INCIDENCE, CLASSIFICATION AND MANAGEMENT OF APPENDICULAR BONE FRACTURES IN DOGS IN NAIROBI COUNTY, KENYA.

A RETROSPECTIVE STUDY

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DEDICATION

I dedicate my dissertation work to my family and many academic friends. A special feeling of gratitude to my late loving mother, Elisah Ndou whose words of encouragement and push for tenacity ring in my ears. My wife Shiela has never left my side and She is very special. I also dedicate this dissertation to Agriculture Head of Department Limpopo, and Human Resources Development Division staff who have supported me throughout the process. I will always appreciate all they have done. I dedicate this work and give special thanks to my supervisor Senior Manager Veterinary Services Limpopo and my wonderful daughter Phuletshedzo for being there for me throughout the entire Masters Program. Both of you have been my best cheerleaders.

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ABSTRACT

Dogs and cats constitute the majority of domestic pets worldwide, Kenya included. These pets are prone to sustain appendicular bone fractures, which are frequently caused by traumatic injuries, or bone pathology**.** A retrospective study was carried out with the objectives of determining the incidence and associated risk factors of appendicular bone fractures; establishing the types and frequency of occurrence of fractures of appendicular skeleton; determining existing protocols for the management of appendicular fractures, and the associated complications and challenges, in small animal practices, in Nairobi County.

The incidence and associated risk factors of appendicular bone fractures and the types of fractures and their frequency of occurrence were determined by retriving all records of cases diagnosed with appendicular skeletal bone fractures in the practices between April 2007 and December 2013. Data on each case which included the diagnosis, date, month and year of occurrence, breed, gender, age, type of fracture, limb affected, bone affected and the description of the fracture, were obtained and recorded. Protocols for management of appendicular bone fractures, associated complications and challenges were determined by analyzing data collected through structured questionnaires and review of patient records in participating practices.

A total of 402 cases of fractures were retrived at the practices surveyed in this study. Out of these, 59 were appendicular fractures, giving an incidence of 14.7%. The incidence of hind limb fractures was higher than that for the forelimbs. Ninety percent (90%) of appendicular fractures affected entire males and females. The age of affected dogs ranged from 4 months to

10 years. The German shepherd breed of dogs and its crosses were the most affected. Male dogs (69%) were more affected than their female counterparts (31%).

In the forelimb, the radius-ulna had the highest incidence of fractures (22%) followed by humeral fractures (13.6%). In the hind limb, femoral fractures had the highest incidence (30.5%), followed by tibia-fibula fractures (18.6%). Overall, diagnosis of fractures was achieved through physical examination of dogs and confirmation by radiography.

Unknown trauma was the principal cause of fractures; followed by motor traffic accidents, human abuse, animal bites, falls and indoor trauma. The most common types of fractures encountered were complete simple transverse fractures (65%), followed by oblique (15%) and comminuted (5%) fractures. Fracture management comprised external and internal fixation techniques. The most common internal fixation technique employed was intramedullary fixation of long bone fractures. Other devices used included orthopedic wires, bone plates and bone screws. Cast bandage was used largely for external coaptation.

These were no complications following appendicular fracture management in 22% of the cases. However, complications were encountered in 44% of the cases. Delayed union, non union and implant failure were the most encountered complications. Osteomyelitis, implant migration, arthritis and wound infection were usually seen in cases with unstable comminuted fractures. The challenges of managing appendicular bone fractures were non-compliance by the owners, limitations of resources and lack of appropriate surgical instrument, equipment and expertise. Record keeping was also noted as a major challenge in a number of practices.

The study concluded that the incidence of appendicular bone fractures in dogs in Nairobi County is low, male dogs were affected more than female dogs and hind limb fractures were more common than fore limb fractures. Unknown trauma and motor traffic accidents were the two most common causes of fractures. Furthermore, the outcomes of managed appendicular fractures were largely not satisfactory and post-management complications were not uncommon. Whereas the necessary materials for fracture management may be readily available, their use is constrained by high cost, limited surgical skills and lack of appropriate surgical equipment. There is need to improve surgical skills in orthopaedics for better surgical outcomes in fracture cases. Also there is a need to keep proper records in small animal practices in Nairobi County. These can be achieved through targeted training.

