Surgical Approach of the Anatomical Sites for Bone Marrow Aspiration in Dogs

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ABSTRACT

Key words: Bone marrow, sternum, femur, iliac crest, dogs.

Bone marrow as a soft material found in the central core of bones is vitally important for the production of blood cells and platelets. Bone marrow is commonly collected and examined when abnormalities are found in the circulating blood. The presented investigation aimed to describe the best anatomical sites for aspiration of the bone marrow in dogs and to record the computed tomographic anatomy and detection the site of needle aspiration. The present study was carried out on 7 apparently clinically healthy mongrel dogs (3 male and 4 female). The dog's weights were 15 - 50 kg bwt and their ages were 8 - 24 months. Three dogs (one male and two females) were euthanized to perform a cadaveric study to approach humerus, sternum, iliac crest and femur to detect the best site to introduce different sizes of aspiration needles to aspirate bone marrow samples. The other four dogs were undergone three dimensions (3D) computed tomography (CT) to detect the length of the needle inside the bone to aspirate bone marrow samples. In conclusion, the anatomical details of long bones (humerus and femur) and flat bones (sternum and ilium) were well showed by bone window of anatomical computed tomography. The Transverse plane showed that, humerus, femur and ilium are viewed in this plane with clear defined intra medullary cavity and the aspiration needle was obvious through head of humerus; Meanwhile, this plane was not valuable to detect medullary cavity of the sternum. The three-dimensional view cleared that, the humerus, femur, ilium and sternum were viewed from all directions to detect anatomical sites for needle introduction. The sternum is anatomically detailed as a different length of sternebrae and needle insertion is safe in the longest sternebra (2nd one).

1. INTRODUCTION

Evaluation of a bone marrow aspirate and a bone marrow core biopsy may provide valuable information about the status of the bone marrow, its ability to respond to correct abnormalities in the peripheral blood and/or to determine if there is infection, myelofibrosis, necrosis, neoplasia or other abnormalities (Cowell et al., 1989). Bone marrow aspiration is frequently performed in dogs with unexplained hematologic abnormalities when a diagnosis cannot be established based on blood evaluation (Moritz et al., 2010). Bone marrow aspiration is frequently performed in dogs with unexplained hematologic abnormalities when a diagnosis cannot be established based on blood evaluation (Moritz et al., 2010). Bone marrow aspiration is frequently performed in dogs with unexplained hematologic abnormalities when a diagnosis cannot be established based on blood evaluation (Moritz et al., 2010). 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nevertheless commonly chosen. Aspiration from the pelvis or femur may be particularly challenging if the site is covered with abundant adipose tissue (Fleisher, 2005 and Kasashima et al., 2011). An alternative to this procedure is cytological evaluation of bone marrow samples obtained from the epiphysis of long bones or regions of the ilium, such as the iliac crest or acetabular rim (Riley et al. 2004). Sternal puncture under local anesthesia has been routinely used to obtain bone marrow samples for cytological evaluation in human medicine since its description by Arinkin (1927 and Osgood and Seaman (1944). The sternum has historically not been aspirated in animals because of concerns regarding thoracic penetration (Moritz et al., 2010). However, the sternum has less soft tissue coverage than the ilium, femur, or humeral head, and the thinner cortex is readily accessible (Guillot et al., 2011). A recent research showed that, aspiration of sternal bone marrow with hypodermic needles was feasible and safe in small dogs under anesthesia, and samples equivalent in quality to those from the humerus or ilium can be obtained from clinically normal dogs (Defarges et al., 2013). The presented investigation aimed to describe the best anatomical sites for aspiration of the bone marrow in dogs and to record the computed tomographic anatomy and detection the site of the needle aspiration.

2. MATERIAL AND METHODS
2.1. Animal grouping
The present study was carried out on 7 healthy mongrel dogs (3 male and 4 female). The dog’s weights were 15 - 50 kg and the average age was 8 - 24 months. Three dogs (one male and two females) were euthanized to perform a cadaveric study, which included anatomical approach for humerus, sternum, iliac crest and femur to detect the best site to introduce different sizes of aspiration needles for aspiration of bone marrow samples. Four dogs were undergone three dimensions (3D) computed tomography (CT) to detect the length of the needle inside the bone to aspirate bone marrow samples. This study was performed at the department of surgery, by the committee of scientific research ethics of Faculty of veterinary medicine, Alexandria University

2.2. Anatomical study
Three recently euthanized adult dogs were euthanized by administration of a lethal dose of thiopental sodium (Epico, Egyptian company), 500 mg injected rapidly intravenously. The site of iliac crest and the sites around head of femur, the head of humerus and the sternum bone were prepared by incision and dissection. The approaches were directed to recognize and describe the best site for introduction of needle for bone marrow aspiration.

2.3. Humerus
A small dorsal stab skin incision was made over greater tubercle of humerus and dissect subcutaneous fascia. By index finger detect greater tubercle to insert jamshidi needle (Fig 1).

2.4. Femur
A small dorsal stab skin incision was made over greater trochanter and dissect subcutaneous fascia and insert jamshidi needle (Fig. 2).

