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Ultrasonographic early diagnostic tools for detection of different bone fractures in dogs

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A B S T R A C T

The aim of this study is to through a light on the importance of ultrasonography as a useful, accurate, safe, quick and available tool for detection and diagnosis of fractures in dogs and compares the results of ultrasonographic findings with that of radiographic results. In the current study, twelve mongrel dogs suffering from different fractures were examined and diagnosed by ultrasonography and radiography. The recorded fractures are two cases of mandible fracture, three cases of radial fracture, five cases of femur fracture and two cases of iliac shaft fracture. All fractures types, ultrasonographic appearance of these fractures were hyper-echoic appearance for healthy region of bones while an-echoic areas at the site of fractures and the ultrasonographic examination revealed that presence of hypo-echoic area at the site of hematoma in case of femur fracture dogs underwent to radiographic examination. All ultrasonographic finding were correlated with the results of radiographic examination with 100 %. In conclusion, ultrasonography is a good tool for early diagnosis of different fractures in dogs without any pain, discomfort and stress to the animals. Ultrasonography may be in the future replaces X- Rays and Computed tomography for the early diagnosis of bones fracture in extremities and superficial situations.

Keywords: Ultrasound, Fractures, Bones, Dogs.

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1. INTRODUCTION

Orthopedic affections are frequently present in pets especially those caused by trauma (Piermattei et al., 2006 and Scott and McLaughlin, 2007). Fractures of long bones are commonly orthopaedic problem in canine practice (Simon et al., 2010). Physical examination is the preliminary method for diagnosis of long and flat bones fractures and it cannot determine the fracture complexity (Blaivas et al., 2000). The two most commonly imaging tools used in fractures diagnosis are x-rays and CT (Hacihaliloglu et al., 2008). Traditional diagnostic imaging capabilities are limited due to excessive size, dangerous causes vigorous diseases like cancer, expensive, not present easily in any place and weight prevents (Marshburn et al., 2004). Plain radiographs may be normal for several weeks before a callus or a fracture line appears in case of stress fractures. Early diagnosis in this case depends on MRI or bone scan scintigraphy (Banal et al., 2006). In human, previous investigations have demonstrated the ability of ultrasound to image fractures of the clavicle (Graif et al., 1988) orbit (Hirai et al., 1996 and Jenkins and Thuau, 1997) foot and ankle (Singh et al., 1990 and Wang et al., 1999), rib (Mariacher-Gehler and Michel, 1994) femur, and humerus (Patten et al., 1992; Chhem et al., 1994; Watson and Ferrier, 1999 and Dulchavsky et al., 2002) and to image occult fractures not identifiable by traditional radiography.(Graif et al., 1988;Mariacher-Gehler and Michel, 1994 and Wang et al., 1999).

Orthopedic ultrasound is possible due to the hyper-echoic reflection of the superficial cortex of bone in ultrasonogram Ultrasound (US) imaging is non-ionizing, non-invasive, safe, fast to perform, portable, Low cost and capable of real time imaging (Bennour et al., 2014). The aim of this study is detection the role of ultrasonography in early diagnosis of different long and flat bone fractures types and compare it with the radiographic finding.

2. MATERIAL AND METHODS

This was a prospective evaluation of a diagnostic method US against reference standard radiographs. In The present study, twelve dogs were admitted to the surgery, anesthesiology and radiology department, Faculty of Veterinary Medicine, Beni Suef University weighting 10-15 kg and aged from six months to 1.5 years with various bone fractures. Complete case history and physical examination were carried out for each case. All animals underwent to physical examination as a routine manner.

Ultrasonographic and X- Rays examinations were done for all dogs. Ultrasonographic examination was done by using Mindray veterinary ultrasound device 5000 connecting with linear multi -frequency transducer 5.0-10.0 MHz. The examined areas (mandible, radius, ulna, femur and iliac shaft fractures sites) were shaved and ultrasound coupling gel was applied. The prepared areas were scanned in both sagittal and transverse planes to early and easily detection the fracture site in different bones by10.0 MHz for all fractures types except in case of iliac fracture by 7.5 MHz. Then, the radiographic examination performed at 50 – 60 kVp and 15-20 mAs for all animals to detect the type of fracture. Radiographs were taken in Ventro-Dorsal and Lateral projections and compare the ultrasonographic appearances with that of plan X-rays films.

