



## ULTRASONOGRAPHIC IMAGING OF THE NORMAL STIFLE JOINT IN BUFFALOES (*BOS BUBALIS*)

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### ABSTRACT

The diagnosis of a stifle disorder can be a challenge and various imaging modalities are routinely used to arrive at an accurate diagnosis. This study describes the normal ultrasonographic anatomy in relation to cross sectional anatomy. Patellar and collateral ligaments: lig. popliteum obliquum and common tendon of origin of the Mm. extensor digitorum longus and peroneus tertius were imaged in longitudinal planes as homogeneous, echogenic structures with linear pattern. In the transverse planes, they are difficult to differentiate from the surrounding because small diameter and linear fibers not appear but can be evaluated in tendon because of the tendon synovial sheath. The bone surfaces of the patella, femur and tibia were imaged as hyperechoic structures. The infrapatellar fat pad appears as heterogeneous echogenic structure with hyperechoic dots. The joint capsule could not be differentiated from the adjoining soft tissues, as they showed the same echogenicity.

**KEY WORDS:** Buffalo, Cross Sectional Anatomy; Stifle, Ultrasonography.

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### 1. INTRODUCTION

The stifle joint is often exposed to many surgical problems as patellar luxation, patellar upward fixation, gonitis (stifle arthritis), synovitis, fracture, meniscal tearing and cruciate ligament sprain in the bovine.

Ultrasonography is a safe, noninvasive method and consequently can be performed in the conscious patient or under light sedation in the carnivore [20]. Ultrasonography is still regularly used in many clinics because of the relative high cost of MRI and its lack of widespread availability.

Ultrasonographic imaging was a challenge because there are some factors that interfere with imaging like animal temperament, difficult to yield proper acoustic window and inability to flex the stifle joint in the horse [18, 19].

Radiography may provide a definitive diagnosis to the bones, but it shows slight

data on the soft tissue structures. Ultrasonography provides excellent visualization of soft tissue structures. The normal ultrasonographic appearance of the distal limbs, tarsus and stifle joint has been reported in the cattle [8, 13, 14] and horse [7, 9, 17, 21].

Several shortage factors associated with ultrasonography imaging that limit its use for the judgment of the stifle joint because each image represent only a part of the sectional anatomy for any given level of the body. The visualization of some ligaments are not diagnostic even if are succeed to be imaged like the intrarticular ligaments because of narrow interarticular space and also not diagnostic to caudal ligaments because heavy musculature of the thigh [20].

Performing Ultrasonographic examination of the equine stifle requires a systematic approach and an adequate knowledge of

the cross-sectional anatomy of this joint [9].

The aim of the present study is to give reference data for the ultrasonographic examination of buffalo stifle disorders.

## 2. MATERIALS AND METHODS

Twenty stifle joints collected from adult buffaloes 2-3 years of age to both sexes showing neither bony nor articular deformities that previously confirmed by the case history and palpation were used in the study; the animals had been collected from freshly dead animals in teaching farm at Fac. Vet. Med. and Fac. Agr., Benha University. All joints were preserved in refrigerator, the cadaver stifles then were defrosted before they could be imaged because of frozen artifacts.

The specimens after to application of ultrasound coupling gel examined by the ultrasonography by using A real time, B- and M-mode linear array ultrasound Scanner (Scanner 240 Vet., Pie medical company, Maastricht, Netherlands). A black and white video graphic printer (UP-890 MD, Sony®, Toyohashi, Japan) was used For printing the frozen image. The scanner is provided with either 6.0 or 8.0 MHz linear transducer or 3.5 MHz curved linear transducer without a standoff pad. The trochlear ridges and its articular cartilages were imaged underneath the patellar ligaments. The patellar ligaments were palpated individually with special consideration to the ligament inclination, followed by a transverse and longitudinal scan. The insertion of the gluteobiceps tendon onto the lateral patellar ligament was imaged in midway between the patella and tibial tuberosity. After the medial and lateral collateral ligaments palpation from the medial and lateral aspects of the femorotibial joint respectively, they were imaged with their corresponding menisci. The meniscus was imaged either underneath the corresponding collateral ligament or between the patellar ligament and the corresponding collateral ligament.