2.5. Ilium
A small dorsal stab skin incision was made over wing of ilium (flat bone) and dissect subcutaneous then introduce small sized needle vertically in iliac crest (Fig. 3).

2.6. Sternum
A small ventral stab skin incision was made at level of the 3rd rib, then by the index finger detects the space between 2nd and 3rd sternebra (Fig4).
For more anatomical details, 3D computed tomography (CT scanner) was applied on 4 dogs which were anesthetized by xylazine HCL as pre-anesthetics medication (Chanazine HCl, ADWIA, Egypt) in a dose of 1 mg/kg bwt IM. After 10 minutes ketamine HCL (Troikaa) was administrated in a dose of 5 mg /kg bw IM for induction of general anesthesia.

The Siemens Emotion 6 features a slim yet wide-open gantry offering greater patient comfort and an ease of use was designed to produce high resolution images with the lowest possible dose for patients. The system features the Syngo user interface, an air-cooled, high-speed gantry, fast 3D-processing tools, Sure View multi slice image reconstruction, SOMATOM Work Stream, and optional Lung CARE CAD and Colonography PEV.

CT study was used to determine the anatomical details of the previously described bones, sites of needle insertion and length of needle introduced within the cavity.

**There were two planes were used to visualize detailed anatomy of aspiration sites of bone marrow for each bone :**

1. Three dimensions plane.
   - The long bone as humerus and femur and flat bone as ilium and sternum were viewed from all directions to detect the anatomical sites for needle insertion to aspirate bone narrow sample.
2. Transverse plane.
   - This plane was applied to detect the position of aspiration needle inside the bone.

**3. RESULTS**

**3.1. Anatomical study**

**3.1.1. Humerus :**
- Dorsal insertion of Jamshidi needle (aspiration needle) and direct laterally till 6 cm of needle length inside greater tubercle of humerus bone, then by sterile syringe aspirate bone marrow. 3 ml of bone marrow can be collected.

**3.1.2. Femur:**
- By index finger detect inter trochantric fossa between the greater trochanter and lesser trochanter then direct aspiration needle inside femur till 4 cm of needle length inside the femur then aspirate 2 ml of bone marrow with a sterile syringe.

**3.1.3. Ilium:**
- Through stab incision a 2 cm length of jamshidi needle was inserted vertically in iliac crest and collect 2 ml of bone marrow.

**3.1.4. Sternum:**
- small sized aspiration needle introduced inside 2nd sternebrae through stab incision to get 1 ml of bone marrow sample with a sterile syringe.

**3.2. Computed Tomographic study:**

**Dimension plane:**

**The humerus:**
- The humerus with this view was anatomically detailed. This view showed anatomical greater tubercle of humerus and the length of inserted needle inside bone was 2.1 cm (Fig., 6). The proper
anatomical site for aspiration needle insertion through greater tubercle clearly defined.

**The femur:**
The anatomy of the femur was typically showed. This view showed the needle insertion was performed through the trochanteric fossa inside femur and the direction of the needle was clearly viewed (Fig., 7).

**The ilium:**
The anatomy of ilium was clearly showed. The needle insertion was performed through the iliac crest and the direction of needle could be detected (Fig., 8). The anatomical distance between the vertebral column and iliac crest was detected about 10 cm.

**The sternum:**
The sternum in this view was anatomically detailed and the different lengths of sternebrae and the needle insertion in the longest and the most safe sternebra (2nd one) were detected (Fig. 9).

**Transverse plane:**

**Humerus:**
The humerus was viewed in this plane with clear defined intramedullary cavity. Jamshidi needle was obvious through head of humerus (Fig., 10).

**Femur:**
The femur was clearly viewed in this plane showing intramedullary cavity and distance from hip joint to inserted aspiration needle (Fig. 11).

**Ilium:**
This plane of ilium was showed medullary cavity and length of inserted aspiration needle was 1.8 cm to get bone narrow sample (Fig. 12).

**Sternum:** The plane of sternum was not valuable to detect medullary cavity.

**Figure (6):** Showing computed tomographic imaging of humerus, 1-Aspiration needle (2.1 cm), 2-Humerus.

**Figure (7):** Showing Computed tomographic imaging of femur, 1- ilium, 2- inserted aspiration needle, 3- femur

**Figure (8):** Showing computed tomographic imaging of ilium, 1-Aspiration needle, 2-Iliac crest.3 _femur

**Figure (9):** showing 3D CT of sternum during aspiration of marrow sample with veterinary needle.1.inserted veterinary needle.2.2nd sternebrae.

**Figure (10):** Showing transverse plane of humerus 1-humral medullary cavity .2- inserted jamshidi needle in greater tubercle of left

**Figure (11):** showing transverse plane of femur 1-femoral intramedullary cavity. 2-inserted aspiration needle.
4. DISCUSSION
Needle aspiration of bone marrow and biopsy of primary and metastatic tumor tissue from the sternum was complicated by inadequate specimen retrieval secondary to marrow necrosis and/or tissue destruction by tumor. In these cases, CT guidance was useful in the precise localization of the bulk of the tissue mass and consequently the successful retrieval of adequate diagnostic specimens. CT guidance is an excellent and convenient alternative in circumstances where adequate marrow aspirations and biopsies are difficult and complicated (Huang et al., 1999).

