles of the tibia	83.25	± 1.79
a- Medial condyle		
- Craniocaudal dimension		
- Mediolateral dimension		
b-Lateral condyle	88.28	± 2.08
-Cranoicaudal dimension	56.93	± 1.94
-Mediolateral dimension		
C- Menisci	85.77	± 2.88
1- Medial meniscus	59.81	± 0.36
- Thickness of the abaxial border		
*Cranially		
*At the middle		
*Caudally	14.71	± 0.24
-Width of the cranial extremity	11.19	± 0.09
-Width of the caudal extremity	14.75	± 0.06
- Distance between two borders	19.44	± 0.16
- Depth of the notch	17.45	± 0.19
1- Lateral meniscus	23.66	± 0.23
- Thickness of the abaxial border	19.54	± 0.04
*Cranially		
*At the middle		
*Caudally	19.35	±0.06
-Width of the cranial extremity	15.55	±0.12
-Width of the caudal extremity	23.93	±0.13
- Distance between two borders	23.49	± 0.60
- Depth of the notch	29.37	± 0.08
	27.91	± 0.03
	12.59	± 0.04



Histogram (1): Showing the length of the medial and lateral collateral ligaments of the femorotibial joint in buffalo.

The articular surface of the femur concerning the femorotibial joint is represented by two condyles, medial and lateral, separated by the intercondyloid fossa.

The medial condyle is larger and lower in level than the lateral one. It is ovoid in shape. Its craniocaudal dimension is larger (115.83± 0.88mm) than the mediolateral one (69.43± 1.03mm).The craniocaudal dimension of the medial condyle is more convex, so it is relatively short.

The lateral condyle is smaller and higher than the medial one. The craniocaudal dimensionis longer (111.65± 2.3 mm) than its mediolateral dimension (83.25±1.79mm).

The condyles of the femur are obliquely placed with their long axes directed distally, cranially and medially. This oblique situation is more pronounced in the medial condyle than in the lateralone.Theintercondyloid fossa is deep and wide.

a- Condyles of the tibia:(Table 1; Fig.2)

The articular surface of the tibia consists of two condyles separated by the intercondyloid eminence. Each condyle is gently saddle shape, concave transversely and convex craniocaudally.

The medial condyle is smaller than the lateral one. It is convex craniocaudally and reaches 88.28+ 2.87mm and concave transversely and reaches 56.93± 1.94mm. It is covered by the medial meniscus except its medial part which comes incontact with the medial condyle of the femur.

Table (2): Showing dimensions of the ligaments of the femorotibial joint of buffalo in mm. (Mean & S. E).

Items	Mean	S. E
A- Meniscal Ligaments		
I- Ligaments of medial meniscus		
1-Cranial ligament		
-Length	30.76	± 0.40
-Width	16.7	±0.23
-Thickness	6.49	± 0.20
2-Caudal ligament		
-Length	20.29	± 0.25
-Width	18.26	± 0.04
-Thickness	4.32	± 0.03
II-Ligaments of lateral meniscus		
1-Cranial ligament		
-Length	34.34	± 0.26
-Width	19.39	± 0.20
-Thickness	4.11	± 0.02
2-Caudal ligament		
-Length	38.61	± 0.14
-Width	28.57	± 0.15
-Thickness	2.88	± 0.05
3-Meniscofemoral		
-Length	49.62	± 0.13
-Width	14.87	± 0.12
-Thickness	3.85	± 0.05
C- Cruciate ligaments		
1- Cranial cruciate ligament		
-Length	59.13	± 0.05
-Width	13.12	± 0.03
Thickness	7.25	± 0.01
2- Caudal cruciate ligament		
- Length	70.88	± 0.08
-Width	11.45	± 0.13
-Thickness	4.1	± 0.04
D- Collateral ligaments		
1- Medial collateral ligament		
-Length	138.53	± 0.86
-Width	17.03	± 1.41
-Thickness	2.43	± 0.09
2- Lateral collateral ligament		
- Length	107.73	± 5.62
-Width	16.40	± 0.82
-Thickness	3.27	± 0.18

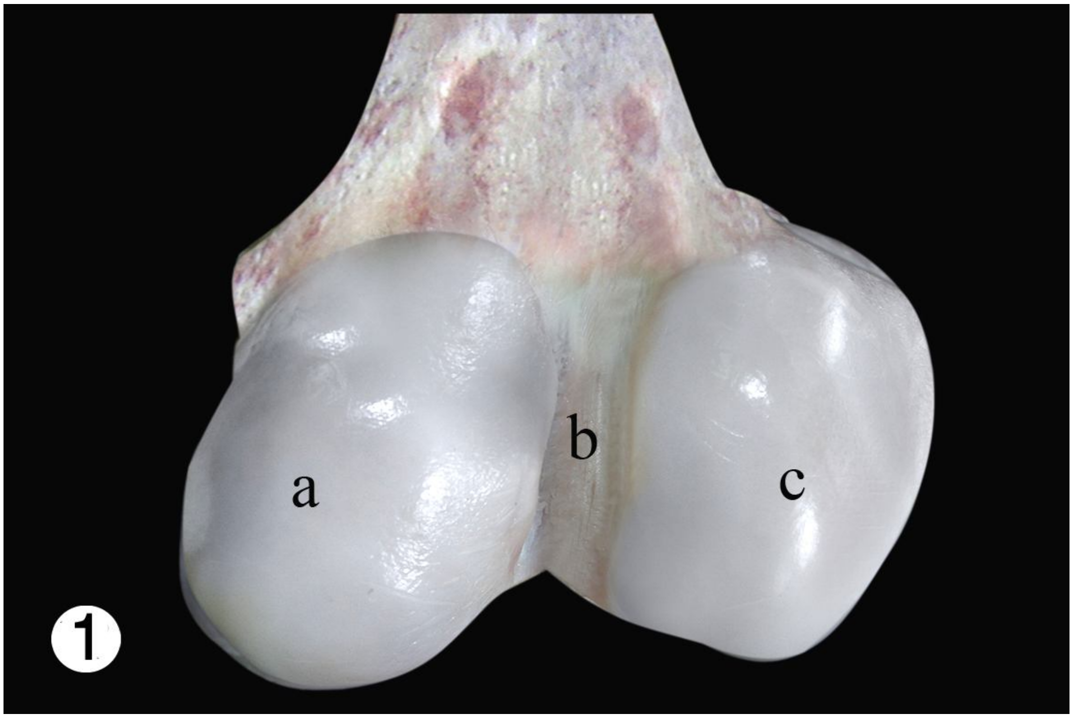


Fig. (1): Photograph of distal extremity of right femur of buffalo. Caudal view.

a- Medial condyle of femur
b- Intercondyloid fossa of femur
c- Lateral condyle of femur.