A depth of 3 to 4 cm provides excellent resolution of the collateral ligaments and 4 to 6 cm to the menisci. The medial compartment of the femorotibial joint was imaged just cranial to the medial collateral ligament. The lateral meniscus was imaged too between the tendon of origin of the peroneus tertius and the long digital extensor tendon. The position and echogenicity of all imaged structures were determined. Some imaged structures were measured using the electronic calipers.

Ten of the previously examined specimens were carefully dissected in the fresh state to study the morphological feature of the articular surfaces, ligaments and the other related structures. In the other ten specimens, the articular capsule were distended by either red colored gum milk latex. Immediately after injection, the joints were flexed and extended 100 times. This was followed by specimens' preservation in refrigerator for 48 hours, then the stifle specimens were sectioned into successive cross sections using local manufactured electric saw; 10 horse electric power (1 cm slice thickness).

## 3. RESULTS

### 3.1. *Ligaments, tendons and menisci:*

The medial patellar ligament is seen to originate from the medial parapatellar fibrocartilage attached to the medial border of the patella. The insertion of the lateral patellar ligament is identified directly caudal to the insertion of the intermediate patellar ligament on the tibial tuberosity (Figs.1, 2, 5). The lateral collateral ligament is imaged directly contiguous to the tendon of origin of the M. popliteus, which separates it from the lateral meniscus (Fig.8). The medial collateral ligament (Fig.10) is imaged adhering to the medial meniscus. In longitudinal planes, the ligaments and tendon of origin of the M. popliteus (Fig.8) appeared as homogeneous, echogenic structures with linear pattern due to the fibers distribution so they were differentiated from the

surrounding connective tissue, fatty tissue, bone and muscles while in transverse planes, it's difficult to differentiate them because of small diameter and linear fibers don't appear. The medial patellar fibrocartilage (Fig.11) appears as hypoechoic structure and measures 22 mm in mean width. The large, infrapatellar fat pad (Fig.4, 12), located between the patellar ligaments and the femoropatellar joint capsule appears as heterogeneous echogenic structure with hyperechoic dots. The Common tendon of origin of the Mm. extensor digitorum longus and peroneus tertius is seen in transverse (Fig.6) and longitudinal planes (Fig.7), originating from the lateral epicondyle, distolateral to the lateral trochlear ridge of the femur and running over the extensor groove of the tibia, lateral to the tibial tuberosity. Further distally, on the cranio-lateral aspect of the tibia, the tendon-muscle transition is visualized: the echogenic tendon changed to a mainly anechoic muscle belly with echogenic septa (Fig.7).

The menisci appeared as homogeneous, triangular structures enclosed by the femoral and tibial condyles. The medial meniscus (Fig.10) is more echogenic than lateral one (Fig.8). The medial meniscus protruded abaxially from the joint margins where it intimately contacted to the echogenic medial collateral ligament. The lateral meniscus is separated from the lateral collateral ligament by the clearly visible echogenic popliteal tendon. The meniscotibial ligaments of the medial and lateral meniscus couldn't be imaged.

The cranial and caudal cruciate ligament couldn't be imaged in flexed and extended cadaver limbs. In live animals it's so difficult to hold the hindlimb in flexed position for imaging. The transducer is placed between the intermediate and lateral patellar ligament in close vicinity to the tibial tuberosity.

### 3.2. *Bone surfaces and articular cartilages:*

All the bone surfaces appear as hyperechoic structures. The medial and lateral trochlear ridges (Fig.3, 4) and the intertrochlear groove imaged distal to the patella as hyperechoic structures that covered by a thin layer of anechoic articular cartilage. The mean thickness of the articular cartilage of the lateral and medial trochlear ridges and the intertrochlear groove (Fig.3) measures about 1.9 mm, 1.8 mm and 2.2 mm respectively. The mean distance between the most cranial parts of the medial and lateral trochlear ridges is 38.9 mm.

The medial femoral condyle and epicondyles (Fig.10) could only be imaged dorsal to the proximal meniscial surface and the lateral femoral condyle and epicondyles (Fig.11) imaged laterally. The femoral condyles covered by anechoic articular cartilage. The medial and lateral tibial condyles can be imaged distal to the medial and lateral meniscus respectively. Also the extensor sulcus (Fig.6) can be scanned medial to the Common tendon of the extensor digitorum longus and peroneus tertius.

