GROSS AND MORPHOMETRIC ANATOMY OF MENISCI IN PRE AND POSTNATAL STAGES OF BUFFALO (*BUBALUS BUBALIS*)

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ABSTRACT

Two menisci from 24 stifle joint from different age groups of buffalo were collected and morphometric measurements were recorded and ANOVA analysis was done from SPSS 17 programme. Grossly age related changes like in Group I menisci was quite reddish and fleshy in nature, Group II and III were whitish whereas Group IV was yellowish. The length and width of lateral menisci increased significantly from Group I (5.10±0.66 cm and 0.74±0.17 cm) to Group IV (11.96±0.31 and 2.02±0.15 cm) contrary to medial meniscus significant increase in length seen only from Group I (4.72±0.62 cm) to Group II (9.32±0.47 cm). Significant increase thickness of lateral meniscus at three different regions in two phases from Group I (5.49±1.97, 6.78±1.37 and 5.79±2.71 mm) to Group II (13.3±0.89, 17.22±1.03 and 12.78±0.78 mm) and Group III (14.21±0.25, 17.86±1.15, 13.23±0.60) to Group IV (16.95±0.39, 21.78±0.85 and 14.20±0.59 mm) in case of medial meniscus increase in thickness from Group I (4.46±0.86, 5.11±1.40 and 4.04±0.71 mm) to Group II (11.39±0.60, 12.09±0.35 and 11.08±0.33 mm) only.

Keywords: *Bubalus bubalis*, buffaloes, menisci, prenatal, postnatal, morphometry

INTRODUCTION

Menisci are C shaped fibrocartilaginous structure found in between the proximal extremity of tibia and distal extremity of femur, which enhances the conformation and confrontation of articular surfaces and aids in the smooth sliding of the same.

Meniscal tearing and meniscal wearing are the most common problems these a days in human populations wherein surgical intervention is needed for the same. Amongst animals especially in buffalo which has major share in contribution of GDP of Indian economy has least anatomical study regarding menisci. Objectives is to study the gross and morphometrical anatomy of menisci in accordance to the age from prenatal to postnatal.

MATERIALS AND METHODS

Animals were grouped into four groups

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viz, Group I (Prenatal), Group II (young), Group III (adult) and Group IV (old) based on dentition by FAO and Soliman's formula for prenatal stages. Stifle joint specimens of all groups were carefully dissected to study all its constituent ligaments and articular ends and various gross morphometrical and morphological features were studied and recorded with a thread and scale and digital Vernier caliper's which ever was necessary. The length, width and thickness of the medial and lateral menisci. Thickness of both the menisci were recorded at three regions *viz* anterior, middle and posterior areas. The recorded values were analyzed by SPSS 17 programme for Analysis of variance and graphs were plotted accordingly.

RESULTS AND DISCUSSION

Incongruent articular surfaces of femoro-tibial articulation in stifle joints of buffalo studied were compensated by the presence of two half moon or semi-lunar shaped, hard fibrocartilagenous plate like medial and lateral menisci. Their thick convex peripheral border coupled with thin inner concave border which in turn consisted of 'U' shaped notch increased the concavity of proximal surface of each meniscus. This modification remarkably helped in adapting to the convex surface of the femoral condyles. Flattened distal surface sat comfortably on the tibial condyles anchored by ligaments. These features coincided with the reports of Sisson (1975); Nickel *et al.* (1986); Konig and Liebich (2004); Dyce *et al.* (2010) in cattle; Supriya (2010) in buffalo calves and Hifny *et al.* (2012) in adult buffalo. They further stated that meniscus lateralis did not cover the posterior-lateral part of tibial condyle, instead was over played by tendon of muscle popletius which was also true in the present study (Figure 5 and 9). In fresh state both the menisci were shiny white and fleshy in color in Group I (Figure 1), smooth and glistening white in that of Groups II and Group III (Figure 2), whereas both the menisci in Group IV showed slight yellowish discoloration on proximal surface (Figure 2 and 6). Increased thickness and toughness of the stifle joint menisci in buffalo through the age groups showed that young and adult menisci (Groups II and Group III) were shiny white and very hard in nature.

