Comparative Anatomical and Ultrasonographic Study of the Shoulder Region in Equine with Reference to Some Affections

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ABSTRACT

This study was performed on five apparent healthy donkeys and six clinically affected horse suffered from shoulder lameness. A zoning system assigned to the biceps brachii tendon was adapted to facilitate understanding of the images. Ultrasonography was performed with a real-time B-mode semiportable sector scanner using 6-8 MHz transducers. Ultrasonography images were compared with frozen specimens to correlate the ultrasonographic findings with the gross anatomy of the shoulder. Ultrasonography allowed easy evaluation of the biceps brachii tendon and its bursa, the superficial muscles of the shoulder, and the underlying humerus and scapula. Ultrasonographic appearance, orientation, and anatomic relationships of these structures were described. The gross anatomical study helps to wide range in identifying the different structures in the ultrasonographic images obtained. In 6 lamed equine species diagnostic ultrasound aided the diagnosis of the bicipital tendenitis and bicipital bursitis. It could concluded that diagnostic ultrasonography is effective in identifying and characterizing soft-tissue structures of the shoulder region and other structures causing lameness in equine. It proved to be a valuable, noninvasive diagnostic aid.

INTRODUCTION

Diagnosis of equine lameness is one of the most important responsibilities of equine practitioners. The difficult evaluation of soft tissue abnormalities continuously needs a new technology for accurate diagnosis.

In recent years the use of ultrasonography in the evaluation of equine soft tissues disorders has increased rapidly, greatly enhancing our ability to diagnose and monitor soft tissue musculoskeletal injury accurately and non invasively *(1)*.

The ability to perform and interpret an ultrasonography depends on accurate knowledge of anatomy about the involved region, and the availability of facilities to perform the diagnostic examination. The basic understanding of the relevant regional anatomy is necessary to detect any minute alteration or lesion into the intended part *(1, 2)*.

If lameness is diagnosed in a certain region ultrasound examination should be performed in order to diagnose which site is affected. Clinically lameness can be diagnosed by swelling, heat or sensitivity of the joint, tendon or ligament. Moreover, joint affections could be expressed by joint-swelling with or without radiographic explanation *(3)*.

Ultrasonographic examination of joints requires a linear probe of 7.5-MHz. A 10-MHz probe if available could showed more details of the most superficial structures and the definition of cartilage, subchondral bone and superficial articular surfaces *(4- 6)*.

Scanning could be performed without removing the hair. The image quality in this case is improved by thorough wetting of the hair coat, followed by smoothing of the coat in the direction of hair growth *(1, 7)*. Image quality is affected by the quantity of body hair present. Both the hair and the air trapped within the hair attenuate the ultrasound beam. The best image is achieved by clipping and shaving the site to be scanned, especially if the clipped surface is soaked with water. A coupling gel is applied on the site to be examined. The maintenance of an adequate amount of gel is essential for proper contact and obtaining good image quality *(1, 8)*.

The diagnostic-ultrasound is valuable for joint evaluation in any of the following circumstances ***(9, 10):***

- Joint enlargement.
- The pain has been localized to a joint.
- Radiography of a joint demonstrates an abnormality, but needs further evaluation of its soft contents.
- Difficulty to image the joint radiographically as shoulder and hip.
- When the treatment fails to improve the joint lameness.
- When additional informations are needed about joint.
- Preoperative planning.

On contrary to the contrast-radiography and arthroscopy, diagnostic ultrasound allows imaging of the joint capsular abnormalities of distended joint which non-invasive or non-irritating. Normally the joint capsule is situated close to the underlying bone and is difficult to be identified separately. The detailed ultrasonographic assessment of the non-distended joint capsule requires intra-articular injection of physiologic saline, to facilitate an invasive imaging procedure. Moreover, it is effective in demonstrating a synovial herniation, narrow synovial fistula and traumatic communication between joint cavity and tendon sheath or bursa ***(11).***

The diagnostic ultrasound is a valuable complementary procedure to radiography for complete assessment of all joint structures. The ultrasonography allows the identification of minute lesions in the joints where radiographic images appeared normal ***(12, 13).***

The diagnosis and characterization of the equine shoulder diseases are frequently difficult. Proper evaluation of shoulder lameness is based on understanding the anatomic features of the shoulder joint and surrounding region ***(14)***. Ultrasonography has been used to evaluate the soft tissue injuries in the equine shoulder region. The normal ultrasonographic appearance of selected anatomic structures of the equine shoulder has been previously described ***(15, 16).***

The diagnostic ultrasonographic imaging of the soft-tissue in the shoulder region allows easy dimensional and qualitative assessments. Ultrasonography of the shoulder-region is useful in diagnosis of the biceps brachii tendenitis and ossification, bicipital bursitis, affections of infraspinatus and supraspinatus muscles, infraspinatus tendonitis, infraspinatus bursitis, osteochondrosis of the humeral head, degenerative joint disease and arthritis of the shoulder-joint ***(17).***

The aim of the present study was to evaluate the ultrasonographic imaging of the shoulder region in equine ally in comparison with its gross anatomy, in addition to the ultrasonographic pictures of some affections.