### 3.3. *Synovial sacs:*

The Lateral femorotibial joint craniodistal pouch could be differentiated from surrounding structures. It appeared as an anechoic structure located between the extensor sulcus of the tibia and common tendon of origin of the Mm. extensor digitorum longus and peroneus tertius. The proximal compartment of the medial femorotibial sac (Fig.9) could be scanned longitudinally cranial to medial collateral ligament by adjusting the probe from craniomedial to caudolateral direction but this view make medial meniscus to appear as heterogeneous anechoic structure. The fibrous capsule femoropatellar synovial sac could not be differentiated in all examined specimens from the adjoining soft tissues, as they showed the same echogenicity.

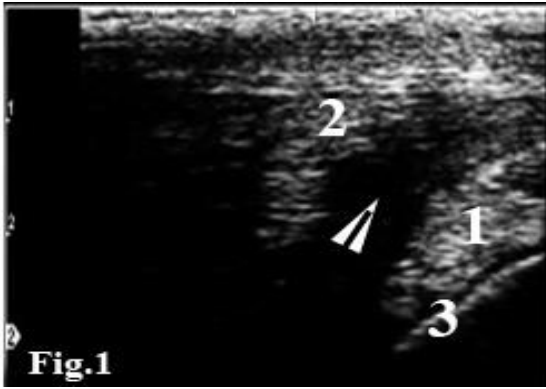


Fig.1 Transverse Ultrasonographic image to the cranial stifle region of a normal buffalo; shows Lig. patellae laterale (1) et intermedium (2) by positioning of 6 MHz linear transducer transversely just proximal to their insertion on the Tuberositas tibiae (3). The arrow head indicate the distal infrapatellar bursa in between the insertion of both ligaments.



Fig. 4 Longitudinal Ultrasonographic image to the cranial stifle region of a normal buffalo, showing the medial trochlear ridge (1) by placing 6 MHz linear transducer longitudinally above the medial trochlear ridge between the intermediate and medial patellar ligament. Note bone surface of the medial trochlear ridge, the Cartilago articularis (arrow) and Corpus adiposum infrapatellare (2).

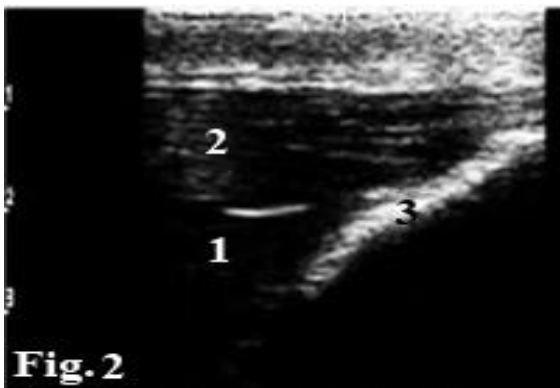


Fig. 2 Longitudinal Ultrasonographic image to the cranial stifle region of a normal buffalo, showing Lig. patellae laterale (1) et intermedium (2) by positioning of 6 MHz linear transducer longitudinally just proximal to their insertion on the Tuberositas tibiae (3).

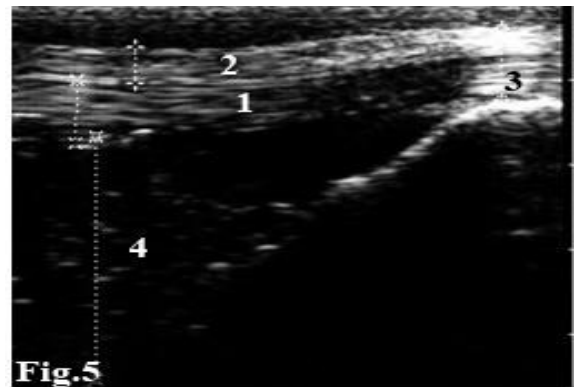


Fig. 5 Longitudinal Ultrasonographic image to the cranial stifle region of a normal buffalo showing Lig. patellae laterale (1) et intermedium (2) by positioning of 6 MHz linear transducer longitudinally oblique along their length before insertion on the Tuberositas tibiae (3). Caudal to the ligaments, Corpus adiposum infrapatellare (4) appears as anechoic structure with hyperechoic dots.