Menisci were firmly anchored to tibial plateau by tough ligaments thus creating a closely fit and efficient joint space between the articular surfaces. Such anatomical adaptation helped in strengthening the stifle joint of buffalo which resembles the knee joint in humans studied by Messner and Gao (1998). They opined that menisci are capable of distributing load and thus reduces stress on tibia and therefore are essential for cartilage protection and prevention of osteoarthritis.

Each meniscus consisted of two ligaments *viz*., cranial and caudal which anchored the menisci to the intercondylar area and surface of tibial plateau (Figure 4 and 6). The cranial ligament of the medial meniscus extended distally and laterally to be inserted cranially in front of the attachment of cranial cruciate ligament in anterior aspect of inter condyloid area (Figure 4 and 7). The tough cranial ligaments of medial and lateral menisci are anchored firmly in intercondylar fossa of tibial plateau in front and in between the two divisions of the ACL respectively. Caudal ligament of medial meniscus originates as a strong tendon from its axial surfacecrossed obliquely and inserted in intercondyloid fossa, thus anchoring the meniscus to the entire surface of medial tibial condyle. Caudal ligament of lateral meniscus originates

from posterio-medial aspect of femoral condyle by a thick, strong flat tendon which blends on its post surface, whereas some fibres passed distally to be inserted below the rim of tibial plateau in popliteal notch under the PCL. The sturdy cruciate ligaments helped stabilize the joint in extreme movements of extension and flexion. These observations support the opinion of Ghosh (2006) in ox and Cheriver *et al*. (2009) in domestic animals who expressed that menisci play an important role in weight bearing, joint stabilization, shock absorption and protection of AC from stress.

Unlike the smaller and more circumferential medial meniscus when compared to the larger ovoid shaped lateral meniscus described in sheep and goats by Little *et al.* (2010), the buffalo menisci in the present study were almost alike in shape and size and resembled the description of menisci by Cheriver *et al.* (2009) in domestic animals and Hifny *et al.* (2012a) in adult buffalo and cattle. The latter authors quoted that these fibrocartilagenous plates were crescent shaped and showed great resemblance with those of the ox, camel, horse and sheep.

The length and width of the lateral meniscus increased significantly ($P \leq 0.01$) from Group I (5.10±0.66 cm and 0.74±0.17 cm) to Group IV (11.96±0.31 and 2.02±0.15 cm). Whereas thickness of the lateral meniscus in three regions increased significantly from Group I (5.49±1.97, 6.78±1.37 and 5.79±2.71 mm) to Group II (13.3±0.89, 17.22±1.03 and 12.78±0.78 mm) and also from Group III (14.21±0.25, 17.86±1.15, 13.23±0.60) to Group IV (16.95±0.39, 21.78±0.85 and 14.20±0.59 mm) specimens (Table 1). Change in the thickness of the lateral meniscus was insignificant between specimens of Group II and Group III wherein it was almost equal.

The growth in length of the medial meniscus was significant from Group I (4.72±0.62 cm) to Group II (9.32±0.47 cm) specimens. Thereafter it did not increase significantly up to Group III. But from this stage to the next a significant increase in length was noticed. The mean length of the medial meniscus in Group IV was 11.32±0.64 cm (Table 1). In case of its width a significant increase was seen from Group I (0.55±0.10 cm) to Group IV (1.73±0.04 cm), whereas the growth in thickness was significant only from Group I (4.46±0.86, 5.11±1.40 and 4.04±0.71 mm) to Group II (11.39±0.60, 12.09±0.35 and 11.08±0.33 mm). Beyond this stage the thickness of the medial menisci was more or less the same up to Group IV (Table 1). Growth in length of lateral meniscus increased significantly ($P \leq 0.01$) from Group I to Group IV, whereas in case of medial meniscus a significant increase in length was noticed in two spells *i.e*., between Group I to Group II and from Group III to Group IV (Table 1 and Plate 1). The mean length and width of lateral and medial meniscus in adult animal (Group IV) was 11.96±0.31 cm and 2.02±0.15 cm; 11.32±0.64 cm and 1.73±0.04 cm respectively. These measurements indicate that both the menisci were nearly of the same shape and size. The thickness of lateral meniscus in three regions was slightly more numerically than that of medial one. The above findings slightly differ with Hifny *et al.* (2012a) who recorded that the abaxial border of lateral meniscus of adult buffalo in cranial and caudal extremity was almost similar (19.35±0.06 mm and 23.93±0.13 mm) to the medial one (19.44±0.16 mm and 17.45±0.19 mm) respectively.