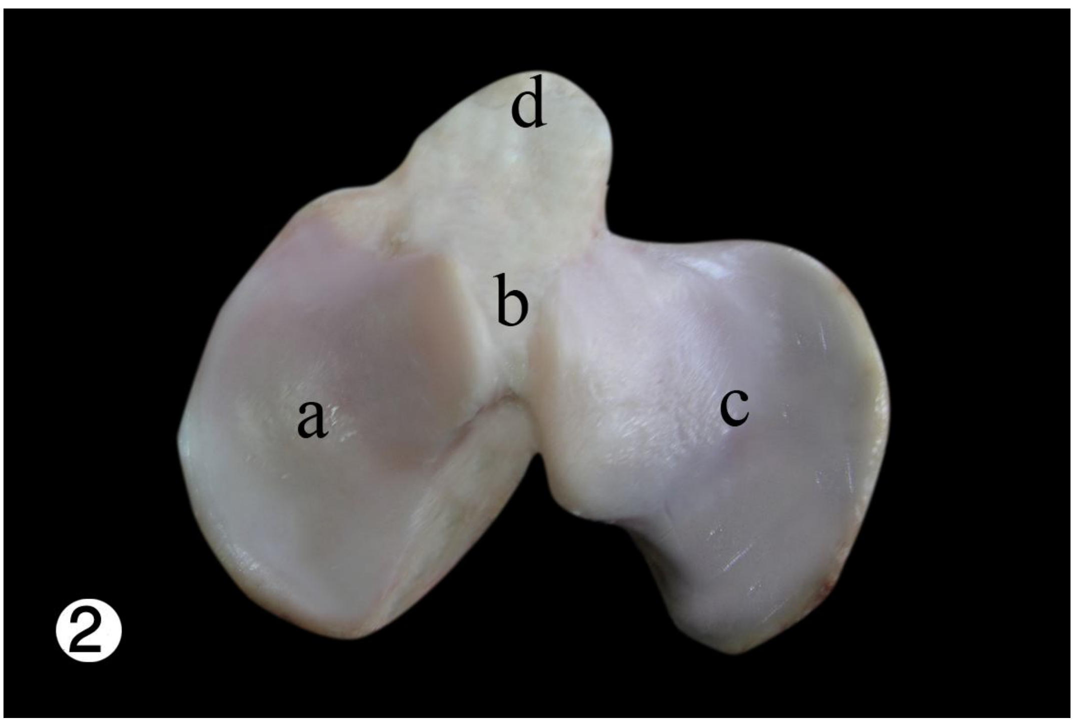


Fig. (2): Photograph of the proximal extremity of right tibia of buffalo. Proximal view.

a- Medial condyle of tibia
b- Central intercondyloid area of tibia
c- Lateral condyle of tibia
d- Tibial tuberosity.

The articular surface of the lateral condyle is larger than that of the medial condyle. Itscraniocaudal dimension is 85.77± 2.88 mm and mediolateral dimension is 59.81± 0.36 mm.

The lateral part of the lateral condyle is convex and covered by the large tendon of origin of popliteus which separates the lateral meniscus from the lateral collateral ligament.

The medial part of the lateral condyle extends on the lateral eminence of the tibial spine. It articulates proximally with the lateral meniscus keeping its medial part in contact with the corresponding condyle.

The lateral condyle extends more cranially than the level of the medial one but caudally they are located at the same level and separating from each other by popliteal notch.

The intercondyloid eminence or spine is subdivided into medial and lateral tubercles. The medial tubercle is higher than the lateral one. Between these tubercles a relatively large central intercondyloid area is located. Cranial and caudal to the tibialeminence, there are cranial and caudal intercondyloid areas. The caudal intercondyloid area is larger and deeper than the cranial one. Lateral to the cranial intercondyloid area there is a shallow depression. A small ridge is located between the cranial intercondyloid area and the abovebeformentioned depression.

c-Menisci(Table 1;Figs.3, 4, 5)

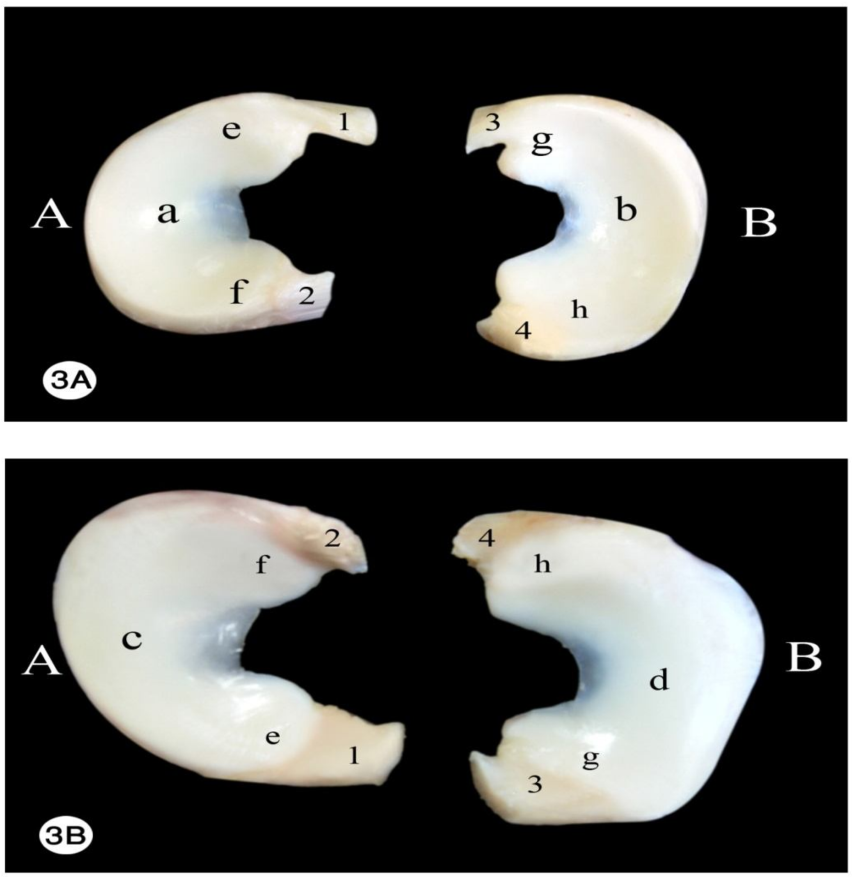
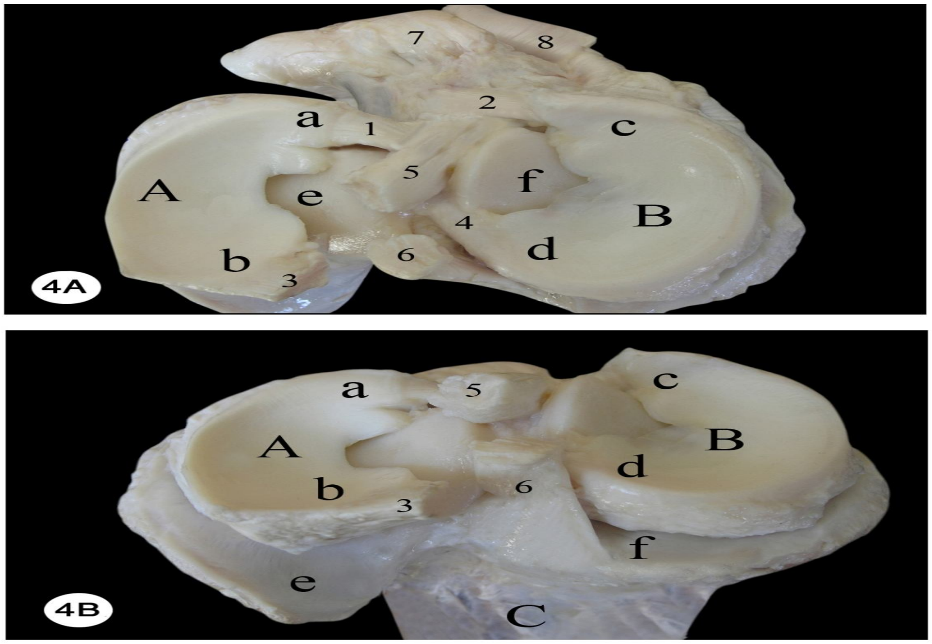