MATERIAL AND METHODS

The present study was carried out in both clinics of Surgery Department, Faculty of Veterinary Medicine, Zagazig University and Mashtul El-Souk Veterinary Training Center during the period of 2006-2010. This work was carried out on 11 animals of equine species.

The study was divided into two categories

Group (I): In order to compare ultrasonographic imagining with anatomical features five apparently healthy donkeys were subjected to ultrasonographic examination of the shoulder joint. After the ultrasonographic study the animals were euthanatized by saturated solution of Magnesium Sulphate I/V ,then the two fore legs of each animal were frozen in a deep freezer (-25°C) for 2-3 day. After complete freezing, they were transversely and longitudinally sectioned using electrical saw at the same levels of each area used for ultrasonographic examination (acoustic windows) as shown in fig.1, and then photographed. Nomenclature was done ***(18).***

The anatomic structures that were sonographically examined around the shoulder joint included: cranially, the tendon of the biceps brachii muscle with its bicipital bursa and laterally, the caudal aspect of the articular cartilage of the humeral head.After having recognized by palpation the cranial part of the greater humeral tubercle, and its adjacent intertubular groove the transducer was positioned perpendicularly to this groove to obtain a transverse image of the biceps brachii tendon.

Group (II): was carried out on 6 horses suffering from different shoulder joint affections.

The affected animals were subjected to thorough clinical examination as well as diagnostic ultrasonography. For ultrasonographic examination, the animal to be examined was tranquilized using xyalazine 2% (Xylaject: Adwia, 10^{th} of Ramadan, Egypt) at a dose of 0.25-0.5 mg/kg B.wt.

The area to be examined was clipped and shaved thoroughly and a coupling gel (SGMOSCAN, SGMO chemical industry, Egypt) was applied.

Equipment and technique

The scanner was adjusted and a suitable transducer (probe) was chosen. The ultrasound machine, used in this work is commercially available real time linear scanner (Scanner: pie-Medical 240 parus)

Documentation of the obtained images were recorded either by vidioprinter (Sony up-885MD) with its thermal paper (Sony type 1 normal upp-110S 110mmx20m) or 3/4 inch video cassettes (Gold star co) allowing retrospective analysis.

Acoustic windows for examined area at a cross or sagittal planes were planed as follows: by palpation of the cranial part of the greater humeral tubercle (shoulder point), biceps brachii tendon examination was performed and the area was divided into four zones: A, B proximal and C, D distally to this point *(17)*.

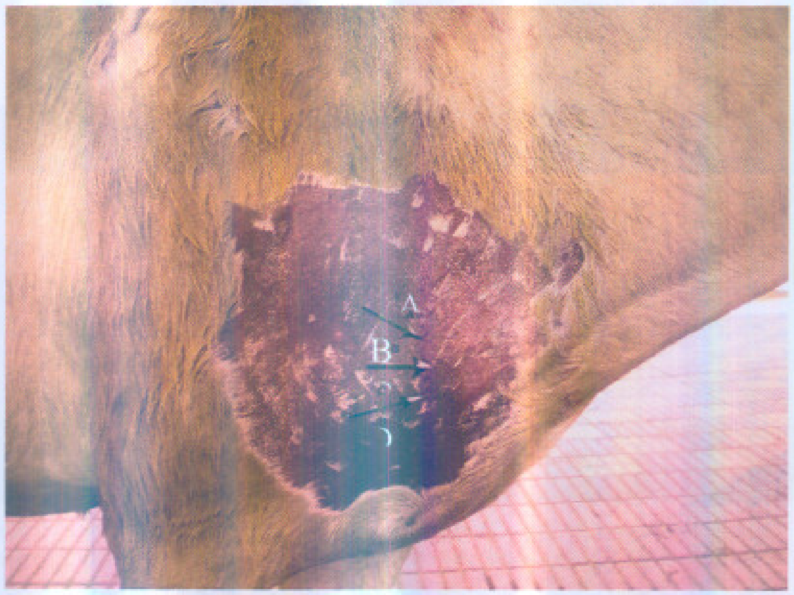


Fig.1: prepared shoulder region showing the levels at which scanning was performed; the middle arrow point to the cranial part of the greater humeral tubercle (shoulder point) and the area was divided into four zones: A, B proximal and C, D distally to this point.

