RADIOGRAPHIC AND ULTRASONOGRAPHIC DIAGNOSIS OF SEPTIC CARPITIS IN EQUINE: AN EXPERIMENTAL STUDY

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A B S T R A C T

Experimental septic arthritis was induced in the radiocarpal joint of 18 donkeys by intra-articular injection of staphylococcus aureus (3-4x106 CFU). The inoculated animals were divided into three groups (6 donkeys in each group). The clinical symptoms, radiographic and ultrasonographic examination were recorded before induction of septic carpitis and 3 day after induction of infection (group one), 14 day after induction of infection (group two), and 28 day after induction of infection (group three). The clinical symptoms of septic carpitis included marked joint swelling, hotness, pain and lameness. The lateral and anterio-posterior radiographic views showed mainly soft tissue swelling. The ultrasonographic findings of septic arthritis differ according to the stage of induction. There is joint effusion associated with internal echoes with a variable echogenicity, ranging from anechoic to a mixed echogenicity especially in the third infected group

Key Words: Arthritis, Septic, Equine, Ultrasound, Diagnosis

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1. INTRODUCTION

Infectious or septic arthritis results from sequestration of bacterial infection in a joint [1].Septic arthritis is a potentially debilitating condition associated with significant morbidity and mortality in foals. The source of infection may be haematogenous spread, occurring most frequently in foals and rarely in mature horses; Wounds particularly puncture one or adjacent to the joint are the most common cause of synovial sepsis in mature horses with introduction of foreign material, along with microorganisms, exacerbating the infection [2,3].

Pain, exhibited as lameness and/or positive response to a flexion test is generated when noxious mechanical, chemical, and thermal stimuli activate peripheral afferent fibers through their receptors [4].

The clinical symptoms of septic arthritis were consistently induced within 24 hours of inoculation of the *Staph.aureus* in the radiocarpal joints of donkeys. These signs included marked joint swelling, hotness, pain response to joint pressure or flexion and lameness [5]. The clinical signs of septic synovitis include heat, effusion and rapidly developing lameness [6].

A combination of radiography and ultrasonography is often sufficient for visualizing the lesions [7].Radiographic examination of each infected joint is recommended in order to evaluate the presence of ostitis, osteomyelitis, and fracture. Horses with acute intra-articular fractures may present with clinical signs similar to horses with septic arthritis. Adult horses with chronic septic arthritis or foals with hematogenous septic arthritis may have accompanying osteomyelitis. If osteomyelitis is diagnosed concurrently with septic arthritis, the prognosis is decreased and

aggressive medical and surgical treatment is required [8].

The radiographic picture of experimentally induced septic arthritis in donkeys was mainly soft tissue swelling. They also added that marked radiographic evidence of bone erosion or new bone formation had not been recorded [5].

Typical radiographic changes consistent with infectious arthritis in equine are soft tissue swelling (localized or generalized), joint capsule distention with or without apparent widening of the joint space, joint space loss and central or marginal osseous erosion [9]. Increased joint space is associated with joint effusion while the decreased joint space is due to cartilaginous erosion and degeneration [10].

Ultrasonography is a useful imaging modality for the examination of joint abnormalities as it enables the evaluation of soft tissue components of the joint and provides information on the regularity of the bony contours [11, 12].

The transducer of the highest frequency could maintain adequate depth penetration. The high-frequency transducers produce superior spatial and contrast resolution, while the low-frequency transducer improves tissue penetration [13].

The ultrasonography is highly helpful in the detection of carpal soft tissue abnormalities in horses. The extensor carpi-radialis and the common digital extensor tendons, were the most easily visualized structures. They added that the ultrasonography is ideal to evaluate the soft-tissue structures, surrounding the articualr regions, e.g. the equine carpus [14, 15].

Ultrasonographic examination of the carpus revealed that the extensor tendons were normally imaged over the dorsal aspect of the carpal joints. The extensor carpi radialis tendon was echogenic with a parallel fiber pattern and was surrounded by a synovial sheath containing a very small amount of anechoic fluid. The common and lateral digital extensor tendons both have synovial sheaths. The extensor carpi obliqus tendon is also surrounded by sheath [16].