CHAPTER ONE

1. INTRODUCTION

Dogs and cats constitute the majority of domestic pets worldwide, Kenya included. These pets are prone to sustain appendicular bone fractures, which are frequently caused by traumatic injuries, or bone pathology. With the relative increase in pet animal ownership, bone fractures constitute a major problem among dogs and cats (Senna, 2001; Harari, 2002). Irrespective of the etiology, bone fractures result in loss of function, which may be characterized by varying degrees of lameness, pain, soft tissue swelling and bleeding. Collateral injuries may affect soft tissues as well as nerves.

Studies have shown that the incidence of pectoral limb fractures is highest in young animals under the age of six months. Male dogs are affected more than female dogs of all age groups and nondescript dogs tend to have the highest incidence of pectoral limb fractures (Cook, 1997; Shiju *et al*., 2011). Among the various bones of the pectoral limb, the incidence of fractures is highest in the radius and ulna followed by humerus. The occurrence of oblique/transverse fractures has been found to be more than overriding and comminuted fractures (Shiju *et al.*, 2011). Pectoral limb fractures are due to high energy trauma and therefore can result in life threatening injuries, severe and permanent disability (Kolata *et al*., 1974).

Diagnosis of fractures is based on history of trauma and clinical signs. Accurate radiographic examination is important for confirmation and classification of the type of fracture and determination of appropriate treatment options. It also provides baseline data for comparison with immediate postoperative radiographs. When regular serial radiographs are available, they aid in monitoring progress of bone healing and facilitate decision-making for removal of orthopaedic devices (Lappin *et al.*, 1983; Hobbs, 2012). Fractures may be classified on the basis of age of the fracture, number and position of the fracture line, direction and location of the fracture line, forces acting on the fracture, stability and, degree of soft tissue damage, among other characteristics (Piermattei *et al.*, 2006; Shales, 2008b).

Accurate classification and description of fractures is essential as it encourage the practitioner to examine the radiographs very carefully. This reduces the probability of missed fissures or involvement of the joint and ensures that all relevant diagnostic information is conveyed using a consistent format. Optimal bone healing requires observation of the Association for Osteosynthesis (AO) principles for fracture fixation (Shales, 2008a). These include the accurate reduction of fracture fragments, rigid fixation satisfying the biomechanical requirements of the fracture, preservation of the fracture biology by atraumatic surgical technique and the early return to pain-free movement and weight bearing to minimize fracture disease. Articular fractures require special consideration for preservation of joint function and avoidance of callus formation. Articular fracture repair therefore requires: rigid internal fixation; interfragmentary compression; anatomical reconstruction; and early return of joint mobility (Piermattei *et al.*, 2006). External and internal fixation of bone fractures in dogs involves the use of cast bandages, bone plates and screws, plate-rod stabilization, intramedullary and rush pins, interlocking nails, cerclage wiring and tension band wiring (Gemmil, 2007). Management of fractures is not always without its complications. These complications may arise from among other things, the surgical procedure, and factors inherent in the patient or devices used to manage the fracture. To minimize poor outcomes, it is required that veterinary surgeons be knowledgeable on the etiology and incidence of fractures, appropriate fracture management protocols, likely untoward outcomes and how to respond to them. Such information is either lacking or inadequate, despite the long history of existance especially small animal veterinary practice in Kenya.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Definition of fracture

A fracture is a complete or incomplete loss of continuity in bone resulting from the application of excessive force (Collins English Dictionary, 2003). Fractures can be classified as either traumatic or nontraumatic in origin, with trauma considered to be the most common etiology in animals (Adams *et al*., 2010).

2.2 Incidence of bone fractures in dogs

Studies have shown that the incidence of pectoral limb fractures is highest (36%) in young animals over 1.5 to 6 months of age (Shiju *et al*., 2011). The same studies showed that majority of the fractures were in nondescript dogs (38%), male dogs were affected more (59%) than female dogs of all the age groups and that among the various bones of the pectoral limb, the incidence was highest in the radius and ulna (65%), followed by the humerus (16%). In terms of breed, the German shepherd dog is more prone to fractures than other breeds of dogs (Harasen, 2003a; Senn *et al*., 2004). Humeral fractures in dogs are common. They represent approximately 10% of all limb fractures. They usually result from motor vehicle accidents, falls, gunshots, or minor trauma. There are three classic patterns for humeral fractures: approximately 20% of humeral fractures are physeal fractures in immature dogs; approximately 50% of humeral fractures are diaphyseal fractures resulting from major trauma, and half of these fractures are comminuted; and approximately 20% of humeral fractures are condylar fractures in adult dogs, occurring secondary to incomplete ossification of the humeral condyle (Marcellin-Little *et al.*, 1994; Kumar *et al.*, 2007).

