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Ultrasonographic Evaluation of Mandible Fracture Healing after Bone Plate Fixation in Dogs: An Experimental Study

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A B S T R A C T

The goal of the present study was estimate the capability of the ultrasonography (US) for following up the simple, transverse and non-complicated mandibular fracture healing in dogs. nine dogs aged from 2-3 years and weighted from 15 to 20 kg were used. Mandibular fracture was induced experimentally and the fractured parts were fixed by Dynamic Compression Plate (DCP) and bone screws. Fracture healing was arbitrated by using ultrasonography. The results showed that, the fracture line was appeared ultrasonographically as an-echoic to hypo-echoic area neighboring to the hyper-echoic bone and the bone plate was appeared hyper-echoic after fixation. During chase the fracture healing of the mandible by using US, there were changes appeared in the echogenicity at the site of fracture. In conclusion, the Ultrasonography could be utilized to assess the stages of mandibular fracture healing in dogs.

Keywords: Ultrasound, Fracture Healing, Mandible, Dogs.

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1.INTRODUCTION:

Ultrasound (US) was used for following up of the secondary fracture healing (Moed *et al.*, 1998; Maffulli, 1999 and Risselada *et al.*, 2005). Secondary fracture healing depends on callus formation that evolves and advances through hematoma, granulation tissue and soft callus formation that become ossification (Remedios, 1998 and Hulse and Hyman, 2003). This type of fracture healing was appropriated for ultrasonographical evaluation, as a soft callus can be estimated by using US but not radiography. US can be giving an earlier diagnosis of fracture healing in animals than radiography (Risselada *et al.*, 2005).

Fracture healing requires bones segments on the fracture site to be reduced with little to no gap was present and to be rigidly fixed. If this is achieved, the fracture healing was done by direct bone growth and there is minimal to no callus formation (Perren, 1993 and Hulse and Hyman, 2003) If a small gap persists after reduction and fixation, the gap will be filled initially by soft callus then instead by hard callus (Hulse and Hyman, 2003 and Risselada, *et al.*, 2006).

Evaluating of fracture healing ultrasonographically after plate fixation would confer good rule of the possible complications which may be done in the future, such as delayed union or nonunion, can be likened to it. *The aim of this study* is assessing the simple, transverse, non-complicated mandibular fracture healing by using US after bone plate fixation in dogs.

2.MATERIAL AND METHODS:

This study was conducted on nine adult apparently healthy male mongrel dogs weighting 15–20 kg and aged 2–3 years. This work was done at surgery, anesthesiology and radiology department, Faculty of Veterinary Medicine, Beni Suef University. All dogs were pre-medicated with I.V injection of a mixture of atropine sulfate 0.05 mg/kg. (Atropine sulfate 1 mg/ml Med. Co., A. R. E) and diazepam 1 mg /kg. (Neuril 0.5% sol. Memphis Co. for pharm. & chem. Ind. Cairo A.R.E). Anaesthesia was induced immediately through I.V injection of a mixture of Ketamin 10 mg/kg (Ketamar 5% sol. Amoun Co. A.R.E) and Xylazine 1 mg / kg (Xyla-Ject 2% ADWIA Co., A.R.E.) (Schmidt-Oechtering and Alef, 1995 and Torad, 2000).

The right mandibular side was prepared for aseptic surgery. The skin incision was made at the ventral border of the mandible, blunt dissection was done by blunt scissor till reach to the bone and by using bone hummer and bone chisel; the simple, transverse, non-complicated mandibular fracture was done**.** Stabilization of the fractured mandible was done after reduction the fracture ends by using a sufficient length of Dynamic Compression Plate (DCP) of four holes; two screws cranially and two screws caudally of 3.5 mm Ø and 1.5 cm length. The bone plate was contoured by using plate bender for taking the shape of the ventral border of the mandible. Using the bone drill to create holes in mandible and butting the screws by screw driver. The surgical field was flushed several times by normal saline then irrigation by gentamycin 10%. The surgical wound was closed by using polyglactin 910 (Vicryl) No. 0 through simple continuous fashion. The skin was sutured by Silk No. 1 through continuous interlocked suture pattern**.**

All fractures healing was assessed by US *(Ultrasonographic examination was done by using Mindray veterinary ultrasound device 5000 connecting with linear multi -frequency transducer 7.5 MHz.).* Ultrasonic conductive gel was applied for transducer coupling with the skin. All animals were calmed by xylazine HCL 2% with 1 mg/ kg *(Xyla-Ject 2%. ADWIA Co., A.R.E.),* then make sure for correct positioning of the animals on the table. A linear transducer and standard approaches were used (Risselada et al., 2003). Following up of the fracture healing were scheduled at one week, two weeks, three weeks, four weeks and five weeks to detect the changes which done in the fracture gap by changes in the echogenicity appearance of the fracture gap.

3.RESULTS:

After inducing of mandible fracture, the fracture gap was visible ultrasonographically as an-echoic disrupted area presented between hyper-echoic intact bones of the mandible (Fig. 1). *Immediately postoperatively*, the fracture gap was nearly not visible due to good alignment of the fracture ends after fixation by bone plate and screws which were appeared ultrasonography as hyper-echoic rod beside the bone of the mandible and the screws also appeared as hyper-echoic small spiral rods inside the mandible (Fig. 2). *After one week*, there was increasing in the echogenicity of the fracture gap from the day of operation; this ensure that beginning of fracture healing stages which are inflammatory stage and presence of hematoma was performed (Fig. 3). *After three weeks*, the fracture gap was unnoticeable due to increasing in echogenicity due to soft callus formation (Fig. 4). *Finally, after five weeks*; the fracture gap was completely unnoticeable, and the echogenicity of the fracture gap was nearly similar to the echogenicity of the mandible (Fig. 5).