Ultrasonographic examination of the tarsocrural joint in septic arthritis showing accumulation of anechoic fluid filled with hypo echoic dots within the joint capsule [17].

This study aimed to through a light on the early clinical signs as well as on the ultrasonographic assessment of articular and periarticular pathology of an induced septic arthritis (*Staphylococcus aureus*) of the radiocarpal joints in donkeys, which cannot be detected by radiography.

2. MATERIALS AND METHODS

The present study was performed experimentally on 32 healthy, adult donkeys of both sexes. Fourteen animals were used for serial propagation of the *Staph. aureus* till reach to the infective inoculums. The remaining 18 donkeys were divided into three groups each group consists of 6 animals. In all these groups, assessment of the normal general health condition of the animals was done. The normal radiographic and ultrasonographic appearance of the radiocarpal joints was performed. In these animals, induction of septic carpitis in the radiocarpal joints of donkeys by *Staph. aureus* was induced. After the induction of septic carpitis, the clinical signs, radiographic examination and ultrasonographic imaging were recorded. These animals were divided into three groups. The examination of the three infected groups was applied 3, 14 and 28 days after induction of septic carpitis of the radiocarpal joint.

2.1. *Induction of septic arthritis (septic carpitis):*

The induction of septic arthritis in donkeys was performed by using of a viable Staphylococcus aureus colony (standard colony). *Staph. aureus* used for induction of septic arthritis in this study was isolated

from a donkey suffering from septic arthritis. A sample from the infected synovial fluid of the carpal joint was aspirated, inoculated in nutrient broth and incubated at 24 hours at 37°C. Each radiocarpal joint was inoculated with 3 to 4 x 10^6 colony-forming units of viable *Staph. aureus*.

2.2. *Diagnosis of septic carpitis:*

2.2.*1. Clinical Assessment:*

General health conditions (appetite, temperature, heart and respiratory rates) after induction of septic carpitis were recorded. Also, regional examination to determine the extent of hotness, swelling, pain, the degree of limitation to ordinary physiological movement of the affected joint. Lameness was evaluated and graded from (1-4) [18] according to the attitude of the animal in standing position, walking and trotting.

2.2.*2. Radiographic examination:*

The radiocarpal joint of each animal was radio-graphed in standing position. Dorsopalmar and lateromedial views are all obtained with the animal standing bearing weight evenly on all four limbs, with the limb to be radio-graphed vertical. A flexed lateromedial view is also obtained. The radiographic films were taken at (40Kv and 10 MAs) and a focal film distance of 70 cm. Radiographic examination was performed by mobile x-ray machine*.

2.2.*3. Radiographic examination:*

Ultrasonographic examination was performed with a mobile ultrasound machine** (7.5 MHZ linear probe) and (8 MHZ sector probe) in the faculty of veterinary medicine Benha university and a real time Toshiba company ultrasound system***, using multi-frequency probes (7 micro convex and 8&10MHZ linear probe) in the faculty of veterinary medicine, Cairo university with displayed depth of 4-6cm.The scans were frozen and photographs were taken on Polaroid films in both longitudinal and transverse scans. The hair over the carpal region was clipped and shaved, and then sonographic contact gel was applied on the skin.

*Mobile x-ray machine Fisher, Germany& Simply Hp X-ray machine.

**LOGIQ TM 180 Medical System. & 240 vet peri-Medical, Netherlands.

***Toshiba Medical Company ultrasound system.

3. RESULTS

The serial propagation of staphylococcus aureus in donkey's carpal joints revealed that the infective dose of septic carpitis was 3-4x10^6CFU.

The radiographic examination for all animals was done prior for injection of the infective dose and the radiocarpal joints of these animals appeared normal and no bony changes detected (Fig.1.A, B, C).

The longitudinal ultrasonographic scanning of the common digital extensor tendon (CDET) and the extensor carpi-radialis tendon (ECRT) was performed on the dorsolateral (CDET) and dorsomedial (ECRT) aspects of the carpal joint. Both tendons appeared as parallel linear hyper echoic structure. ECRT size was larger than CDET (Fig.2.A,B)

The transverse image of the common digital extensor tendon(CDET) and the extensor carpi radialis tendon (ECRT) appeared ultrasonographically as an elliptical to oval echogenic in shape structure and ECRT had a larger size than CDET (Fig, 3)

The ultrasonographic examination of the radiocarpal joints revealed that the synovial fluid appeared as a small anechoic area surrounded by hyper-echoic capsule (Fig, 4).