Previous studies have shown that humeral condylar fractures were most often seen in puppies 4 to 6 months of age. The vast majority involved the lateral condyle. Fractured radius and ulna in dogs represented (19 %) of fractures while those of the metacarpals represented 3.4 %. Furthermore, bone fractures in small pets occurred in the hind limbs more than the fore limbs as they expose their hind quarters to the major force of the impact in order to protect the forequarters (Harasen, 2003b). It is opined that presence of thick muscular covering does not protect the femur from getting fractured (Aithal *et al.*, 1999b). The incidence of diaphyseal femoral fractures is about (20-25%), which is the highest for long bone fractures in the body. Furthermore, the distal half of the femur is away from the long axis of the pelvic limb, which makes it more susceptible to bending forces and leads to fracture (Wong, 1984; Aithal *et al*., 1999a).

Other studies (Ben Ali, 2003) have reported the incidence of femoral fractures in dogs and cats as 37.5 % and 25 % respectively. The most common sites of the fractures in the femur were the shaft (diaphysis), distal metaphysis and supracondylar in dogs. Occurrences of oblique/transverse fractures were more (43%) than overriding (30%) and comminuted fractures (18%) (Shiju *et al*., 2011).

The very high incidence of pelvic limb fractures observed in nondescript dogs might be due to their free roaming habits which make them more vulnerable to road accidents (Maala and Celo, 1975).

In previous studies (Shiju *et al*., 2010) the incidence of pelvic limb fractures in dogs was highest in young animals (46.0%) less than six months of age. A majority of these fractures were recorded in nondescript dogs (47.5%), with male dogs being affected more (61.5%) than females dog of all age groups (Shiju et al., 2010). Most of the fractured dogs were entire males and females. This could reflect the fact that neutering is not a routine practice for population control (Ben Ali, 2003). Consequently, intact pet animals wandering outdoors during the mating seasons may be subjected to traumatic fractures (Senn *et al*., 2004).

Among the various bones of the pelvic limb, the incidence of fractures was highest in the femur (47.5 %), followed by the tibia and fibula (42.7%). Tibial fractures in dogs represented 21.5 % whereas humeral fractures represented 7.9% (Shiju *et al*., 2010).

2.3 Examination and assessment of fractures

When planning the repair of a fracture, mechanical requirements and biological factors likely to influence healing potential should be taken into account. Each fracture must therefore be considered in the context of the entire animal, to determine the exact requirements of the techniques ultimately chosen for stabilization (Shales, 2008a). Biological assessment includes patient age, character, systemic illness and nutritional status. The fracture environment factors must also be considered and these include blood supply to the fragment, whether it is an open or closed fracture, absence or presence of foreign materials, loss of bone and whether it is recent as opposed to being an old fracture (Komatsu and Warden, 2010).

2.4 Confirmatory diagnosis of fracture

Confirmatory diagnosis of fractures can be done using radiography, ultrasound and Computed Tomography (CT) scan. Radiographs should be taken prior to fracture repair, immediately afterwards and at regular intervals postoperatively in order to properly monitor a patient's progress. Before attempting fracture repair, it is normal practice to obtain two orthogonal radiographic views (i.e., taken at 90° to each other) of the whole bone including the joints proximal and distal to the fracture. In some cases, additional oblique, stressed or non-standard views may be helpful. Radiographic views of the normal contra lateral bone are also useful for comparative purposes, particularly when dealing with a severely comminuted fracture, as they give information about the original dimensions and shape of the bone (Hobbs, 2012). Radiography, ultrasonography and histology have been used as tools for fracture healing assessment and their results do not differ (Rrisselada *et al.*, 2005).

2.5 Bone fracture classification systems

Fractures can be classified either as traumatic or nontraumatic in origin, with trauma considered to be the most common etiology in animals. Trauma may result from blunt or penetrating injury, while nontraumatic fractures can be benign or malignant. Causes of benign nontraumatic fractures include metabolic bone disease, osteogenesis imperfecta, and ‘stress’ fractures. Nontraumatic fractures may also be due to primary, multicentric or metastatic neoplasia (Adams *et al.*, 2010).