3. RESULTS

Physical examination was positive and could detect the site of fracture by palpation in all fractures types but it somewhat difficult in iliac shaft fracture. All fractures in dogs were detected with ultrasound and were confirmed by radiography. In this series, the sensitivity and specificity for ultrasound detection of fractures were 100%. No signs of pain, discomfort and/or stress appeared on dogs during ultrasonographic examination.

There are two cases mandibular fracture and all cases the fracture at the right side at the middle part of the mandible. In ultrasonographic appearance, presence of hyper-echoic mandibular bone with an-echoic disruption area at the site of fracture (Fig. 1) while in the radiographic picture showed transverse radiopaque fracture line (Fig. 2).

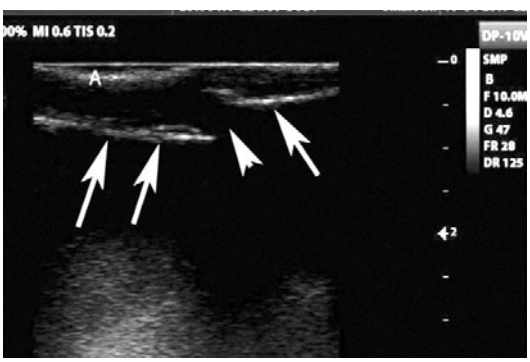

Fig. (1) Ultrasonogram showing hyper-echoic mandibular bone (white arrow) with an-echoic disruption area (head white arrow) at the site of fracture, (A) bade of alveolar cavity

Fig. (2) Transverse radiopaque fracture line in mandible (white arrow)

In radius fracture, there are three cases, two cases at right radius and only one case at the left side. ultrasonographic appearance, presence of hyper-echoic cortical bone of radius with an-echoic disruption at the site of fracture but the ulna appeared hyper-echoic without any changes (Fig. 3) while in the radiographic picture showed transverse radiopaque fracture line at the shaft of the radius and the fracture ends were impacted (Fig. 4).

Five cases suffered from femur fracture at the right side, in ultrasonographic appearance, presence of hyper-echoic cortical bone of femur with an-echoic disruption at the site of fracture (Fig. 5) while the radiographic picture showed oblique radiopaque fracture line and the fracture ends were overlapped. Presence of hematoma at the site of fracture which appeared ultrasonography as hypo-echoic area (Fig. 6)

In iliac shaft fracture, there are two cases and in ultrasonographic appearance, presence of hyper-echoic cortical bone of femur with an-echoic disruption at the site of fracture (Fig. 7) while the radiographic picture showed oblique radiopaque fracture line (Fig. 8).

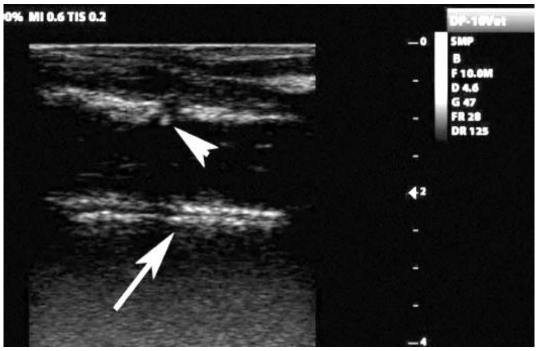

Fig. (3) Ultrasonogram showing hyper-echoic ulna bone (white arrow) an-echoic disruption area (head white arrow) at the site of radius fracture transverse radiopaque fracture line and the fracture ends at the site of radius fracture

Fig. (4) Lateral radiographic projection showing were impacted (white arrow) the fracture ends at the site of radius fracture

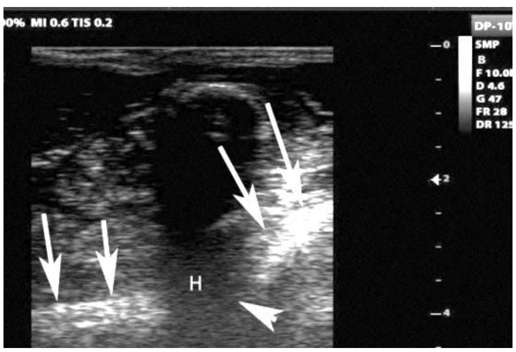

Fig. (5) Ultrasonogram showing hyper-echoic femur bone (white arrow) with an-echoic disruption area (head white arrow) at the site of femur fracture and (H) haematoma