RESULTS

I. Cross and longitudinal-sectional anatomy and normal ultrasonographic appearance of donkey shoulder

Transverse images: In zone A. the biceps brachii tendon originated from the supraglenoid tubercule of the scapula, which appeared as a hyperechoic convex structure. The tendon had crescent shape with a homogenous echogenic appearance (Fig. 2). The supraspinatus muscle, which had a moderate echogenicity wraps around the biceps brachii tendon.

In the proximal part of zone B, the tendon was irregularly elliptic in shape, had a heterogeneous echo pattern and a trilobulated appearance (Fig. 3). There was a fat pad between the tendon and the shoulder joint. This fat pad was hypoechoic to the tendon and in between the tendon lobes.

In the distal zone B, the tendon became biportioned, almost homogeneously echogenic (Fig. 4). The thickest portion was located laterally. A hypoechoic fat pad infiltrated between the two portions and over the cranial aspect of the tendon in all the examined donkeys.

In proximal zone C, the tendon filled the deeply convoluted intertubular groove that is characterized by a well defined and smooth hyperechoic contour, the lateral lobe remaining bigger than the medial one (Fig. 5). The anechoic thin interface interposed between the intertubercle groove and the tendon represents the synovial space of the bicipital bursa and the hyaline cartilage layer. In the distal zone C, the tendon lobes became progressively more even in size (Fig. 6). The biciptal bursa was well visualized (two cases); the hypoechoic brachiocephalicus muscle covers the tendon medially.

The zone D, the tendon began to merge with the hypoechoic biceps brachii muscle acquired an irregular shape and therefore was more difficult to identify. In this zone, a hyperechoic fat pad was present between the tendon and hyperechoic humorus.

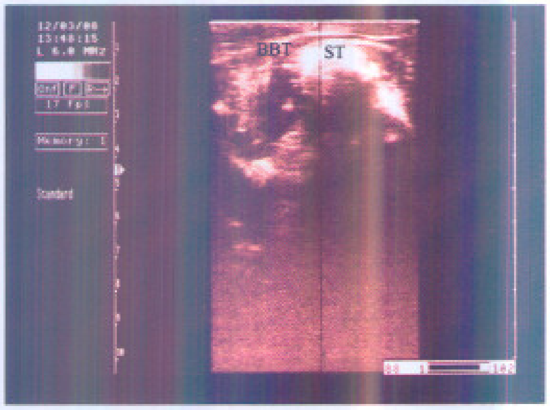


Fig. 2A: Transverse image of the Biceps Brachii Tendon (B.B.T.) in zone A showing crescent shape with a homogenous echogenic appearance of the tendon. ST: supraglenoid tubercle.

Fig. 2B: Cross section of donkey shoulder at the level of supraglenoid tubercle of the scapula (zone A).

1- Scapular neck.
2-Tendon of muscle biceps brachii.
3-Pectoral group of muscle.
4-Supraspinatus muscle.
5-Infraspinatus muscle.
6-Muscle deltoideus.
7- Subscapular muscle

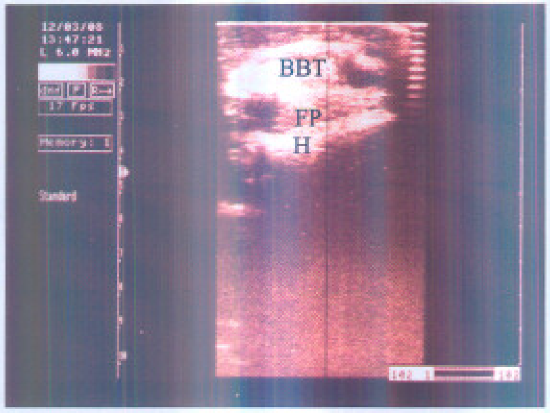


Fig. 3A: **Transverse image of the Biceps Brachii Tendon in the proximal level of zone B showing irregularly elliptic shape, heterogeneous echo pattern and a trilobulated appearance of tendon. H: humerus, FP: fat pad**

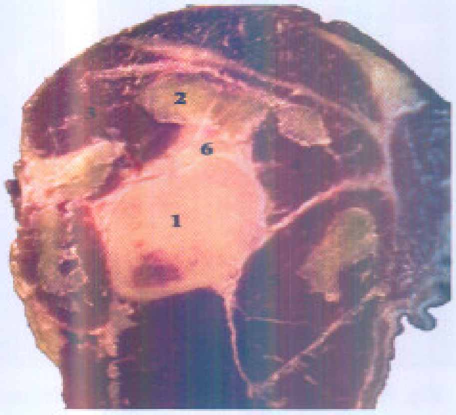


Fig. 3B: Cross section of donkey shoulder joint (zone B).