A correct description of a fracture is essential as it requires the practitioner to examine the radiographs very carefully, thereby reducing the probability of missed fissures or involvement of the joints, and so on. It is useful to adopt a standardised method of fracture classification/description in order to convey all the relevant information to colleagues (Shales, 2008a).

2.5.1 Classification of fractures based on description of presenting characteristics

In this classification system, fractures are classified based on a number of characteristics/features as presented. Fractures may be classified based on the cause of the fracture; whether the fracture is open or closed; the extent of bone damage; the number and position of fracture lines; direction of fracture lines; fracture location; forces acting on the fracture; stability of bone fracture; degree of soft tissue damage and age of fracture (Shales, 2008b). The study by Ben Ali (2013) has shown that the most common types of fractures encountered in dogs were complete, simple, transverse or oblique and comminuted. The findings corroborate the similar results in dogs by Shiju *et al. (*2010) who recorded that occurrence of oblique/transverse fractures was more (44.8%) than comminuted (26.8 %) and avulsion fractures (7.5%).

2.5.2 Salter-Harris classification of physeal injuries

Salter-Harris classification of physeal injuries is based on the direction of fracture line, as type I to type VI. Type I fracture lines run through the physis, type II fracture lines run through the physis and a portion of metaphysis, types III and IV are articular, type V results from crush damage to the physis and type VI is caused by callus bridging the physis (Fossum, 2007).

2.5.3 Unger system of bone fractures classification

This is a computer filing system based on the Association for Osteosynthesis classification used for human fractures (Muller *et al*., 1987) that ranks fractures within anatomical regions of a bone according to increasing severity or complexity. The alphanumeric code provides easy input into the computer database and the retrieval of the information is straightforward (Miller *et al*., 1998).

2.6 Principles and techniques of fracture management

2.6.1 The principles of fracture management

Understanding the different types of fractures and their incidence will be helpful in developing improved techniques of fracture fixation in dogs (Aithal *et al*., 1999). When choosing the most suitable technique to manage a particular fracture, some basic rules should be kept in mind, including the general principles of the AO group (Arbeitsgemeinschaft für Osteosynthesefragen, now known as the Association for Osteosynthesis), which pioneered many of the techniques for fracture fixation. These principles include: reduction and fixation of fractures to restore anatomical relationships; stability of the fixation to reflect the requirements of the fracture and injury; use of gentle surgical techniques to preserve the blood supply to bone and soft tissues; early and safe mobilisation of the patient and affected bone (Aithal *et al*., 1999a).

Fractures can be treated with either external or internal fixation techniques. Facture treatment with either external or internal fixation has some biomechanical problems as the method of fracture fixation changes the bone geometry and alters its normal mechanical strength (Carter and Spengler, 1982). In fracture treatment, it is important to choose an implant system that is capable of adequately neutralizing all the disruptive forces at the fracture site and allowing bone healing to rapidly progress. These forces cause bending, compressive, tensile, shear, or torsional stresses to act on the fractured bone and fixation system at the same time (Ayyappan, 2011).

Different types of fractures are treated using different approaches and techniques. For example, forelimb fractures in dogs are particularly challenging in orthopedic surgery as dogs bear most of their weight with the thoracic limbs (Fox, 1997). In the pelvic limb, femoral fractures are repaired by different implant systems that include intramedullary pinning, bone plates and screws, external skeletal fixation, lag screws and interlocking nails (Komatsu and Warden, 2010).

During management of articular fractures, the preservation of function and avoidance of callus formation should also be taken into account. The principles of this type of fracture repair will therefore aim to attain: rigid internal fixation; interfragmentary compression; anatomical reconstruction and early return to joint mobility (Shales, 2008b; Claes *et al.*, 2011). Stabilisation and triage should take priority over investigation of potential fractures, even though orthopaedic injuries are often obvious when a trauma patient is presented for treatment (Shales, 2008a).

Open fractures should be covered immediately with a sterile dressing while basic first aid is being performed. Blunt trauma patients may have significant internal injuries such as pneumothorax, diaphragm rupture, pulmonary contusions or urinary tract rupture, which require investigation and treatment before the more obvious fractures are managed. Triage should follow the ABC mnemonic: airway; breathing and circulation. Once the patient is stabilised, fractures below the stifle and elbow can be stabilised with splints or modified Robert–Jones dressings pending radiographic assessment. Fractures above these joints can be left undressed and the animal confined or a spica splint applied to reduce movement (Toombs *et al.*, 1985).