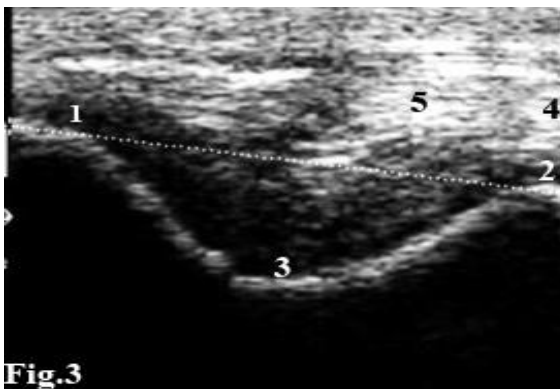


Fig. 3 Transverse Ultrasonographic image to the cranial stifle region of a normal buffalo showing both medial (1) and lateral (2) trochlear ridges and the intertrochlear groove (3) and Cartilago articularis covering them, also Lig. patellae laterale (4) et intermedium (5) by positioning of 6 MHz linear transducer transversely during standing position. Note the relative position of Lig. patellae laterale et intermedium to the lateral trochlear ridge

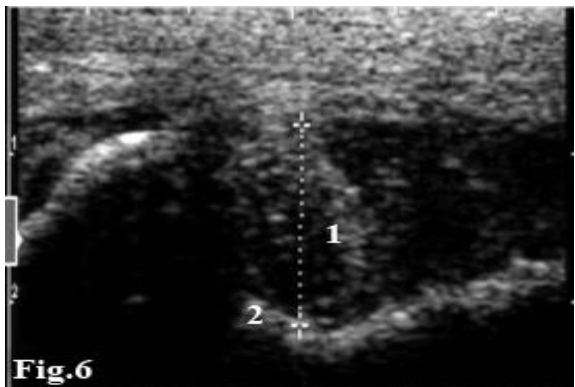
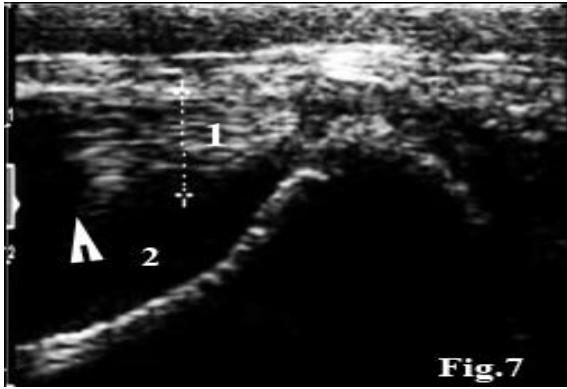


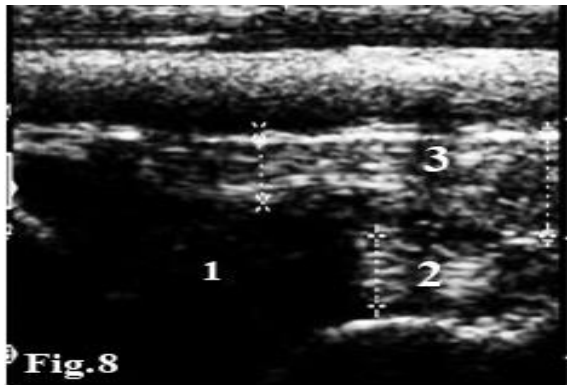
Fig. 6 Transverse scan of the common tendon of origin of the Mm. extensor digitorum longus and peroneus tertius (1) lateral to the tibial crest within the Sulcus Extensorius (2) of the Tibia by positioning of 8 MHz linear transducer transversely lateral to proximal end of tibial crest.