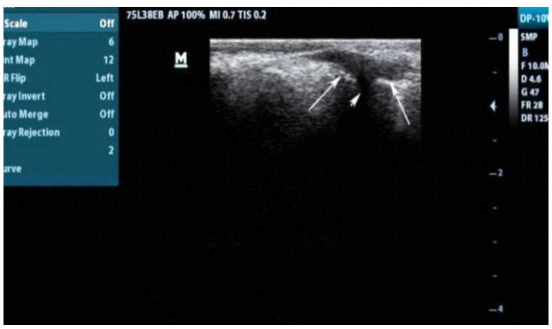

Fig. (1) Longitudinal ultrasonogram, showing hyper-echoic mandibular bone (white arrows) with an-echoic disruption area (white arrow head) at the site of fracture gap.	Fig. (2) Longitudinal ultrasonogram, showing hyper-echoic bone plate screws (two white arrows) with echoic bone (B) and an-echoic disruption area (white arrow head) at the site of fracture directly after operation (P) bone plate (DCP).

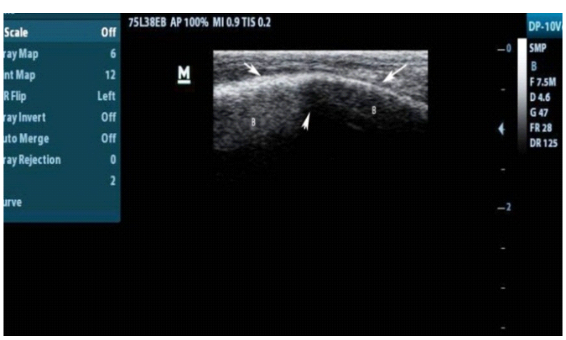

Fig. (3) Longitudinal ultrasonogram, showing hyper-echoic bone plate (two white arrows) with echoic bone (B) and an-echoic disruption area (head white arrow) at the site of fracture gap after one week.	Fig. (4) Longitudinal ultrasonogram, showing hyper-echoic bone plate screws (two white arrows), increasing of the echogenicity of disruption area (head white arrow) at the site of fracture after three weeks. Bone plate (P).

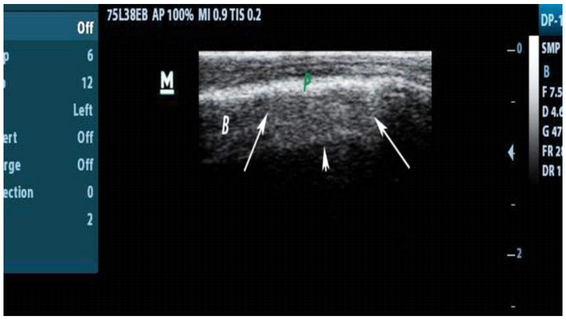

Fig. (5) Longitudinal ultrasonogram, showing hyper-echoic bone plate (P) and hyper-echoic bone plate screws (two white arrows) with **nearly** homogenous of echogenicity in disruption area with the whole bone (head of arrow) at the site of fracture after five weeks.

4.DISCUSSION:

Ultrasound considered as a good diagnostic imaging tool for fracture detection and following up to the fracture healing. Although ultrasound was already presupposed to be limited by ultrasound wave reflection at the bone cortex, following realization found that the sonic characterization of bone actually gets a better visualization of cortical disruptions (Chhem *et al.*, 1994 and Grechenig *et al.*, 1998).

The fracture gap was visualized before and after operation, this in correlation with (Risselada, *et al.*, 2006 and Ragab and fathy, 2017). our study was initially step based on the guess that US would be sufficient to visualize a small interruption in the bone cortex, even after fixation with a compression plate. This is important because the ability to visualize this gap is necessary to diagnose healing based on changes in the echogenicity of the fracture gap as standard steps of bone healing (Risselada, et al., 2007).

By using Ultrasonography able to assess mandible fracture healing which treated by bone plate fixation, based on the absence of a detectable fracture gap, or interruption in the bone. US also gave an earlier evaluation of fracture healing, which was comparable to its described use in secondary fracture healing. This is agreement with (Ricciardi 1993; Moed, *et al.*, 1998a; Moed *et al.*, 1998b; Maffulli, 1999 and Risselada *et al.*, 2005).

In correlation with (Risselada, *et al.*, 2006) who reported that the US does provide for an earlier assessment of fracture healing. (Perren 1993; Piermattei and Flo, 1997 and Risselada, *et al.*, 2003) record that the healing was occurred either at 4–5 weeks. Our results decided that US could be used to assess secondary fracture healing. It appeared to allow earlier assessment of fracture healing rather than radiography.

Ultrasonography was considered as more saver and gave ability to identify fracture healing stages earlier than radiography. This is in correlation with (Risselada, *et al.*, 2007 and Ragab and fathy, 2017).

5.CONCLUSION:

Ultrasonography can be used to assess fracture healing and detection of callus formation earlier than when based upon radiographic appearance.

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