Fig. (6) Ventro-Dorsal radiographic projection showing transverse radiopaque fracture line and the fracture ends were overlapped (white arrow)

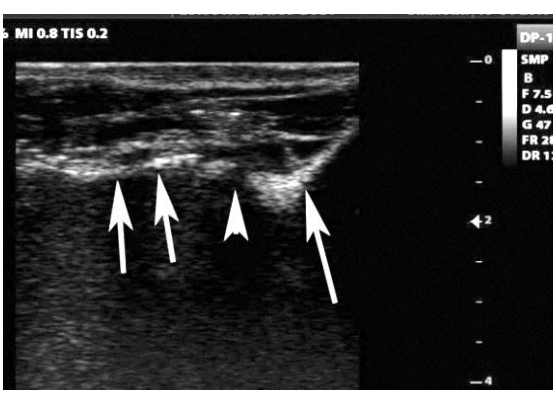

Fig. (7) Ultrasonogram showing hyper-echoic ilium bone (white arrow) with an-echoic disruption area (head white arrow) at the site of ilium fracture

Fig. (8) Ventro-Dorsal radiographic projection showing transverse radiopaque fracture line at iliac shaft (white arrow)

4. DISCUSSION

Ultrasound shows promise as a diagnostic imaging tool in fracture detection. Although ultrasound was previously assumed to be limited by ultrasound wave reflection at bony cortices, subsequent investigations found that this acoustic characteristic of bone actually improves visualization of cortical disruptions. (Chhem et al., 1994 and Grechenig et al., 1998).

Regarding, the development of hand-held ultrasound systems may enable us for more quickly identifying clinically significant fractures, through more rapid image. Furthermore, the small size of these systems enables their use in locations where traditional radiography and experienced physicians are not available. This result is in agreement with Marshburn et al. (2004).

Recent clinical investigations are defining a wider range of conditions in which rapid ultrasound examinations performed by non-radiologist physicians can influence treatment decisions. When comparing ultrasonography US with CT and conventional radiography (CR), US is a cheap, easily available, simple to perform, and has no risk of ionizing radiation (Blaivas et al., 2000 and Frazee, et al., 2001)

Ultrasound techniques easily to teach by non-radiologists with minimal prior ultrasound experience. The ultrasound skills were simple to perform at the patient's bedside. Regarding, discomfort to animals, there is no signs of pain, discomfort or stress were recorded. This result is in agreement with Marshburn et al. (2004). In fact, very light contact of the probe with the patient's skin produced images of sufficient quality for interpretation. Also, ultrasound had high sensitivity for fracture detection like radiography or CT.

Concerning, ultrasound imaging is as good as radiography in the detection of sites of fractures in all dogs. This result is in agreement with (Dominic et al., 2000).

Our result showed that the ability of the ultrasound in detection of hematoma at the fracture site of femur. This result is in agreement with (Moed et al., 1998 and Failla et al., 1999) those reported that, ultrasound's capability to image hematoma formation and soft-tissue interposition in fracture sites.

Regarding, ultrasound in femoral shaft fracture detection is good and confirmed by x-ray This result is in agreement with (Marshburn et al., 2004) who reported that ultrasound of most use in detecting of fracture but it ruling out to femoral and humerus extremities fractures, where it was 100% sensitive in detecting humerus and femoral mid-shaft fractures. Ultrasound was limited in detection of fractures near the hip. All inaccurate ultrasound interpretations occurred with femur fractures at or above the intertrochanteric line. This is most likely due to the surface irregularities of the normal greater trochanter and femoral neck, which can scatter the impinging acoustic wave resulting in a less distinct reflected signal, and may be interpreted as a cortical discontinuity (Moed et al., 1998 and Failla et al., 1999).

Ultrasonography offers a quick, noninvasive diagnostic tool in animals with suspected disorders. Ultrasonography and radiography are equally useful to detect fracture of the ilial shaft disorders. This result is in agreement with (Florian et al., 2009).

5. CONCLUSION:

Ultrasound is easy to teach by non-radiologists with minimal prior of ultrasound experience. Ultrasound system is more quickly identifying clinically significant fractures, through more rapid image. Furthermore, the small size of these systems enables us to use it in locations where traditional radiography and experienced physicians are not available. Ultrasound scans by minimally trained clinicians may be used to detection a long-bone and flat bone fractures with a medium to low probability of fracture. Ultrasound was safe, non-ionized and not causes dangerous diseases to the veterinarian like leukemia.

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