1-Humeral head.
2- Tendon of muscle biceps brachii.
3- Pectoral group of muscle.
4-Supraspinatus muscle.
5- Infraspinatus muscle
6-fat pad

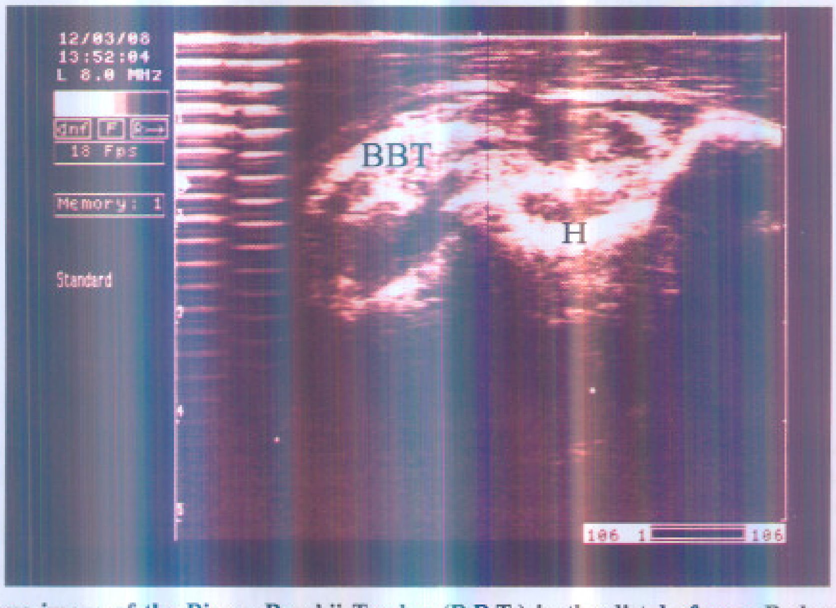


Fig. 4: Transverse image of the Biceps Brachii Tendon (B.B.T.) in the distal of zone B showing the tendon became biportioned, almost homogeneously echogenic. H: humerus.

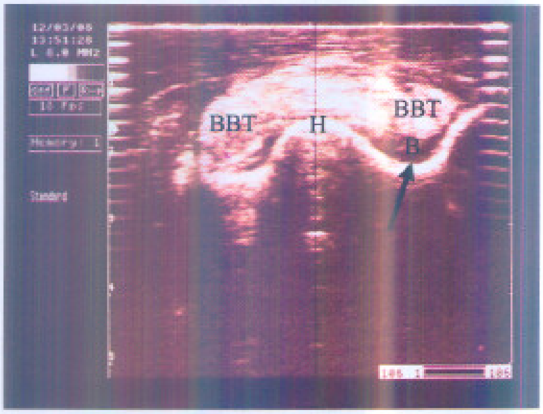


Fig. 5A: Transverse image of the Biceps Brachii Tendon (B.B.T.) in the proximal level of zone C showing a well defined and smooth hyperechoic contour of the tendon, the lateral lobe remaining bigger than the medial one. H: humerus, B: biceptal bursa. Hyaline cartilage (arrow)

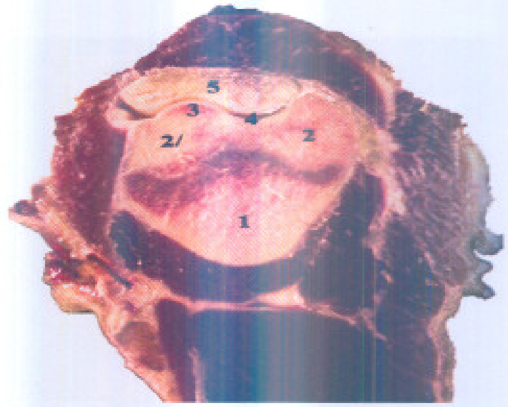


Fig. 5B: Cross section of donkey shoulder joint (zone D).
1-Humeral head
2&2\- Humeral tuberosities.
3- Intertubercular ridge.
4- Intertubercular groove.
5- Tendon of muscle biceps brachii.