Table 1. Morphometric growth of meniscifrom prenatal (Group I) topostnatal (Group II, III and IV) stages.

Sl. No.	Parameter Mean		Group I		Group II		Group III		Group IV	
			SD	Mean	SD	Mean	SD	Mean	SD	Mean
1	Lateral Meniscus	L	5.10[a]	0.66	9.56[b]	0.46	10.60[c]	0.42	11.96[d]	0.31
		W	0.74[a]	0.17	1.45[b]	0.14	1.79[c]	0.06	2.02[d]	0.15
		T1	5.49[a]	1.97	13.3[b]	0.89	14.21[b]	0.25	16.95[c]	0.39
		T2	6.78[a]	1.37	17.22[b]	1.03	17.86[b]	1.15	21.78[c]	0.85
		T3	5.79[a]	2.71	12.78[b]	0.78	13.23[b]	0.60	14.20[c]	0.59
2	Medial Meniscus	L	4.72[a]	0.62	9.32[b]	0.47	9.96[b]	0.14	11.32[c]	0.64
		W	0.55[a]	0.10	1.27[b]	0.08	1.55[c]	0.05	1.73[d]	0.04
		T1	4.46[a]	0.86	11.39[b]	0.60	12.21[b]	0.59	13.01[b]	0.13
		T2	5.11[a]	1.40	12.09[b]	0.35	12.78[b]	0.48	13.43[b]	0.18
		T3	4.04[a]	0.71	11.08[b]	0.33	11.07[b]	0.16	11.34[b]	0.10

L = Length and W = Width (in cm);

T1/T2/T3 = Thickness (in mm) at anterior, posterior and middle aspect of abaxial border ofeach meniscus.

*Means with similar superscript within a row do not differ significantly (P≤0.05).

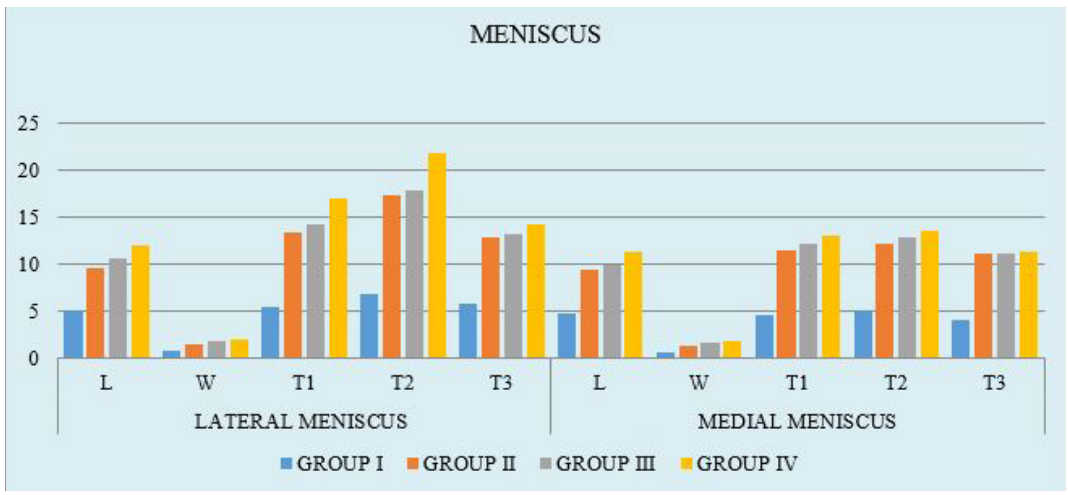

Plate 1. Morphometrical changes in stifle joint Menisci from Prenatal Stage (Group I) to Postnatal Stage (Group IV).