Fig. (3 a, b): Photograph of menisci of right stifle of buffalo.
A-Medial meniscus B-Lateral meniscus
a- Proximal surface of medial meniscus; b- Proximal surface of lateral meniscus;
c- Distal surface of medial meniscus; d- Distal surface of lateral meniscus;
e- Cranial extremity of medial meniscus; f- Caudal extremity of medial meniscus;
g- Cranial extremity of lateral meniscus; h- Caudal extremity of lateral meniscus.
1- Cranial ligament of medial meniscus; 2- Caudal ligament of medial meniscus;
3- Cranial ligament of lateral meniscus; 4- Meniscofemoral ligament.



Figs. (4 a, b): Photograph of left proximal extremity of tibia with menisci of buffalo and their ligamental attachments..

A- Lateral meniscus B- Medial meniscus C- Tibia

a- Cranial extremity of lateral meniscus; b- Caudal extremity of lateral meniscus;

c- Cranial extremity of medial meniscus; d- Caudal extremity of medial meniscus;

e- Lateral condyle of tibia;f- Medial condyle of tibia.

1- Cranial ligament of lateral meniscus; 2- Cranial ligament of medial meniscus;

3- Meniscofemoral ligament; 4- Caudal ligament of medial meniscus; 5- Cranial cruciate ligament; 6- Caudal cruciate ligament; 7- Lateral patellar ligament;8- Intermediate patellar ligament.

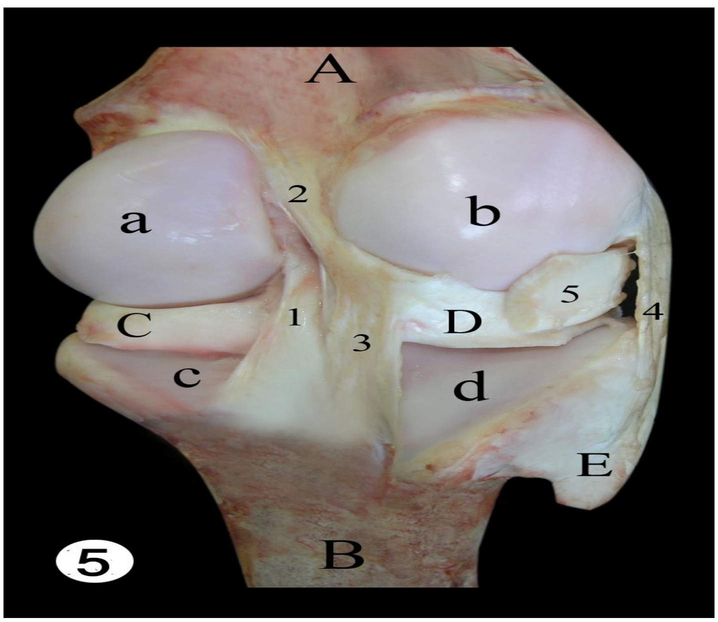


Fig. (5): Photograph of right femorotibial joint of buffalo. Caudal view.

A-Femur B-Tibia

C- Medial meniscus D- Lateral meniscus E- Fibula

a- Medial condyle of femur; b- Lateral condyle of femur; c- Medial condyle of tibia;

. d- Lateral condyle of tibia

1- Caudal cruciate ligament; 2- Meniscofemoral ligament; 3- Caudal ligament of lateral meniscus; 4- Lateral collateral ligament; 5-Tendon of origin of popliteal muscle.

1-Medial meniscus:

The medial meniscus is a fibrocartilaginous plate partially divides the medial femorotibial sac of the femorotibial joint into proximal and distal compartments. It covers the medial condyle of the tibia except its axial part.

It is thin and crescentic in shape; therefore it has two surfaces; proximal and distal, two borders; axial and abaxialand two extremities; cranial and caudal.

Its proximal surface is lower in level than that of the lateral meniscus as the medial condyle of the femur is lower than that of the lateral one. The surface is strongly concave cranoicaudally and transversaly.The distal surface is adapted to the medial condyle of the tibia which is nearly flattened.

The axial border of the medial meniscus is thin and concave. It forms the U-shaped notch which measures19.54±0.04mm depth. The distance between both borders is 23.66±0.23mm.

The abaxial border of the medial meniscus corresponds to the outer margin of the medial condyle of the tibia. It has no muscular or ligamentous attachments and it is related medially to the medial collateral ligaments of the femorotibial joint.

The thickness of this border varies cranially, at middle and caudally where it is 14.71±0.24, 11.19±0.09 and 14.75±0.06 mm respectively. As a result, this border is thinner at the middle than at both extremities. Moreover the thickness of both extremities is nearly equal.

The cranial extremity is about 19.44±0.16mm wide. The cranial ligament of the medial meniscus is attached to this extremity.The caudal extremity is thicker and narrower than the cranial one. It measures 17.45±0.19mm wide.

2-Lateral meniscus:

The lateral meniscus is a fibrocartilaginous plate partially divides the lateral sac of the femorotibial joint into proximal and distal compartments. It covers the articular surface of the lateral condyle of the tibia except its axial part towards the lateral tubercle of the intercondyloid eminence and the caudolateral margin where the tendon of origin of popliteus is located separating it from the lateral collateral ligament of the femorotibial joint.

The lateral meniscus is crescentic in shape; therefore it has two surfaces; proximal and distal, two borders; axial and abaxialand two extremities; cranial and caudal.