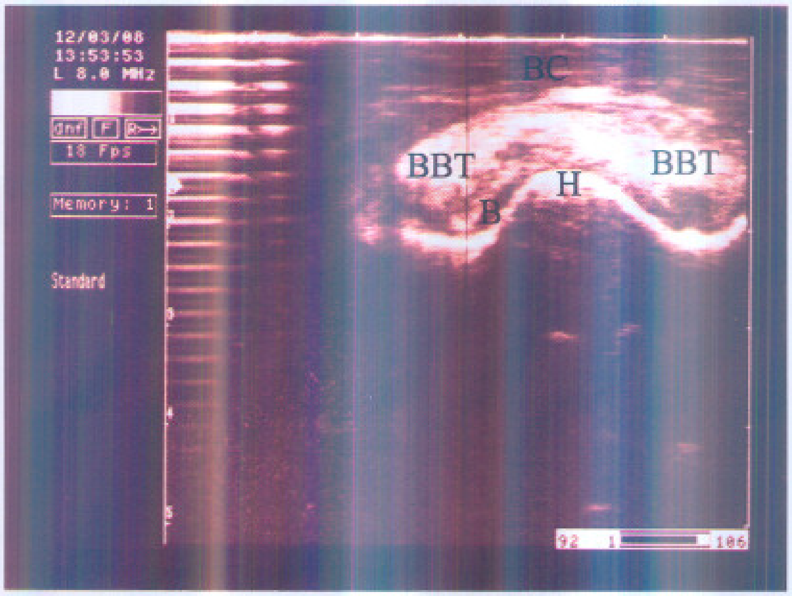


Fig. 6: Transverse image of the Biceps Brachii Tendon (B.B.T.) in the distal level of zone C showing the tendon lobes became progressively more even in size. H: humerus. BC: brachiocephalicus muscle. B: Bursa.

Sagittal images: In zone A, the tendon originated from the convex supraglenoid tubercle and had a parallel linear echoic appearance (Fig. 7). In zone B. the tendon was imaged as an echoic band with heterogenous echogenicity. The less echoic zones within the tendon represent fat between the tendon bundles (Fig. 7). In these zones, the moderately echoic supraspinatus muscle covered the tendon. Muscle covered the tendon. The brachiocepalicus muscle had a linear hypoechoic appearance and represented the most superficial structure.

Distal in zone C, the tendon had a uniform echoic texture and curved sagitally over the hyperechoic line that represented the bony interface of the convex humeral intermediate ridge (Fig. 8). At this level, the bicipital bursa could be seen caudal to the tendon.

In zone D, the tendon had an echogenic pattern and entered distally the hypoechoic muscular portion of the biceps brachii muscle (Fig. 9). The tendon lied against a fat pad appeared somewhat echoic and separated it from the humorus.

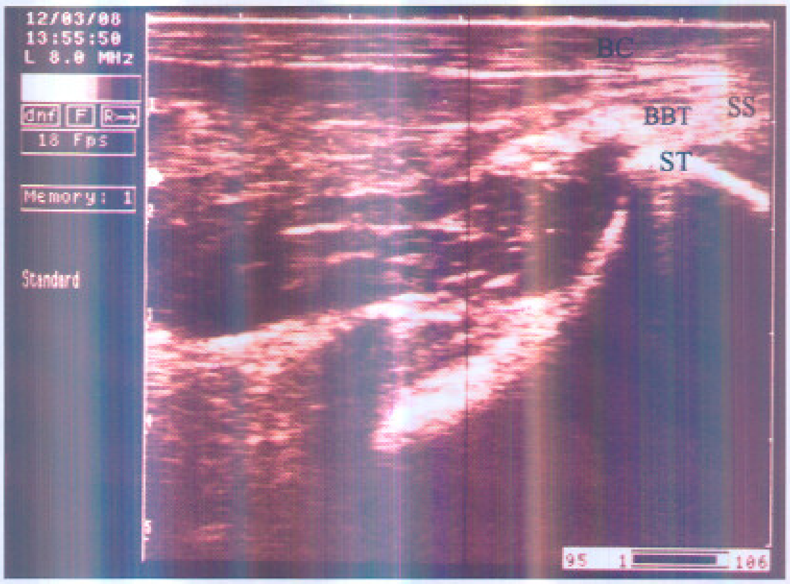


Fig. 7: Sagittal image of Biceps Brachii Tendon (B.B.T.) in zones A and B showing the tendon originated from the convex supraglenoid tubercle and had a parallel linear echoic appearance. ST: supraglenoid tubercle of scapula. BC: brachiocephalicus muscle. SS: Supraspinatus muscle.