L = Length, (in cm),

W = Width, (in cm),

T1/2/3 = Thickness (in mm) at anterior, posterior and middle aspectof abaxial border of each meniscus.

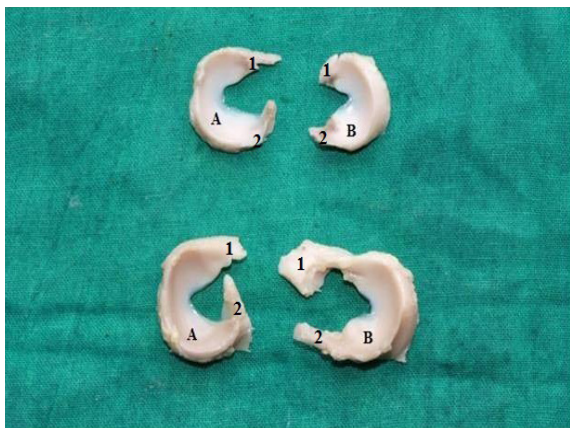

Figure 1. Proximal view photograph of two menisci of Group I specimens aged 164 days (CVRL 40.1 cm) in upper row and 180 days (CVRL 47.5 cm) in lower row.
A - Lateral Meniscus,
B - Medial meniscus,
1 - Cranial ligament,
2 - Caudal ligament

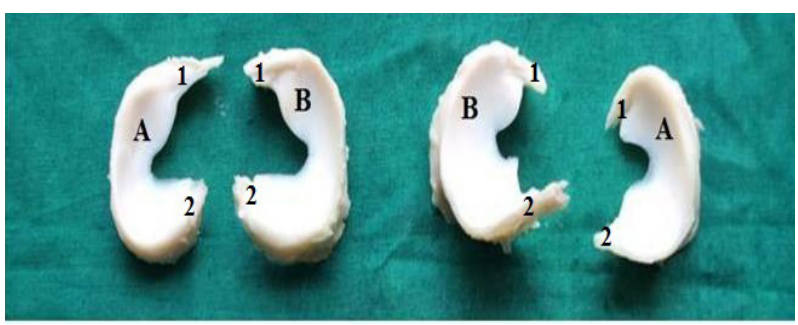

Figure 2. Proximal view of stifle joint menisci Group II.
A - Lateral meniscus,
B - Medial meniscus,
1 - Cranial ligament of respective meniscus,
2 - Caudal ligament of respective meniscus