The proximal surface forms the floor of the proximal compartment of the lateral femorotibial sac. This surface is adapted to the lateral condyle of the femur; therefore, it is strongly concave craniocaudallyand transversely.The distal surface forms the roof of the distal compartment of the lateral femorotibial sac. This surface is adapted to the saddle shaped lateral condyle of the tibia. It is less curved than the proximal surface.

The axial border of the lateral meniscus is thin and concave. It forms the U-shaped notch; therefore the uncovered part of the lateral condyle of the tibia represents the area of communication between the proximal and distal compartments of the lateral sac of thefemorotibial joint. Inturn in this area there is a direct contact between the lateral condyle of the tibia and the lateral condyle of the femur. The depth of the notch is 12.59±0.04mm while the distance between the two borders is about 27.91±0.03mm.

The abaxial border is convex .Its thickness varies cranially, at middle and caudally where it is about 19.35±0.06, 15.55±0.12 and 23.93±0.13mm respectively. Therefore, the abaxial border is thickest cranially and thinner at the middle than caudally. It is observed that, the presence of a groove on the lateral aspect of the outer border where the tendon of origin of popliteal muscle plays. The meniscofemoral ligament and the caudal ligament of the lateral meniscus are attached to the caudal part of the abaxial border.

The synovial membrane of the proximal and distal compartments of the lateral sac of the femorotibial joint is attached to the proximal and distal margins of the abaxialborder respectively.

The cranial extremity of the lateral meniscus is narrow about 23.49±0.6mm wide. The caudal extremity is thicker and broader than the cranial one. It is about 29.37±0.08 mm wide.

II-Articular capsule:

The articular capsule consists of fibrous and synovial layer.

1- Fibrous layer:

The thickness of the fibrous layer decreases in thickness caudalwards. It attaches cranially with patellar ligaments and laterally with the collateral ligaments and the menisci of the femorotibial joint.

It is reinforced medially by the aponeurosis of sartorius and gracilius, laterally by the aponeurosis of the gluteobiceps and tensor fascia lata, proximally by the tendon of quadriceps and distally by the fascia of the leg.

2- Synovial capsule:

The synovial membrane of the femorotibial joint forms two sacs medial and lateral.

Each sac generally extends from the margin of the articular surface of the corresponding femoral condyle to the corresponding of the tibial condyle. The sac is partially divided into proximal and distal compartments by the corresponding meniscus.

Both compartments communicate with each other axially through the axial concave border of the corresponding meniscus.

In general the synovial membrane of the proximal compartment of the medial sac is attached proximally to the margin of the articular surface of the medial condyle of the femur but distally it is attached peripherally to the proximal margin of the medial meniscus and centrally to the inner margin of the medial condyle of the tibia. This compartment communicates proximally above the medial condyle of the femur with the joint cavity of the femoropatellar joint.

The synovial membrane of the distal compartment is attached peripherally to the distal margin of the medial meniscus and distally to the articular margin of the medial condyle of the tibia.

In general the proximal compartment of the lateral femorotibial sac is attached proximally to the margin of the lateral condyle of the femur, while distally it is attached peripherally to the proximal margin of the lateral meniscus and centrally to the inner margin of the lateral condyle of the tibia.

The synovial membrane of the distal compartment of the lateral sac is attached proximally to the distal margin of the lateral meniscus and distally to the articular margin of the lateral condyle of the tibia.

The lateral femorotibial sac gives off two synovial pouches; the craniolateral pouch extends distally through the extensor groove of the tibia. This pouch is located between the common tendon of origin of the long digital extensor and peronaeustertius and the extensor groove of the tibia and the

initial part of thetibialiscranialis .This large sized pouch surrounds mostly (both sides and caudally) the previously mentioned common tendon. This pouch is about 29.89 mm long and 24.45 mm wide. The lateral pouch extends caudomedially under the tendon of origin of popliteal muscle.

The medial and lateral sacs of the femorotibial joint are separated medially by the cruciate ligaments and a small amount of fat which is formed of soft fatty lobules representing the caudal extension of the corpus adiposuminfrapatellare.This fat is observed cranial to the cranial cruciate ligament.

III-Ligaments:

The ligaments of the femorotibial jointjoint include the ligaments of the menisci, cruciate and collateral.

A-Meniscal ligaments:(Table 2;Figs.4, 5, 6)

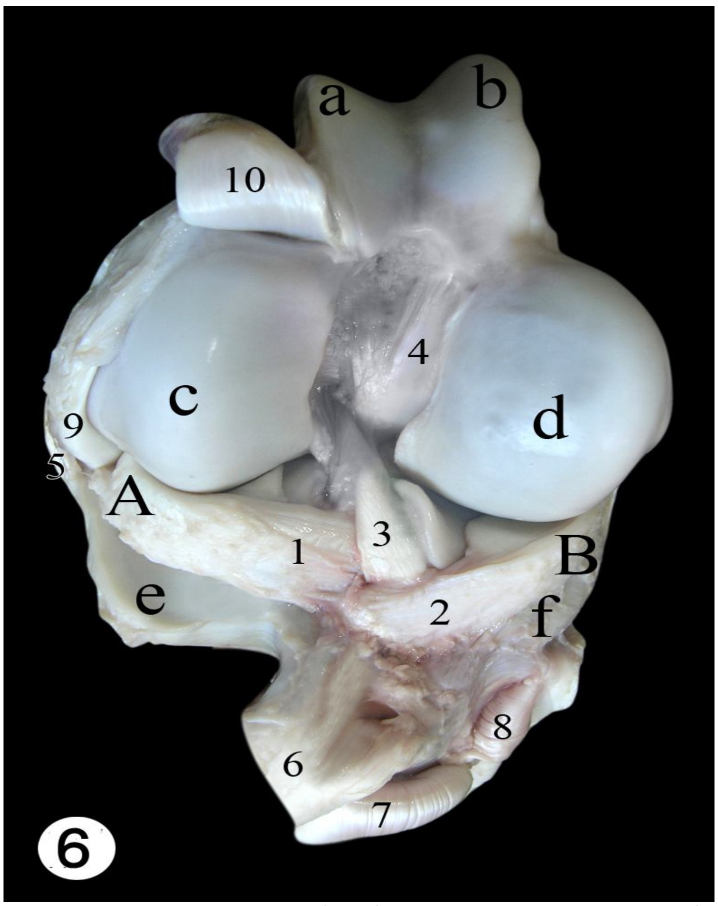


Fig. (6): Photograph showing the distal extremity of the femur and proximal extremity of the tibia and their ligamental attachments of right stifle joint of buffalo. The capsules are removed.

A- Lateral meniscus B- Medial meniscus

a- Lateral ridge of trochlea of femur; b- Medial ridge of trochlea of femur;

c- Lateral condyle of femur; d- Medial condyle of femur; e- Lateral condyle of tibia;

f- Medial condyle of tibia.