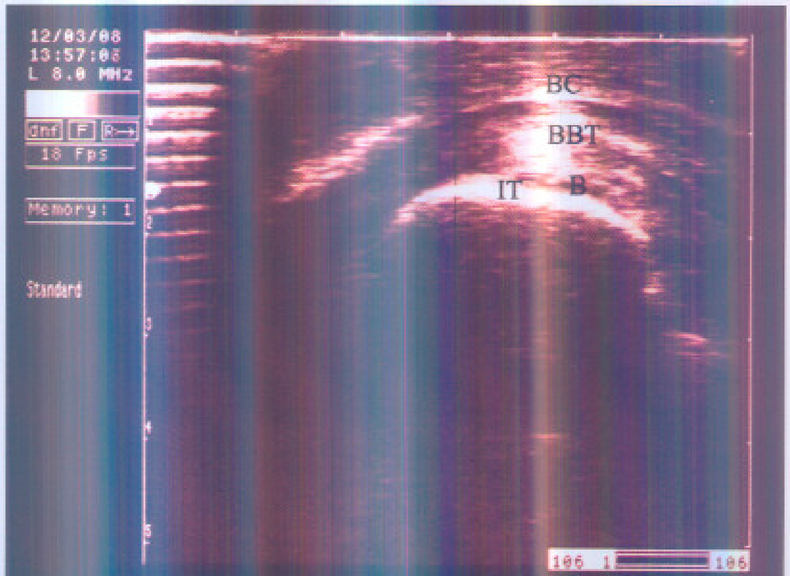


Fig. 8: Sagittal image of Biceps Brachii Tendon (B.B.T.) in zone C showing the tendon had a uniform echoic texture and curves. IT: Intermediate humoral tubercule. BC: Branchiocephalicus muscle. B: Bursa.

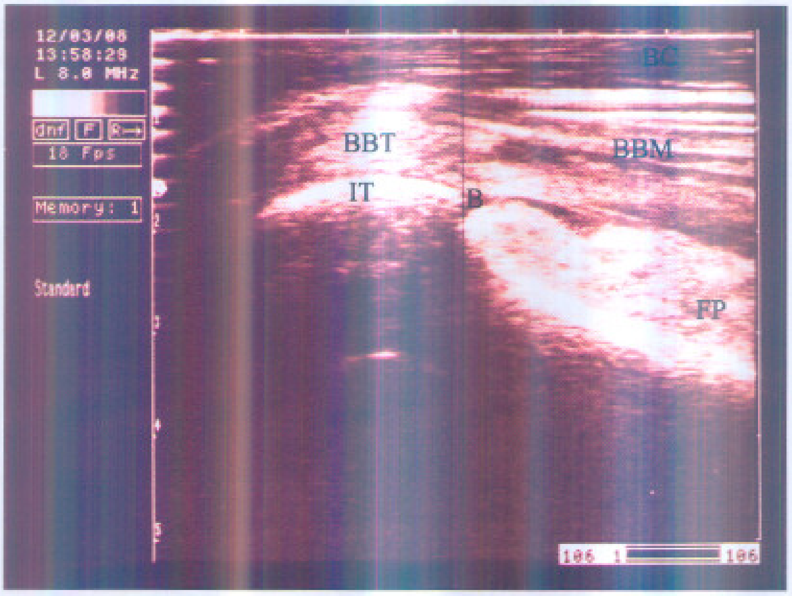


Fig. 9: Reverse sagittal image of Biceps Brachii Tendon (B.B.T.) in zone D showing the tendon had an echogenic pattern and entered distally the hypoechoic muscular portion of the biceps brachii muscle. IT: Intermediate humoral tubercle, B: bicepital bursa, FP: fat pad. BBM: Biceps brachii muscle. BC: Brachiocephalicus muscle.

II: Sonographically diagnosed clinical cases

Horses with bicipital tendenitis (four cases); usually have lameness that varies in severity but is characterized by a shortened anterior phase of the stride. Hypoechoic to anechoic areas imaged within the tendon with loss of normal fiber pattern. Bicipital tendinitis was usually seen in conjunction with bicipital bursitis. The sonographic finding is an increased volume of hypoechoic fluid and fibrin within the bursa. Thickening of the bicipital bursa and its bursal lining were present (Fig.10).