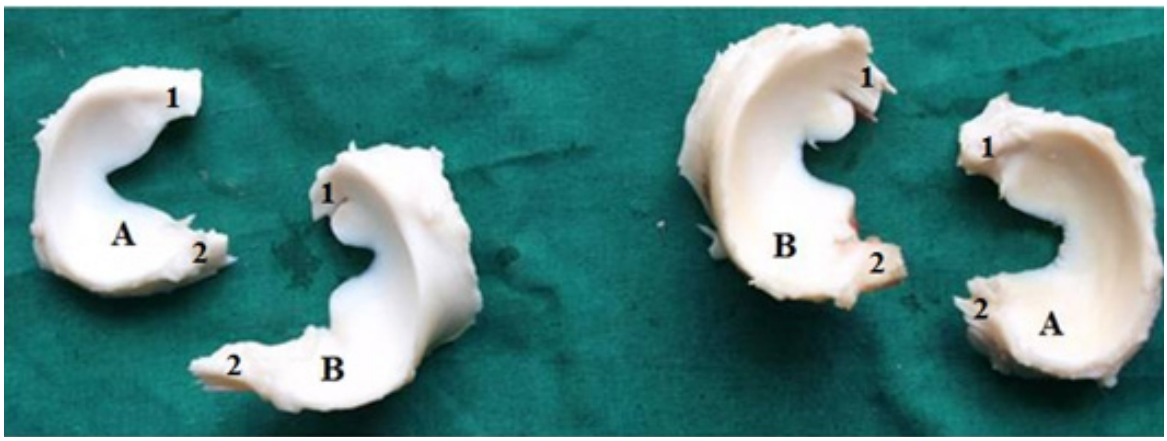

Figure 3. Proximal view of stifle joint menisci III (left) and IV specimens (right).
A - Lateral meniscus,
B - Medial meniscus,
1 - Cranial ligament of respective meniscus,
2 - Caudal ligament of respective meniscus

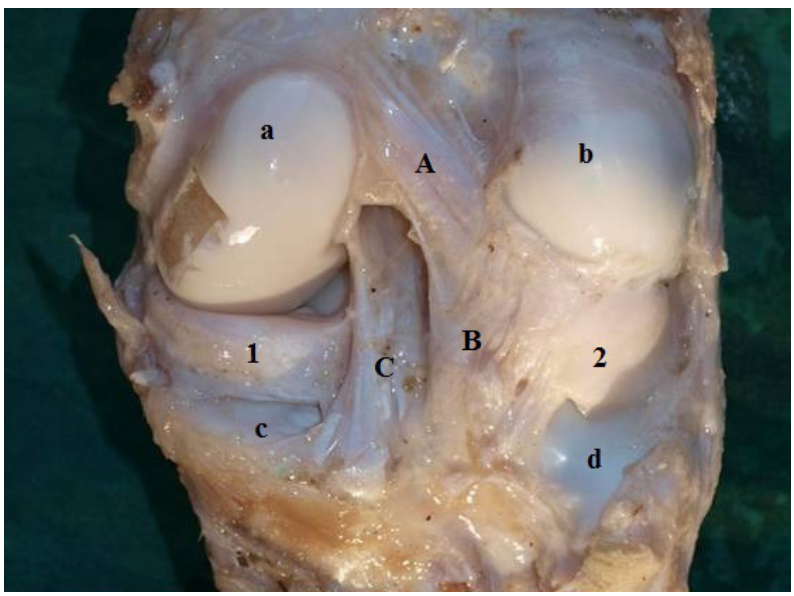

Figure 4. Caudal view of dissected stifle joint of Group II specimen.
A - Menisco femoral ligament of lateral meniscus,
B - Menisco tibial ligament of lateral meniscus,
C - Caudal cruciate ligament,
a - Medial femoral condyle, b - Lateral femoral condyle,
c - Medial tibial condyle, d - Lateral tibial condyle,
1 - Medial meniscus, 2 - Lateral meniscus

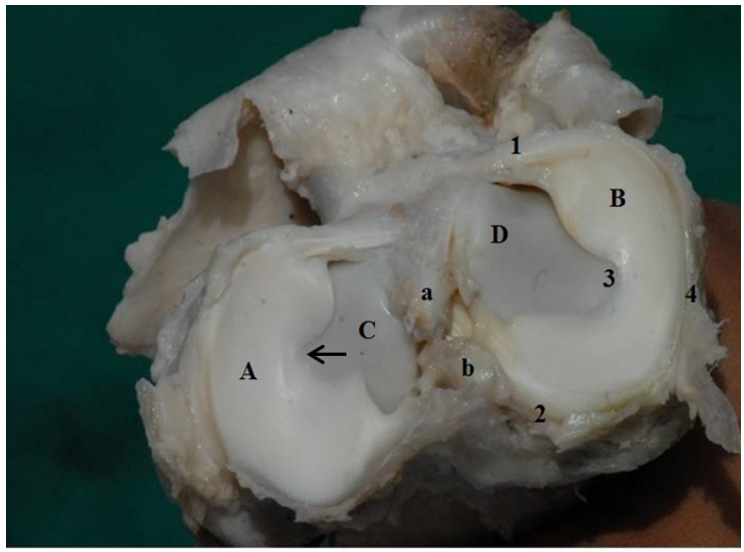

Figure 5. Proximal view of menisci of Group II specimen showing meniscal ligaments attachment.
A - Lateral meniscus, B - Medial meniscus,
C - Lateral tibial tubercle, D - Medial tibial tubercle,
1 - Cranial extremity, 2 - Caudal extremity,
3 - Axial border, 4 - Abaxial border,
a - ACL, b - PCL