1-Cranial ligament of lateral meniscus; 2- Cranial ligament of medial meniscus; 3-Cranial cruciate ligament (Twisted); 4- Caudal cruciate ligament; 5- Lateral collateral ligament;

6- Lateral patellar ligament; 7- Intermediate patellar ligament; 8- Medial patellar ligament;

9-Tendon of origin of popliteal muscle; 10- Common tendon of origin of extensor digitorumlongus&Peronaeustertius muscles;

- **Ligaments of medial meniscus:**

1-Cranial ligament of medial meniscus:

The cranial ligament of the medial meniscus is attached to the cranial extremity of the medial meniscus. It extends laterally and slightly distally to end in a shallow depression in the cranial intercondyloid area cranial to the attachment of the cranialpart of the cranial cruciate ligament. Its length, width and thickness are 30.76±0.4, 16.7±0.23and 6.49±0.2mm respectively.

2- Caudal ligament of medial meniscus:

The caudal ligament of the medial meniscus is thicker than the cranial one.It arises from the caudal extremity of the medial meniscus.It extends cranially and laterally to end in the deep and large caudal intercondyloid area of the tibia.

The length, width and thickness of the caudal ligament of the medial meniscus are 20.29±0.25, 18.26±0.04 and 4.32±0.03 mm respectively.

- **Ligaments of the lateral meniscus:**

1-**Cranial ligament of the lateral meniscus:**

The cranial ligament of the lateral meniscus is attached to the cranial extremity and adjacent abaxialborder of the lateral meniscus. It extends medially and slightly distally on the lateral tibial condyle to terminate in the cranial intercondyloid area between the areas of attachment of the cranial and caudal parts of the cranial cruciate ligament. Its length, width and thickness are 34.34±0.26, 19.39±0.20 and 4.11±0.02 mm respectively.

2-Caudal ligament of the lateral meniscus:

The caudal ligament is a thin fibrous sheet .It arises from the caudal part of the thick abaxial border of the lateral meniscus. It extends distally and slightly medially to turn around the caudal margin of the lateral tibial condyle to end just below it in the popliteal notch undercover the distal portion of the caudal cruciate ligament. Its length, width and thickness are 38.61± 0.14 mm, 28.57± 0.15 mm and 2.88± 0.05mm respectively.

3- Meniscofemoral ligament:

The meniscofemoral ligament is thick well developed fibrous band. It is attached to the proximocaudal part of the abaxial border of the lateral meniscus .It extends proximally and slightly cranially in the intercondyloid fossa to terminate in the proximomedial part of this fossa close to the medial condyle of the femur. Its length, width and thickness are 49.62± 0.13mm, 14.87± 0.12 mm and 3.85± 0.05mm respectively.

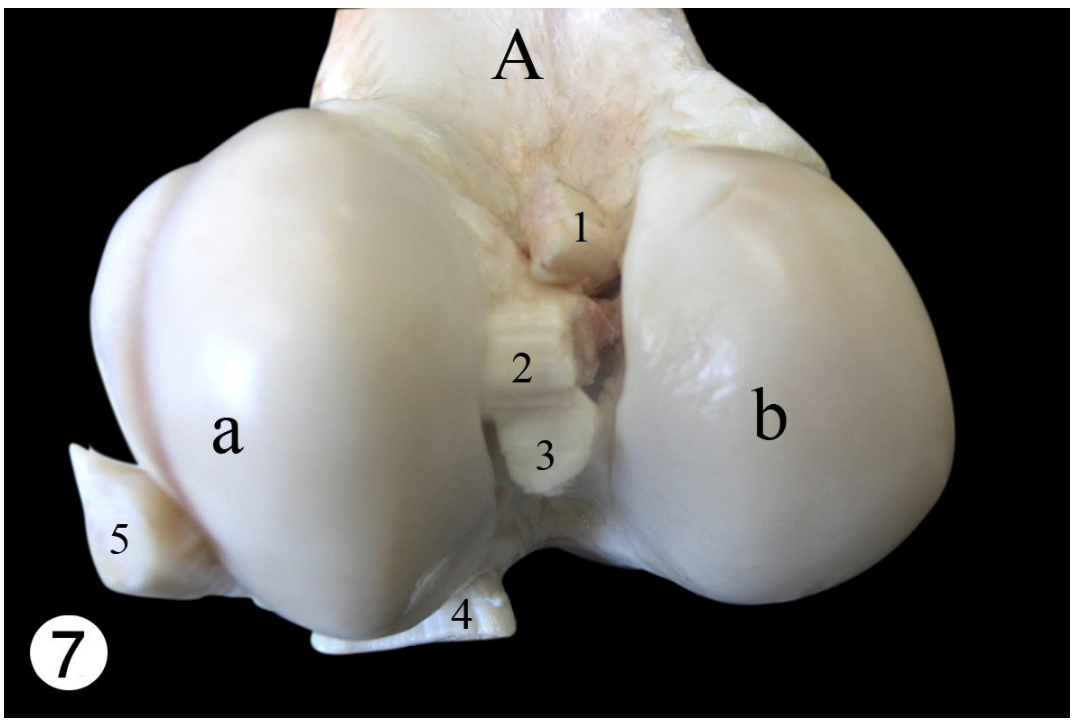


Fig. (7): Photograph of left distal extremity of femur of buffalo. Caudal view.
A-Femur
a- Lateral condyle of femur; b- Medial condyle of femur
1- Meniscofemoral ligament; 2- Cranial cruciate lgament; 3- Caudal cruciate ligament;
4- Common tendon of origin of extensor digitorumlongus&peronaeustertius muscles ;
5- Tendon of origin of popliteus.

B-Cruciate ligaments:(Table 2; Figs.4, 5, 6, 7)

The cruciate ligaments are situated mainly in the intercondyloid fossa of the femur between the two synovial sacs of the femorotibial joint.

1- Cranial cruciate ligament:

The cranial cruciate ligament arises by two parts; cranial and caudal. The cranial part originates from a small ridge located in the cranialintercondyloid area just caudal to the area of attachment of the cranial ligament of the medial meniscus. The caudal part arises from a central intercondyloid area located between the medial and lateral intercondyloid tubercles.

The two parts of the cranial cruciate ligament are directed proximally and caudally fuse together to pass lateral to the caudal cruciate ligament to end in the lateral wall of the intercondyloid fossa of the femur.

It is observed that the cranial cruciate ligament is more twisted than the caudal one. The length, width and thickness of the cranial cruciate ligament are 59.13$\pm$ 0.05, 13.12$\pm$ 0.03 and 7.25$\pm$ 0.01mm respectively.

2- Caudal cruciate ligament:

The caudal cruciate ligament is attached to a large eminence on the medial aspect of the popliteal notch .It extends proximally and cranially medial to the cranial cruciate ligament to end in the cranial part of the intercondyloid fossa of the femur.