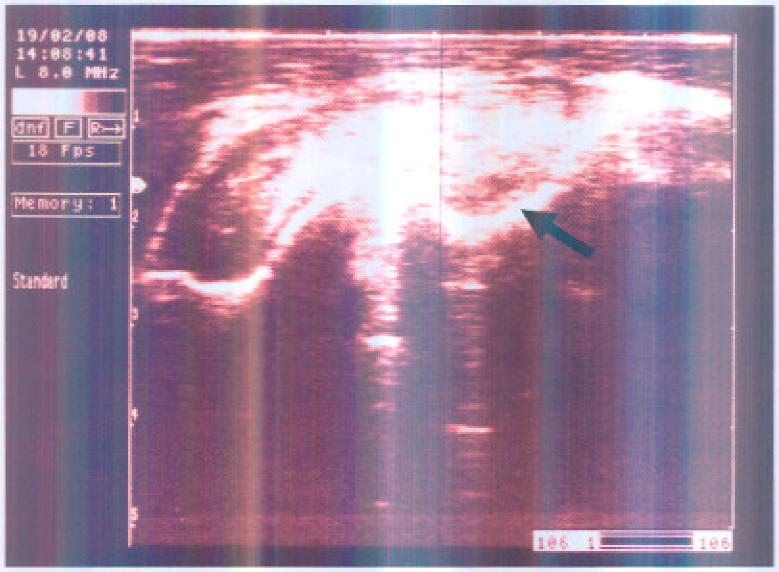
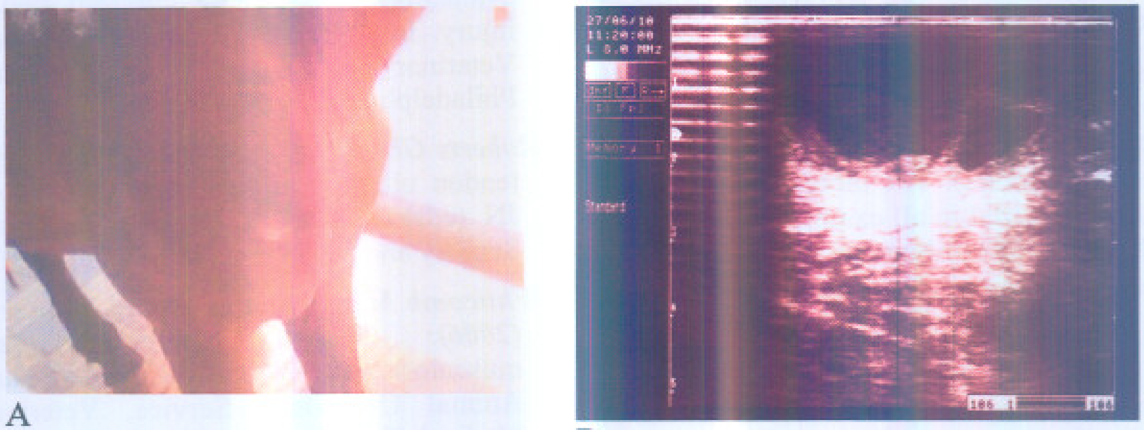


Fig. 10: Ultrasonographic picture of biceptal tendinitis showing increase the echogenicity of biceps brachii tendon with increased the volume of hypoechoic fluid within the bicepital bursa (arrow).

Abscess in prescapular region (two cases)

A mature abscess sonographically was as a hypoechoic cavity in a mass with thickened wall and with internal septation. The contents were hypoechoic with moderate to brigh echogenic cellular debris (Fig. 11).



A

B

Fig. 11: Abscess in prescapular region in a horse(A), ultrasonographic picture appeared as a cavity of hypoechoic mass with internal septation

DISCUSSION

Ultrasonography was found to be a useful recent modality for evaluating the soft tissue affection of different equines species. Ultrasonographic diagnosis has been proved to be highly popular as an easy, safe, rapid, non invasive and non harmful technique to either the operator or the patient under investigation.

The aim of performing the anatomical study in this work was to determine the acoustic windows of shoulder in donkeys for confirmation of the ultrasonographic findings. The anatomic structures in the frozen specimens were similar to those described in standard anatomy texts ***(19- 22)***.

Deeper joint structures could not been visualized due to intervening bone or locations located beyond a depth to which the high frequency beam couldn't easily penetrate. Therefore it is not always possible to image the entire articular surfaces of a joint. However, once the joint space has been located, manipulation usually allows most of the clinically relevant areas to be visualized. Therefore ultrasound could be a useful technique in the investigation of some abnormalities.