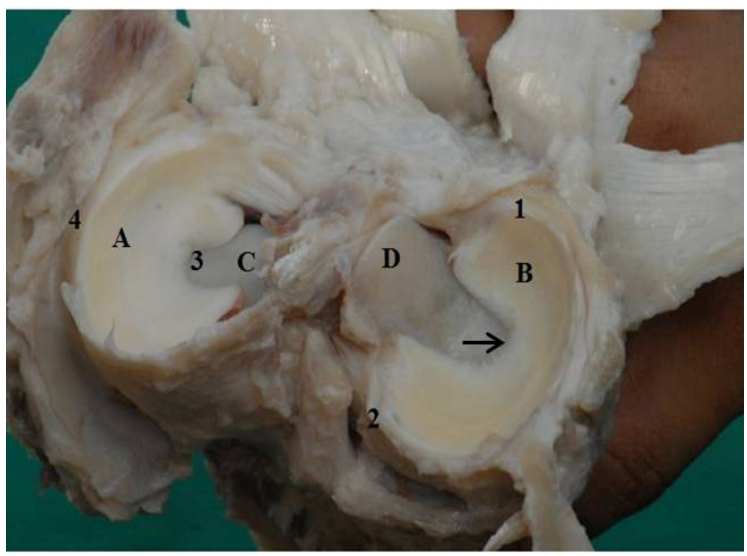

Figure 6. Proximal view photograph of menisci of Group IV specimen showing yellowish discolouration and meniscal ligaments attachment.
A - Lateral meniscus, B - Medial meniscus,
C - Lateral tibial tubercle, D - Medial tibial tubercle,
1 - Cranial extremity, 2 - Caudal extremity,
3 - Axial border, 4 - Abaxial border, Arrow showing u shaped notch.

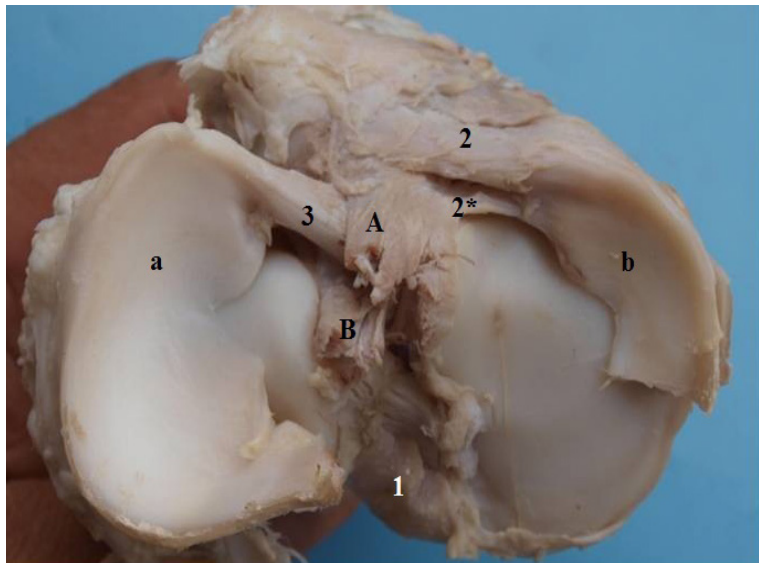

Figure 7. Proximal view of menisci of Group II specimen showing divisions of anterior cruciate ligament.
A - Anterior division of ACL, B - Posterior division of ACL,
a - Medial meniscus, b - Lateral meniscus,
1 - PCL, 2 - Anterior division of cranial ligament of lateral meniscus,
2* - Posterior division of cranial ligament of lateral meniscus,
3 - Cranial ligament of medial meniscus