The length, width and thickness of the caudal cruciate ligament are 70.88$\pm$ 0.08, 11.45$\pm$ 0.13and 4.1$\pm$ 0.04mm respectively.

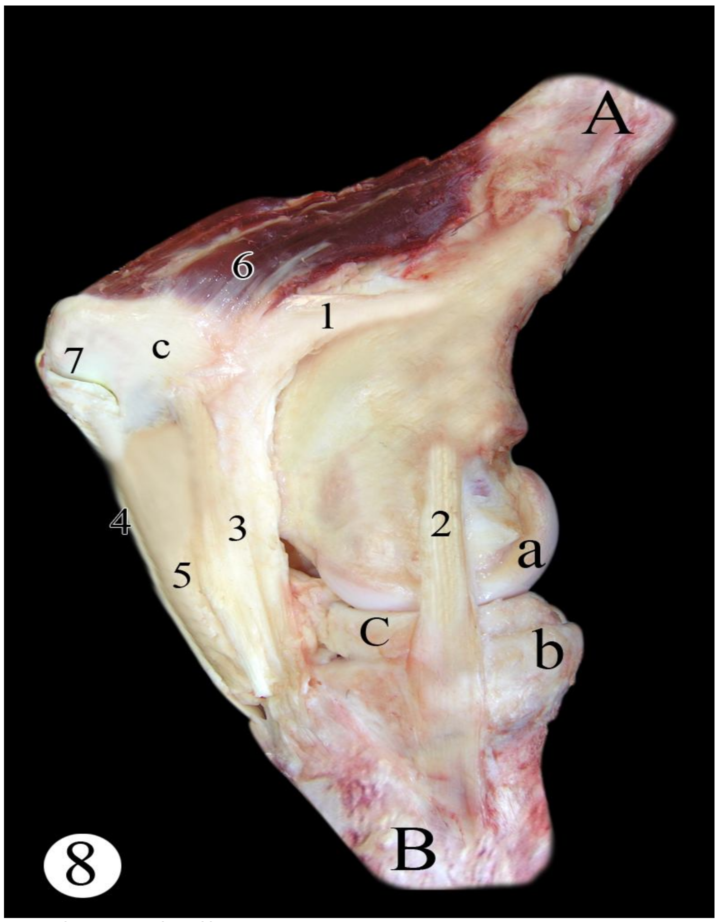


Fig. (8): Photograph of right stifle joint of buffalo. Medial view.
The capsules are removed.
A- Femur B- Tibia C- Medial meniscus
a- Medial condyle of femur; b- Medial condyle of tibia; c- Parapatellar fibrocartilage.
1- Medial femoropatellar ligament; 2- Medial collateral ligament; 3- Medial patellar ligament; 4- Intermediate patellar ligament; 5- Corpus adiposuminfrapatellare; 6-Intermediate vastus muscle; 7- Subtendinous bursa of the medial vastus

C-Collateral ligaments:

1- **Medial collateral ligament:**(Table2; Hist.1; Figs.8)

The medial collateral ligament of the femorotibial joint originates from a tubercle on the medial epicondyle of the femur and directed distally to terminate in the rough area on medial aspect of the tibia 66.24mm distal to the margin of the articular surface of the medial condyle.

The widest part of the medial collateral ligament is the middle portion where it crosses the margin of the medial condyle of the tibia just distal to its crossing a subligamentous bursa is located. This bursa is large measuring 19.43mm long and extends from the margin of the medial condyle of the tibia distally to the line of attachment of this ligament. The length, width and thickness of the medial collateral ligament are 138.53$\pm$ 0.86 mm, 17.03$\pm$ 1.41 mm and 2.43$\pm$ 0.09mm respectively.

2-Lateral collateral ligament:(Table 2;Hist.1; Figs.9,10)

The lateral collateral ligament of the femorotibial joint arises from a depression on the lateral epicondyle of the femur .It is directed distally crossing the tendon of origin of popliteus. A small bursa was observed between the two structures

The ligament crosses the lateral aspect of the lateral condyle of the tibia to end on the head of the fibula. Another relatively large bursa is interposed between the lower part of the lateral collateral ligament and the margin of the lateral tibial condyle.

The length, width and thickness of the lateral collateral ligament are 107.73$\pm$ 5.62 mm, 16.40$\pm$ 0.82and 3.27$\pm$ 0.18 mm respectively.

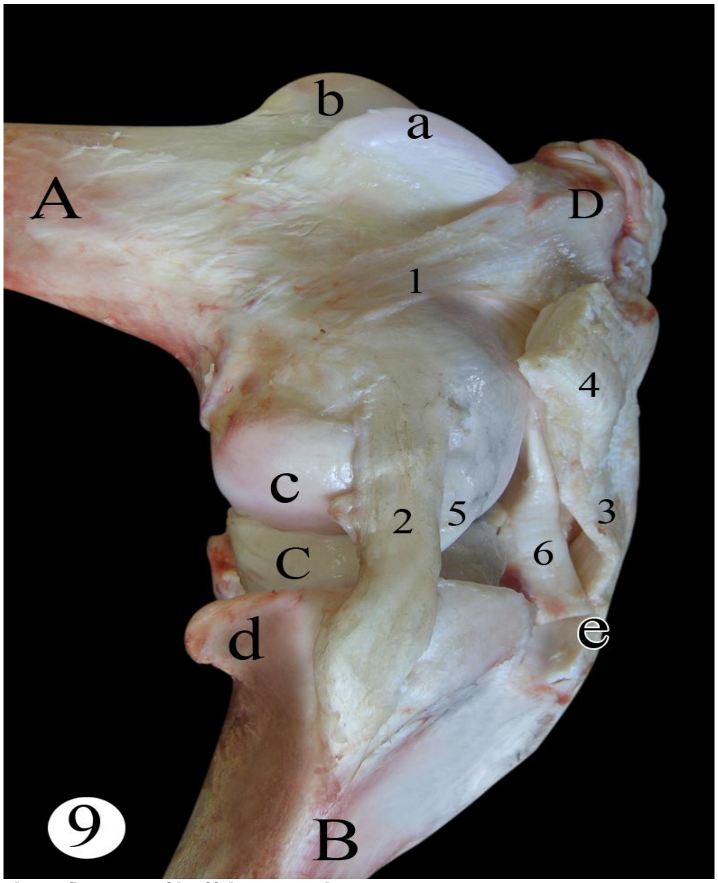


Fig. (9): Photograph of right stifle joint of buffalo. Lateral view.
The capsules are removed.
A- Femur B- Tibia
C-Lateral meniscus D-Patella
a- Lateral ridge of trochlea; b- Medial ridge of trochlea; c- Lateral condyle of femur; d- Lateral condyle of tibia; e- Tibial tuberosity.
1- Lateral femoropatellar ligament; 2- Lateral collateral ligament; 3- Lateral patellar ligament; 4-Tendon of insertion of gluteobiceps; 5-Tendon of origin of popliteal muscle; 6- Common tendon of origin of long digital extensor &Peronaeustertius muscles.