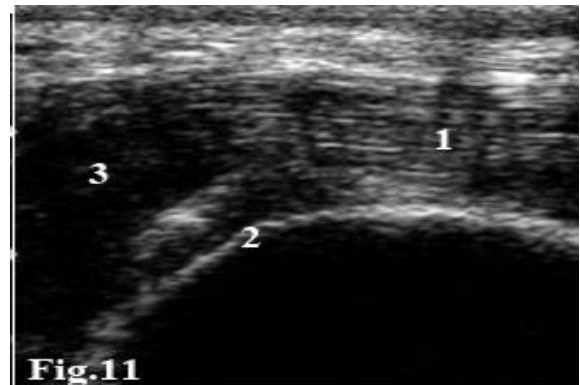
**Fig. 7** Longitudinal scan of the common tendon of origin of the Mm. extensor digitorum longus and peroneus tertius (1) lateral to the tibial crest within the Sulcus Extensorius of the Tibia by positioning of 8 MHz linear transducer lateral to proximal end of tibial crest in cranial part of the Sulcus Extensorius. The arrow head indicate the line of transition from the tendon to the muscle belly. The distal pouch of the Articulatio femorotibialis lateralis (2) was imaged.



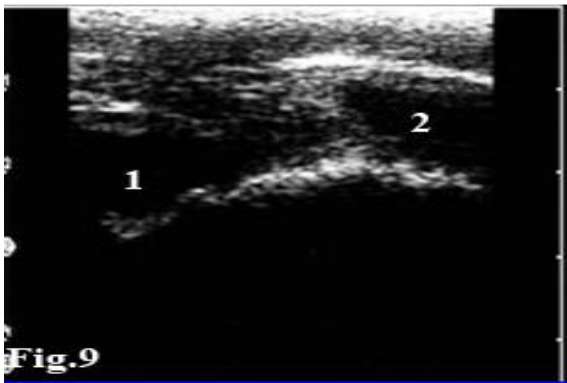
**Fig. 10** Longitudinal Ultrasonographic image to the medial stifle region of a normal buffalo by placing 8 MHz linear transducer longitudinally above the Lig. collaterale mediale (1). The Meniscus medialis (2) lying within the joint triangular space lying beneath the hyperechoic surfaces of the Os femoris and above the hyperechoic surface of the Tibia. The Meniscus medialis appears as hypoechoic structure and the echogenic Lig. collaterale mediale intimately contact to it.



**Fig. 8** Longitudinal scan of the Meniscus lateralis (1) that appears anechoic with hyperechoic dots in between the surfaces of the Os femoris and Tibia by placing 6 MHz linear transducer parallel to the course Lig. popliteum obliquum (2). Note the echogenic Lig. popliteum obliquum, the Lig. collaterale laterale (3).



**Fig. 11** Longitudinal Ultrasonographic image to the medial stifle region of a normal buffalo by using 8 MHz linear transducer, showing Lig. patellae mediale (1) against to the medial trochlear ridge (2), note also the hypoechoic Fibrocartilagine parapatellaris medialis (3) attaches the ligament proximally.



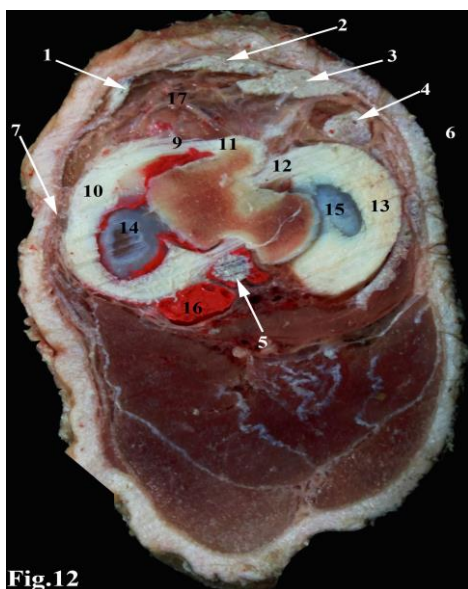
**Fig. 9** Longitudinal Ultrasonographic image to the medial stifle region of a normal buffalo by using 6 MHz linear transducer; was showing a small anechoic area of the Articulatio femorotibialis medialis (1) pouch dorsal to the triangular contour of the Meniscus medialis (2).