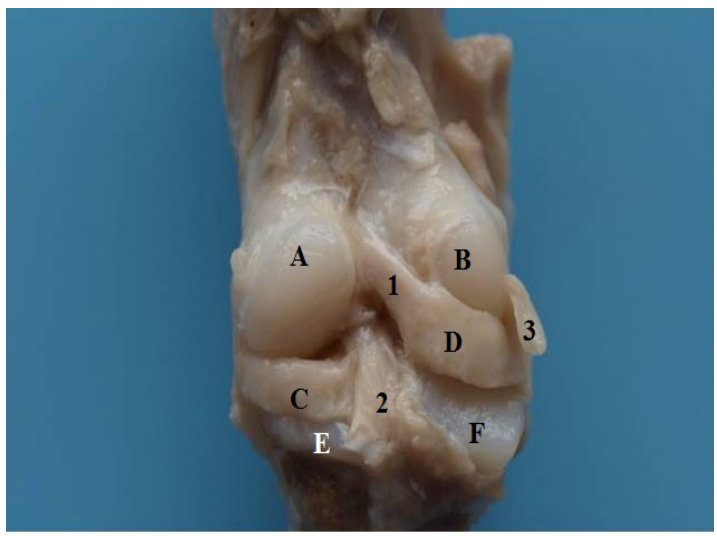

Figure 8. Caudal view of stifle joint of Group I specimen aged 180 days showing menisci and ligaments.
A - Medial femoral condyle, B - Lateral femoral condyle,
C - Medial meniscus, D - Lateral meniscus,
E - Medial tibial condyle, F - Lateral tibial condyle,
1 - Menisco femoral ligament of lateral meniscus, 2 - PCL, 3 - Cut tendon of popliteal tendon

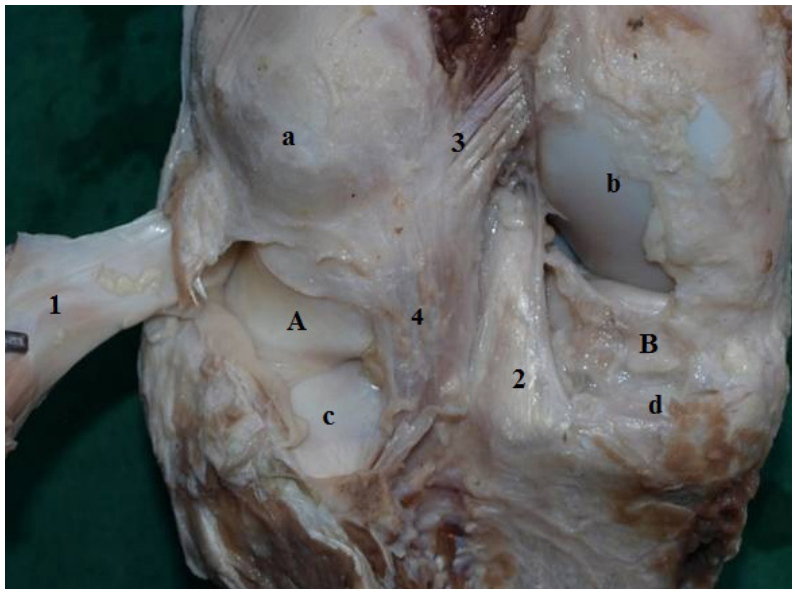

Figure 9. Caudal view of dissected stifle joint of Group IV showing specimen posterior lateral surface of lateral tibial condyle byreflecting popliteal tendon.
A - Lateral meniscus, B - Medial meniscus,
a - Lateral femoral condyle, b - Medial femoral condyle,
c - Lateral tibial condyle, d - Medial tibial condyle,
1 - Cut tendon of popliteal muscle, 2 - PCL,
3 - Menisco femoral ligament of lateral meniscus,
4 - Menisco tibial ligament of lateral meniscus

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