The shoulder joint is surrounded by voluminous soft tissue structures resulting in a limited number of areas where the transducer can be placed in order to obtain adequate images.

In this study, ultrasonographic imaging was performed by using 6-8 MHz transducers which provide adequate images and allowed evaluation of the biceps brachii and its bursa, surface of the underlying humerus and supraglenoid tubercle of the scapula.

The zoning system was developed in horse to facilitate interpretation and best imaging of the biceps brachii tendon images which has different axial orientations ***(17)***. Similar results were obtained in donkeys.

In transverse images, the biceps brachii tendon (zone B) initially appeared trilobulated, and then distally appeared bilobulated ***(16, 17)***. In zone C, over the intertubular groove, the tendon became visualized and appeared uniformly echoic. This may be attributed to its infiltration by hypoechoic areas representing fat. In sagittal images, over zone B, the tendon was heterogeneous in appearance because of the fat within its bundles. It is revealed hypoechoic to the tendinous fibers. Over zone

C, the tendon had a linear, fibrillar echoic pattern; a thin hypoechoic layer was seen in all of the examined animals, extending over the cranial aspect of the tendon representing fibers of the biceps brachii muscle ***(17, 23).***

The biceptal bursa was not visualized in all examined donkeys, and appeared as an anecohoic space underlying the biceps brachii tendon (two horses). The biceptal bursa could be easly visualized in all examined horses ***(17, 24)***. This may be attributed to the difference in shoulder size between horse and donkey.

The articular cartilage of the humeral head could been evaluated ultrasonographically. The cartilage appeared as a smooth anechoic layer, and is delineated by two echogenic interfaces representing the joint capsule in the near field and the well-defined, smooth and convex cartilage-bone interface in the far field (*16, 17, 23*).

Superficial muscles of the shoulder were assessed with ultrasound. The brachiocephalicus muscle covers the craniolateral aspect of the shoulder joint had a hypoechoic appearance with parallel echogenic lines (***17, 25***).

Concerning clinical cases; shoulder injuries were diagnosed in six cases and occured secondary to trauma. Bicipital tendinitis ultrasonographically appeared as hypoechoic to anechoic areas imaged within the tendon with hyperechoic areas and loss of the normal fiber pattern. Bicipital tendonitis was mostly coincided with bicipital bursitis ***(15, 16, 24, 26)***.

Abscess in prescapular region in a horse; sonographically appeared as a cavity in a hypoechoic mass with thickened hyperechoic wall. The hyper-echoic region immediately deep to the hypoechoic mass with distal enhancement which is caused by a decrease in attenuation of the sound beam as it passes through the fluid as compared to surrounding structures (*27*). This was attributed to the sound beam intensity; therefore it is greater as it passes through fluid filled abscess resulting in the region of hyperechogenicity.

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الملخص العربى

دراسة تشريحية و مقارنتها بصور الموجات فوق الصوتية لمنطقة الكتف فى الفصيلة الخيلية مع الإشارة إلى بعض الإصابات

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أجريت هذه الدراسة على عدد خمسة حمير سليمة ظاهريا وعدد ستة حالات خيول تعانى من العرج بمنطقة الكتف فى قسم الجراحة والتخدير والأشعة - كلية الطب البيطرى - جامعة الزقازيق و مركز تدريب الأطباء البيطريين – مشتول السوق.

بالنسبة للحيوانات السليمة ظاهريا(الحمير) قد تم عمل الآتى: فحص منطقة الكتف بالموجات فوق الصوتية (٦-٨ ميجاهرتز). تم اعدام هذه الحيوانات مع فصل منطقة الكتف وحفظها فى درجة حرارة - ٢٥ درجة مئوية لمدة ٢ -٣ ايام. قطعت العينات طوليا وعرضيا عند نفس مستوى الفحص بالموجات فوق الصوتية باستخدام منشار كهربائى. وتمت مقارنة الصفة التشريحية بصور الموجات فوق الصوتية.

بالنسبة للحالات التى تعانى من العرج بمنطقة الكتف(٦حالات), تم فحصها اكلينيكيا وبالموجات فوق الصوتية لتحديد مكان ونوع العرج. خلصت الدراسة الى أن الموجات فوق الصوتية التشخيصية ذات تأثير فعال فى تشخيص اصابات الأنسجة الرخوة والأنسجة الأخرى التى تسبب العرج بمنطقة الكتف.