#### 4. DISCUSSION

The cranial and caudal cruciate ligaments cannot be imaged in this study and if it is possible it was not diagnostic to any of them. This result agrees with previous studies in the cattle [1, 5, 14] and horse [21]. Though, in dog the cruciate ligaments appeared forming a V-like shape as a hypoechoic band [11, 20]. The cruciate ligaments were identifiable in the horse as stated by Penninck et al. [16] and Cauvin et al. [2]. While Hoegaerts et al. [10] reported that cruciate ligament is a challenge due to their position and oblique

orientation and can only be examined in flexion by the curvilinear transducer.

The medial and the lateral collateral ligaments in longitudinal ultrasonographic planes is similar to that recorded by former authors in the cattle [1, 5, 14] and horse [21]. Moreover, the lateral collateral ligament is somewhat hypoechoic appearance [21]. The echogenic medial collateral ligament appears hypoechoic in horse when the ultrasound is not perpendicular to its fibers which was not observed [18]. The present study agreed with previous studies in the buffalo [12], cattle [8] and horse [3, 15] and dog [6, 11] showed that the medial, intermediate and lateral patellar ligaments appear as homogeneous and echogenic structures with linear pattern appearance.



**Fig.12**

Fig. 12 Anatomical Cross section of the right stifle at the level of the menisci. Note the Lig. Patellae mediale (1), intermedium (2) et laterale (3), the Common tendon of the Mm. extensor digitorum longus and peroneus tertius (4), Lig. Cruciatum caudale (5) and Lig. collaterale laterale (6) et mediale (7). The cranial meniscotibial ligaments (9) of the Meniscus medialis (10) and the cranial meniscotibial ligament (12) of the Meniscus lateralis (13) ends at the Area intercondylaris cranialis (11). Note also the medial (14) and lateral (15) femoral condyles, the Articulatio femorotibialis medialis (16) and the corpus adiposum infrapatellare (17).

Nevertheless, Kofler [14] found that the medial patellar showed somewhat hypoechoic appearance in cattle. The transverse diameter of the medial,

intermediate and lateral patellar ligaments were measured ultrasonographically by in the buffalo [12]. According to the present study the insertion of the lateral patellar ligament is identified directly caudal to the insertion of the intermediate patellar ligament on the tibial tuberosity which was not mentioned by other literatures. The present results agreed with former studies in the cattle [1, 5, 14] mentioned that the insertion of the gluteobiceps tendon onto the lateral patellar ligament was imaged midway between the patella and tibial tuberosity. The menisci ultrasonographic imaging was similar to which was observed by former studies in cattle [14] and horse [4, 21]. In the present study the medial meniscus is more echogenic than lateral one. In the contrary, the medial meniscus appears as a hypoechoic (and not echogenic) structure while lateral meniscus appears echogenic structure as described by formerly in cattle [8, 13]. The medial meniscus protruded abaxially from the joint margins where it intimately contacts to the echogenic medial collateral ligament which is similar to that described previously in cattle [4]. However, Denoix [4] showed that the medial meniscus boundary in the horse is at the level of the joint margin. The lateral meniscus is separated from lateral collateral ligament by clearly visible echogenic popliteal tendon by the ultrasonography which is similar to the findings mentioned in previous reports in cattle [8, 13, 14] and horse [3, 3, 21].

In the present investigation, the meniscotibial ligaments of the medial and lateral meniscus couldn't be imaged ultrasonographically same as that mentioned in dogs [20]. However, in the horse, it was reported that cranial part of the meniscus and cranial meniscotibial ligament could be visualized at flexion otherwise it was not appear because flexion widens the joint space and femoral condyle does not cover it [4, 10, 21].

The Common tendon of origin of the muscles extensor digitorum longus and

peroneus tertius ultrasonographic imaging was resemble to that shown by earlier studies in cattle [1, 5, 8, 14] and horse [3, 15]. Moreover in this study, further distally, on the cranio-lateral aspect of the tibia, the tendon–muscle transition was visualized: the echogenic tendon changed to a mainly anechoic muscle belly with echogenic septa.

The infrapatellar fat body appears as heterogeneous echogenic structure with hyperechoic dots by ultrasonography liely similar to that recorded formerly in cattle [8, 14] and horse [3, 15], but differed than that in dog which appeared as hypoechoic structure [11].

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