Following the induction of septic carpitis for the animals in group one (3 day after induction of septic arthritis), the clinical signs of septic arthritis appeared within 24 hours of injection of the inoculums. These signs included marked joint swelling, hotness, pain response to joint pressure or flexion and lameness. The

lameness appeared on the animals of this group was ranged from obvious lameness in both walk and trout (grade 3) to non weight bearing lameness (grade 4).

Clinical assessment of the infected animals in group two (14 day after induction of septic arthritis) revealed sever joint swelling, hotness, sever pain and lameness. Lameness appears on the animals of this group was mainly non weight bearing lameness (grade 4) (Fig, 5). While, the clinical examination of the animals in group three (28 day after induction of septic arthritis) revealed that the joint swelling not sever, slight hotness and lameness. Lameness in this group was obvious lameness in both walk and trout (grade 3) (Fig, 6).

The radiographic examination of the radiocarpal joint of the animals in group one revealed soft tissue swelling and there was no any bone changes (Fig.7. A,B,C), and the radiographic examination of the radiocarpal joint of the animals in group two stated sever soft tissue swelling, joint space widening and there was no any bone changes(Fig. 8.A,B,C)

The radiographic findings of the radiocarpal joint of the animals in group three revealed less soft tissue swelling and there was no any bone changes (Fig.9.A, B, C).

A longitudinal ultrasonographic evaluation of the common digital extensor tendon (CDET) in the infected groups' one, two and three revealed a hyper echoic image of mild to moderate disturbed of linear organization of the tendon fiber (fig.10. A, B, C). The same findings were found in sonographic evaluation of the extensor carpi radialis tendon (ECRT) (Fig.11.A, B, C).

In cross section, the ultrasonographic image of the CDET and ECRT was composed of a highly echogenic, compact stippled echo pattern, nearly to the normal tendon (Fig.12. A, B, C).

In the sonographic evaluation of the radiocarpal joint of the infected three groups of animals, it was found a variable huge amount of anechoic synovial fluid accumulation (joint effusion) with mild hyper-echoic non shadowing echogenicity (fibrinous shadow). Also, thick hyper-echoic joint capsule was showed (Fig. 13. A, B, C).

4. DISCUSSION

Intra-articular inoculation of 3to 4x 106CFU of viable staphylococcus aureus into the radiocarpal joints successfully induce septic carpitis in donkeys. *Staph. aureus* was chosen because it represents one of the most common isolates of septic arthritis in horses [19].

Typical consistent signs of septic carpitis appeared within 24 hours in all injected joints. This findings agrees with [5, 20, 21and 22].

Induced septic carpitis was characterized clinically by joint swelling, hotness and lameness. Joint swelling is usually a result of increased formation and decreased absorption of synovial fluid [1].

The radiographic findings of septic carpitis in donkeys were mainly soft tissue swelling, and widening of the joint space as in group two. This result agrees with [5].

Increased joint space is associated with joint effusion while the decreased joint space is due to cartilaginous erosion and degeneration [10].

Widening of joint space is usually a result of a lack of full weight bearing on the affected limb [23]. Marked radiographic evidence of bone erosion or new bone formation had not been recorded. These findings agree with [5, 23and 24] and disagree with [25] whom stated that the periosteal proliferation and loss of joint space might be evident as early as 14 to21 days post infection.

Ultrasonographic examination of common digital extensor tendon (CDET) and extensor carpi radialis tendon (ECRT) was easily performed on the dorsal aspect of the carpal joints. These findings agree with [16, 26].