The results of the anatomical computed tomography cleared that, the fine needle aspiration biopsies of 4 dogs that were included in the study. Fine-needle aspirates from (four femur, four humerus, four ilium and four sternum) were taken and underwent cytologic examination, with subsequent histopathologic examination. All 16 tissue core biopsy samples were diagnostic (accuracy 100%). Five out of six fine needle aspirates were diagnostic with an accuracy of 83.3%. Four out of five of the cytologic examinations were confirmed by histopathology after euthanasia.

The anatomical details of long bones (humerus and femur) and flat bones (sternum and ilium) were well showed by bone window. This result in line with those of (Daniel and Mitchell, 1999) where they reported that, description for application of CT guided biopsies in animals is limited, and there is only one report regarding the number of biopsies, biopsy location and histopathologic results. Also, Tidwell and Johnson, (1991) observed correct diagnosis was obtained in 12 out of 15 biopsies. Percutaneous free-hand CT-guided biopsy technique is a useful method for bone marrow aspiration without any dangerous effect on the diseases animals and is the best methods for diagnosis of bone lesions in small animals. The results in the Transverse plane showed that, the humerus, femur, is viewed in this plane with cleardefined intramedullary cavity and the Jamshidi needle is obvious through head of humerus. Also, this plane of ilium showed medullary cavity and length of inserted aspiration needle to get bone marrow sample. While, in sternum this plane of the sternum was not valuable to detect medullary cavity.

The present results in line with those of (Chahla et al., 2017) where they reported that, the transverse plane is very important especially when we collect the bone marrow from iliac crest, femur and humerus as the aspiration needle become clear in the marrow cavity. The results on the three dimensional view cleared that, the long bone (humerus and femur ) and flat bone (ilium and sternum ) were viewed from all directions to detect anatomical sites for needle introduction. This results agreed with those of (McDougall et al., 2018) where they reported that, the using of three dimensional image during aspiration of bone is of beneficial effect especially in the long bone (humerus, femur) or flat bone (ilium and sternum) as it clear the direction of aspiration needle without destruction of bone marrow. The humerus, femur, ilium with this view is anatomically detailed. This view showed anatomical head of humerus and length of inserted was 2.1 cm . Also we can detect proper anatomical site for aspiration needle insertion through bicipetal groove. Needle insertion through trochantric fossa inside femur and direction of needle clearly viewed . Also anatomical distances between vertebral column and iliac crest can be detected 10 cm. Also, the sternum in this view is anatomically detailed as I can detect different length of sternebra and needle insertion in the

<table>
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<tr>
<th>Site of needle introduction</th>
<th>Different bones</th>
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<tr>
<td>Greater tubercle</td>
<td>Humerus (long bone)</td>
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<tr>
<td>Intertrochantric fossa</td>
<td>Femur (long bone)</td>
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<tr>
<td>Iliac crest</td>
<td>Ilium (flat bone)</td>
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<tr>
<td>2nd sternebrae</td>
<td>Sternum (flat bone)</td>
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longest sternabrae 2\textsuperscript{nd} one after manubrium. (This results agreed with those of (Vignoli et al., 2004) where they reported that, CT examination after intravenous contrast medium added useful information to avoid large vessels and to biopsy viable tissue.

Free hand CT guided tissue-core biopsy and aspiration appears to be a safe and very accurate procedure for use in the diagnosis of bone associated diseases in small animals. Also, No major complications such as hemorrhage or fracture occurred in the present study. On the other hand Vingoli et al., (2004) reported that only mild bleeding after the biopsy of the nose was observed. Such complications have to be considered in relation to risks of alternative methods and the risk of an incorrect diagnosis. The author added that, assessment of biopsy-associated pain difficult, because dogs were already lame before the procedure. However, we noted worsening of the lameness during the first three days after biopsy in two dogs.

In one patient, complete bone destruction resulted in mild needle displacement because of lack of bony support. However, this did not influence success of the biopsy. Some difficulties were encountered in selecting the correct angle for biopsy of the spine, and in keeping the animals in the same position during the biopsy procedure. In one patient, the examination had to be restarted. However, a diagnostic sample was finally obtained. It could be concluded that the anatomical details of long bones (humerus and femur) and flat bones (sternum and ilium) were well showed in bone window of anatomical computed tomography. The Transverse plane showed that, the humerus, femur, ilium is viewed in this plane with clearly defined intra medullary cavity and the aspiration needle is obvious through head of humerus; While, in the sternum this plane of sternum was not valuable to detect medullary cavity. The three dimensional view cleared that, the long bone (humerus and femur) and flat bone (ilium and sternum) were viewed from all directions to detect anatomical sites for needle introduction. The humerus, femur, ilium with this view is anatomically detailed. Also, the sternum in this view is anatomically detailed as different lengths of sternebrae could be detected and needle insertion is safe in the longest sternebra (2\textsuperscript{nd} one) after manubrium.

REFERENCES