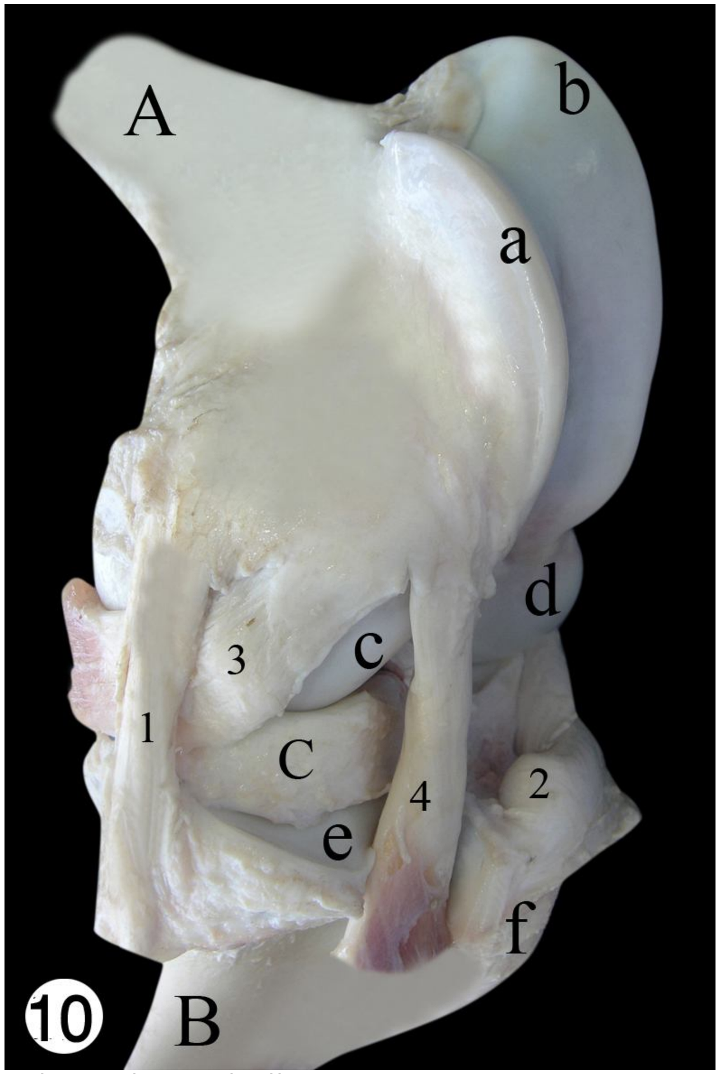


Fig. (10): Photograph of right stifle joint of buffalo. Lateral view.
The capsules are removed.
A-Femur B-Tibia C- Lateral meniscus
a- Lateral ridge of trochlea of femur; b- Medial ridge of trochlea of femur.
c- Lateral condyle of femur; d- Medial condyle of femur; e-Lateral condyle of tibia;
f- Tibial tuberosity.
1- Lateral collateral ligament; 2- Lateral patellar ligament; 3- Tendon of origin of popliteus;
4- Common tendon of origin of extensor digitorumlongus&Peronaeustertius muscles.

DISCUSSION

The stifle is a modified hinge joint that must allows flexion and rotation, yet provide complete stability and control under a great range of loading condition. The stifle consists of two joints, femoropatellar and femorotibial joints.

The bony architecture of the femur, tibia and patella contribute to the stability of the stifle joint, along with static and dynamic restraints of the ligaments, capsule and musculature crossing the joint **(Simon et al., 2000).**

The stifle joint consists of compounded paired femorotibial and single femoropatellar articulation **(Dyce** and **Wensing, 1971)**. The two articulations are interdependent in that the patella is firmly connected to the tibia by ligamentous tissue so that any movement between the femur and the tibia also occurs between the patella and femur **(Evans, 1993)**.

The femorotibial joint is the largest joint in the body and is composed of two condyloid articulations. The medial and lateral femoral condyles articulate with the corresponding tibial condyles. Intervening medial and lateral menisci serve to enhance the conformity of the joint.

The present study denots that the two condyles of the femur of the examined buffalo and cattle are ovoid in shape and slightly oblique in accordance with those given by **Dyce** and **Wensing (1971) in** domestic animals, **Raghavan (1964)** in the ox and **Sisson(1975)** in the horse. However

the latter author added that the lateral condyle is strongly curved similar to that observed in case of buffalo. In agreement with **Sisson (1975)** in the domestic animals the articular surface of the tibia consists of two condyles which are saddle shaped. According to the available literature, there are great differences in the form of the tibial condyles in different animals, they are flat and has a gently undulating surface as mentioned by **Nickel et al.(1986);** and **Dyce et al. (1996).** In the camel **Morcos (1955)** and dog **Evans (1993)** the medial condyle is nearly semicircular or oval while the lateral one is nearly saddle or circular respectively.

The general morphological features of the menisci entering in the formation of the femorotibial joint of buffalo show great resemblance to those of the ox **(Raghavan, 1964),** camel **(Morcos, 1955)**, horse **(Sisson, 1975)** and sheep **(May**, **1970)**. The present finding reveals that the axial border of the menisci is thin andconcave forming a U- shaped notch. through this notch there is a communication between the proximal and distal compartments of the medial and lateral sacs of the femorotibial joint. Also there is a direct contact between thecondyles of the tibia and femur. **Sisson (1975)** and **Frandson**and**Spurgen (1992)** stated that the menisci in domestic animals help to keep the joint congruent, allow greater range or variety of movement and also diminish concussion. However, **Skerritt** and **McLelland (1984)** suggested that the main function of the menisci is believed to provide additional surfaces on which the synovial fluid can exert a lubricating action.

In the present work it can be observed that the medial and lateral compartments of the femorotibial joint have an intervening meniscus located between the femur and tibia. Grossly the menisci are peripherally thick and convex and centrally taper to a thin free margin. The meniscal surfaces confirm to the femoral and tibial contours. The medial meniscus is semicircular; the caudal extremity is wider than the cranial extremity. The cranial extremity is attached to the cranial intercondyloid area in front of the cranial cruciate ligament by the cranial ligament. This attachment is cranial to cranial surface of tibial condyles.

The caudal extremity of the medial meniscus is firmly attached to the caudal intercondyloid area of the tibia by the caudal ligament of medial meniscus cranial and medial to the caudal cruciate ligament tibial attachment side. The ligaments of the femorotibial joint they include meniscal, cruciate and collateral ligaments. Peripherally the medial meniscus is attached to the medial collateral ligament.