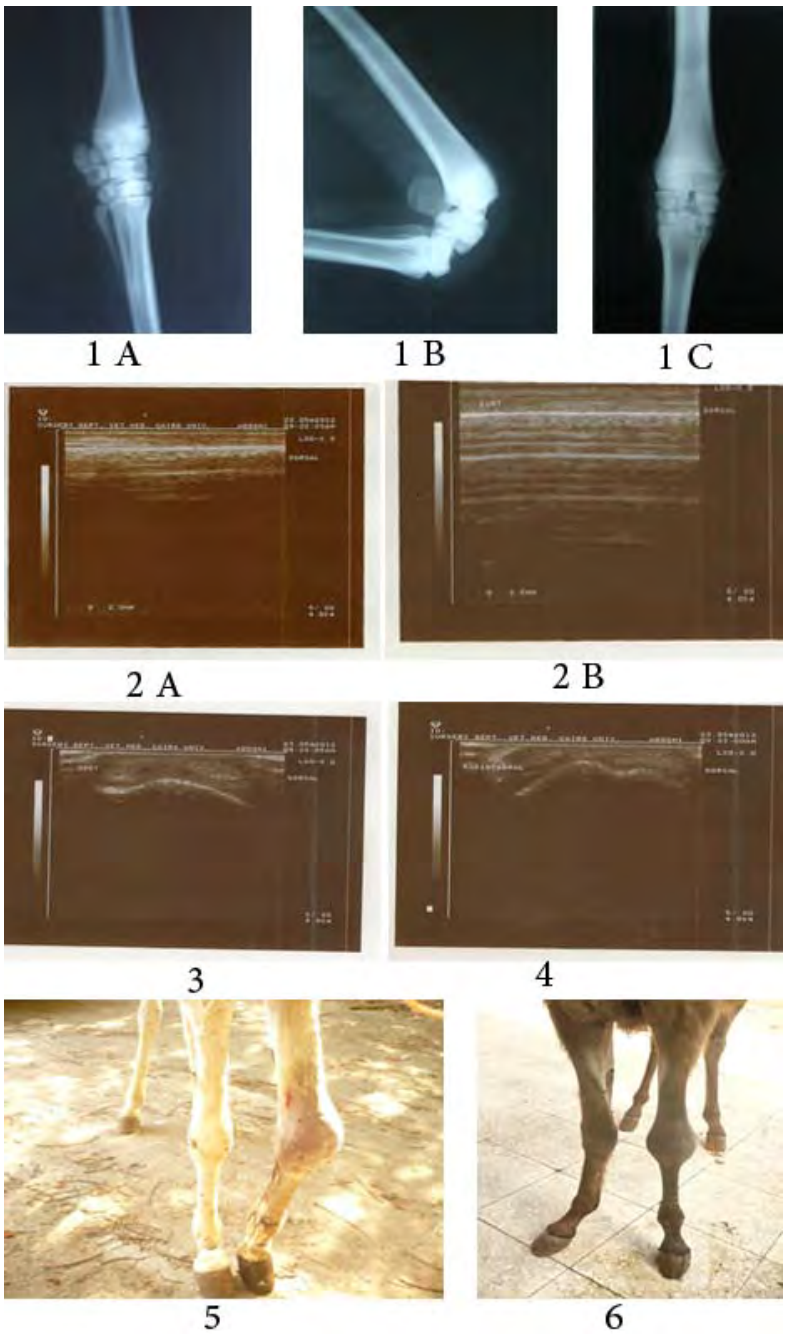

Fig (1, A): lateromedial radiographic view of normal carpal joints in donkey showed normal bone and no changes. Fig (1, B): flexed lateromedial radiographic view of normal carpal joints in donkey showed normal bone and no changes. Fig (1, C): dosopalmar radiographic view of normal carpal joints in donkey showed normal bone and no changes. Fig (2, A): longitudinal ultrasonographic image of CDET in normal donkey showing parallel linear hyper-echoic structure. Fig (2, B): longitudinal ultrasonographic image of ECRT in normal donkey showing parallel linear hyper-echoic structure. Fig (3): transverse ultrasonographic image of CDET& ECRT in normal donkey showing an elliptical to oval echogenic in shape structure. Fig (4): ultrasonographic image of radiocarpal joint in normal donkey showing a small anechoic area surrounded by hyper-echoic capsule. Fig (5): clinical image of radiocarpal joint of a donkey from group two showing swelling at the level of the carpal joint. Fig (6): clinical image of radiocarpal joint of a donkey from group three showing swelling at the level of the carpal joint.