The lateral meniscus is semicircular and covers a large portion of the tibial condyle than the medial meniscus. The lateral meniscus has cranial and caudal meniscal ligaments anchored it to the tibia. The cranial ligament of the lateral meniscus attaches its cranial extremity to the cranial intercondyloid area between the two parts of the cranial cruciate ligament. The caudal one attaches its caudal extremity to the popliteal notch. The lateral meniscus is loose peripherally as it is separated from the lateral collateral ligament by the tendon of origin of popliteus muscle. In addition the lateral meniscus has an attachment through the meniscofemoral ligament to the medial condyle of the femur.

When the stifle joint is flexed the menisci move caudally. Caudal motion of the medial meniscus is guided by its attachment to the medial collateral ligament and semimembranouses, whereas cranial translation is caused by the push of the cranial femoral condyle **(Simon et al., 2000).** The lateral meniscus is stabilized and motion guided by the popliteus tendon and meniscofemoral ligament **(Heller** and**Langman, 1964; Staubli**and**Birrer, 1990).**

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** and**Wensing, 1971).**

From the morphological point of view, the movement between the menisci and the tibia is a gliding movement due to their articular surfaces is nearly flat. As the articular surfaces of the femur and menisci are condylar in shape, therefore this joint is a hinge joint. The menisci are fixed on the tibia by the meniscal ligaments. Therefore the femur moves on the menisci which are fixed on the tibia.

The present investigation reveals that the cruciate ligaments are two strong bands, cranial and caudal; the caudal one is longer but narrower and thinner than the cranial one. The cruciate ligaments are named according to their tibial attachment. The same findings were described in ox **(Habel, 1955; Raghavan, 1964),** camel **(Morcos, 1955),** horse **(Sisson, 1975)** and sheep **(May, 1970).**

In the present work the cranial cruciate ligament arises from the central intercondyloid area and extends proximally and caudally to terminate on the lateral wall of the intercondyloid fossa of the femur. These results are similar to that of the above mentioned animals. The present work revealed that the cranial cruciate ligament represented by two bands, cranial and caudal. The cranial one originates from a ridge located caudal to the area of attachment of the cranial ligament of the medial meniscus. The caudal band is attached to the central intercondylar area of the tibia. The two bands pass proximally and caudally fusing together and pass lateral to the caudal cruciate ligament to the above mentioned termination. While, **Dueland et a**l. **(1982)** in the dog observed that the cranial cruciate ligament has two origins from the lateral condyle of the femur. On the other hand, in dog and man **(Rooster et al., 2006; Goldblatt** and **Richmond, 2003)** the cranial cruciate ligament is arranged anatomically and functionally into distinct bands, craniomedial and caudolateral. In agreement with those described by**Raghavan (1964)** in ox, **Sisson (1975)** in horse and **Skerritt** and **McLelland (1984)** in domestic animals the caudal cruciate ligament is attached to a large eminence on the medial aspect of the popliteal notch. It extends proximally and cranially medial to the cranial cruciate ligament to end on the cranial part of the intercondyloid fossa of the femur.

However, in domestic animals the ligament originates from the intercondylar fossa of the medial condyle of the femur and insert either on the caudal intercondylar area of the tibia **(Shively, 1985)** or on the tibia **(Nickel et al., 1986).**

On the other hand, the cranial cruciate ligament appears to be arranged in two bands both cranial and caudal in canine **(Rooster et al., 2006)** or anteriolateral and posteriolateral in man **(Goldblatt and Richmond, 2003).**

Dyce et al. (1996) 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. They are often susceptible to injury when tautened. The cranial cruciate ligament named for relative position of its tibial attachment, is therefore at highest risk when strained in overextension of the joint, its rupture allows abnormally free forward displacement of the tibia in relation to the femur (the cranial drawer sign). The caudal cruciate ligament is at greatest risk in the flexed position of the joint and its rupture allows excessive caudal displacement of the tibia (the caudal drawer sign). Various surgical techniques for the restoration or replacement of these ligaments use fascial or artificial substitutes. However, **Rooster et al. (2006)** in their study on the cruciate ligaments concluded that the cranial cruciate ligament controls cranial drawer motion, whereas the caudal cruciate ligament acts as a major stabilizer against caudal motion. Furthermore the latter ligament is considered to fine tune normal stifle joint kinematics.

The stifle joint is held in apposition by a medial and a lateral collateral ligament on either side **(Frandson and Whitten, 1981).**The present finding reveals that in the buffalo as in ox **(Habel, 1955;Raghavan, 1964),** horse **(Bradley** and **Grahame, 1946; Sisson, 1975)** and sheep (**May, 1970),** the medial and lateral collateral ligament where the lateral one is shorter and narrower but thicker than the medial one.The medial one originates from the medial epicondyle of the femur. It extends distally and blends with the joint capsule, forming a strong attachment to the capsule and medial meniscus. It terminates on the tibia distal to the margin of the medial condyle of the tibia.**Skerritt**and**McLelland (1984)** stated that the medial collateral ligament has superficial and deep parts; the deep part is closely attached to the joint capsule where the capsule joins the medial meniscus. In the present work as well as in the dog **(Vasseur**and**Arnoczky, 1981; Evans, 1993),** as the medial collateral ligament passes over the tibial condyle a bursa is interposed between the ligament and the bone.

In the present work the lateral collateral ligament has an origin from the lateral epicondyle of the femur. In the buffalo it terminates on the head of the fibula simulate these recorded on the corresponding ligament of the ox **(Habel, 1955; Raghavan, 1964),** horse **(Sisson, 1975)** and sheep **(May, 1970).** On the other hand, the lateral collateral ligament of the femorotibial joint of the domestic animals **(Nickel et al., 1986)** and dog **(Evans, 1993)** ends distally on the lateral of the tibia and also the head of the fibula. The fibular branch is particularly well developed in carnivores.

The present investigation reveals that as the ligament crosses the joint cavity it passes over the tendon of origin of the popliteal muscle. In the case of buffalo this ligament is separated from the muscle by a large bursa similar to that described by **Raghavan (1964)** in the ox and **Skerritt**and**McLelland (1984)** in the horse. Like that of the ox **(Raghavan, 1964)** and horse **(Bradley** and **Grahame, 1946; Sisson,1975; Skerritt**and**McLelland, 1984)** there is another bursa between the lateral collateral ligament and the lateral margin of the lateral tibial condyle.

The collateral ligaments worked together with cruciate ligaments to limit internal rotation. In extension the collateral ligaments were the primary check against internal rotation, in flexion the cruciate were the primary restraint against internal rotation of the tibia. External rotation was limited only by the collateral ligaments in both flexion and extension. **Vasseur** and **Arnoczky (1981)** and **Skerritt**and **McLelland (1984)** added that the ligaments are also important in presenting lateral and medial stability.

The collateral ligaments must be attached close to the margin of the articular surface to fix the direction of movement in extension and flexion. The present work shows that the collateral ligaments are long as they extend more distally from the margin of the articular surfaces. Therefore, this leads to instability of movement extension and flexion, particularly in buffalo.

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