Fig (7, A): lateromedial radiographic view of carpal joints in donkey of group one showing slight soft tissue swelling. Fig (7, B): flexed lateromedial radiographic view of carpal joints in donkey of group one showing slight soft tissue swelling. Fig (7, C): dorsopalmar radiographic view of carpal joints in donkey of group one showing slight soft tissue swelling. Fig (8, A): lateromedial radiographic view of carpal joints in donkey of group two showing soft tissue swelling. Fig (8, B): flexed lateromedial radiographic view of carpal joints in donkey of group two showing soft tissue swelling. Fig (8, C): dorsopalmar radiographic view of carpal joints in donkey of group 2 showing soft tissue swelling. Fig (9, A): lateromedial radiographic view of carpal joints in donkey of group three showing soft tissue swelling. Fig (9, B): flexed lateromedial radiographic view of carpal joints in donkey of group three showing soft tissue swelling. Fig (9, C): dorsopalmar radiographic view of carpal joints in donkey of group 3 showing soft tissue swelling. Fig (10, A): longitudinal ultrasonographic image of CDET in group one showing parallel linear hyperechoic structure. Fig (10, B): longitudinal ultrasonographic image of CDET in-group two showing parallel linear hyperechoic structure.

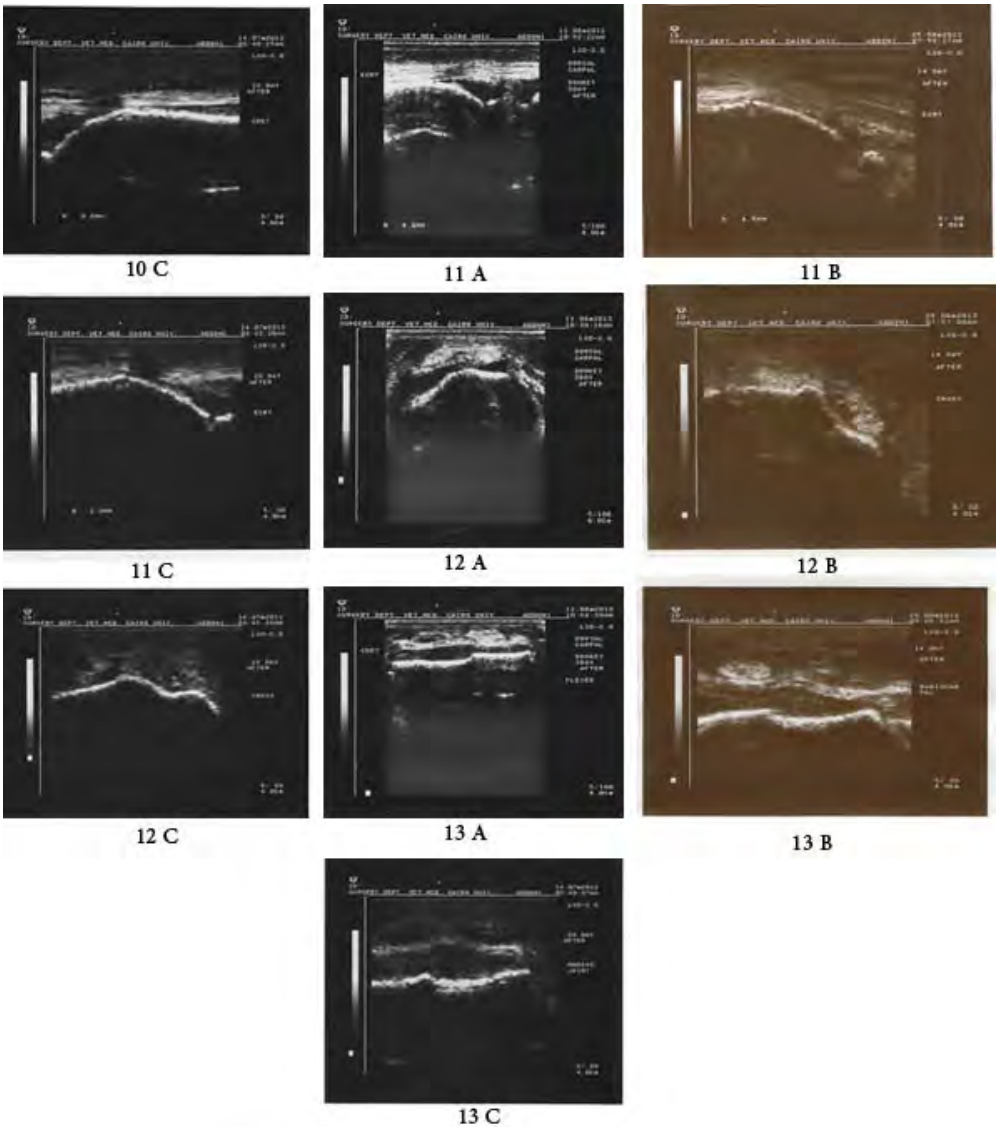

Fig (10,C): longitudinal ultrasonographic image of CDET in group three showing parallel linear hyperechoic structure. Fig (11, A): longitudinal ultrasonographic image of ECRT in group one showing parallel linear hyperechoic structure. Fig (11, B): longitudinal ultrasonographic image of ECRT in group two showing parallel linear hyper-echoic structure. Fig (11, C): longitudinal ultrasonographic image of ECRT in group three showing parallel linear hyperechoic structure. Fig (12, A): transverse ultrasonographic image of CDET&ECRT in group one showing an elliptical to oval echogenic in shape structure. Fig (12, B): transverse ultrasonographic image of CDET&ECRT in group two showing an elliptical to oval echogenic in shape structure. Fig (12, C): transverse ultrasonographic image of CDET&ECRT in group three showing an elliptical to oval echogenic in shape structure. Fig (13, A): ultrasonographic image of radiocarpal joint in group one showing large anechoic area surrounded by hyperechoic capsule. Fig (13, B): ultrasonographic image of radiocarpal joint in group two showing large anechoic area filled with hypoechoic dots, which represent the fibrinous content of the synovial fluid surrounded by hyper-echoic capsule. Fig (13, C): ultrasonographic image of radiocarpal joint in group three showing large anechoic area filled with hypoechoic dots which represent the fibrinous content of the synovial fluid surrounded by hyperechoic capsule.

Ultrasonographic examination of septic carpitis appeared as marked distension of the joint with anechoic synovial fluid which filled with hypo-echoic dots which represent the fibrinous content of the synovial fluid. These findings agree with [17, 27].

In conclusion, the use of ultrasonography in combination with radiography revealed better results in the diagnosis of septic arthritis in equine and through which it can be determine the stage of septic arthritis and choose the ideal method of management.

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مجلة بنها للعلوم الطبية البيطرية **عدد 25 (1): 239-247 سبتمبر 2013**

"التشخيص بالأشعة السينية والموجات فوق الصوتية للالتهاب الصديدي لمفصل الرسغ في الفصيلة الخليلية" دراسة تجريبية"

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الملخص العربي

تم إحداث عدوى بكتيرية في مفصل الرسغ في 18 حمار عن طريق الحقن المفصلي لميكروب المكورات العنقودية. وقسمت الحيوانات إلى 3 مجموعات (6 حيوانات في كل مجموعة) وتم إجراء الفحوصات الإكلينيكية والتغيرات الإشعاعية والموجات فوق الصوتية قبل الحقن مباشرة وبعد ثلاثة أيام من الحقن بالنسبة لحيوانات المجموعة الأولى وبعد 14 يوم للمجموعة الثانية و28 يوم للمجموعة الثالثة 0 وكانت الأعراض الإكلينيكية تتمثل في ظهور أعراض الالتهاب الحاد وعرج شديد. صورة الفحص الإشعاعي لم تظهر تغيرات مرضية في عظام المفصل وأظهرت تغيرات في الأنسجة الرخوة. و أظهرت نتائج الفحص بالموجات فوق الصوتية في المجموعة الأولى مناطق معتمة(السائل السينوفى) في المفصل، أما في المجموعة الثانية والثالثة كانت عبارة عن ظهور تجمعات من سوائل معتمة(السائل السينوفى) تحتوى على نقط شبة معتمة(الخلايا الصديدية) داخل المفصل.

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