2.6.2 Techniques for fracture management

Common injuries in canines in long bone fractures include fractures of the humerus, tibia, and femur. Common incidents such as falls and vehicular accidents can produce excessive forces resulting in these fractures (Harasen, 2003a). Unlike human fractures, dogs cannot be effectively treated using external splinting devices because they are more active and cannot be restricted as humans are post-fracture. Due to this, other correction techniques are used to stabilize the fracture internally (Beale, 2004; Inas *et al*, 2012). Surgical techniques comprising external coaptation and internal fixation; including intramedullary pinning, application of bone plates and screws and cerclage wire have been previously described (Harari, 2002; Denny, 1993; Francuski *et al.*, 1986; Whitney and Shrader, 1987; MacLaughlin, 1999; Oakley, 1999).

Different fixation methods including bone plates and screws, interlocking nails, plate-rod constructs, lag screws and external fixators are used for the management of various long bone fractures in dogs (Dvorak et *al*., 2000; Das *et al.*, 2012). However, intramedullary pins and wires are used most frequently (Harasen, 2003b). Bone plates utilize a metallic plate which is secured to the external surface of the bone, over the fractured region with screws. In contrast, the interlocking nail utilizes a metallic pin or rod which is inserted manually into the medullary canal, using a hammer, and is secured internally with screws. The interlocking nail is superior to bone plates due to its simplified procedure, reduced cost, and reduced invasiveness. However the existing system for this procedure is limited in terms of ease of use and biocompatibility (Capulli *et al*., 2011). The adopted surgical techniques achieved satisfactory results in all treated cases in dogs and were in agreement with reports by others (Denny 1993; Farag, 2002). Management of fractures in growing dogs is difficult, especially in osteopenic bones.

2.7 Fracture complications

The development of complications following a surgical procedure is very troubling for a caring and dedicated surgeon, principally because of the morbidity and additional suffering caused to the patient. The potential for surgical complications seems to be endless, even with seemingly simple procedures (Dvorak *et al*., 2000). Complications in fracture patients can result from improper patient selection, the surgical procedure per se, the implant being used or the decisions and actions of the surgeon. However, in some cases, the reasons for the complications are multi-factorial or not readily apparent. Complications such as pin migration and failure of plate fixing due to inadequate purchase of screws are common (Schwarz, 1991). The importance of a learning curve in surgery is well known, because very experienced surgeons tend to have fewer complications (Johnson, 2012).

Complications may occur with each type of fracture fixation. Some complications are "acceptable" not only for the surgeon, but also the animal. Minor complications such as slight malalignment (which does not require repositioning) and hypertrophic callus are not so serious clinical problems. On the other hand, major complications, including delayed union and non-union, severe malalignment (requiring repositioning), osteomyelitis and implant failure are in numerous cases considered as fatal sequelae (Dvorak *et al*., 2000). Studies on fracture management in small animals use different scales in evaluating the results of treatment. Some veterinarians evaluate the outcome of surgery using more complex classification with radiographic characteristics (Meyer-Lindenberg *et al*., 1991).

Osteomyelitis is fortunately uncommon even after an open (compound) fracture. Motion at the fracture site has a very significant influence on callus formation.

A stable fracture may produce very little visible callus, whereas an unstable fracture will require the formation of a massive bridging callus, which is referred to as the exuberant callus of fracture repair (Hulse, 1997). A sequestrum is a dead or necrotic piece of bone. The presence of a sequestrum is generally indicative of previous surgical repair where a devitalised bone fragment is inadequately stabilised. The sequestrum will either impede fracture healing, and thereby result in a delayed union or non-union fracture, or cause sinus formation. Radiographically, a sequestrum is identified as a dense bone fragment with sharp edges (Johnson *et al*., 1994). Malunion occurs when a fracture heals in an abnormal anatomical position. It can be further classified as being functional or non-functional. Animals can cope with a certain amount of bone shortening and craniocaudal angulation, but only a very limited amount of rotation and mediolateral angulation. The distinction between non-union and delayed union fractures can be a grey area. A non-union fracture is one which will not go on to union without surgical intervention. A delayed union fracture is one that takes longer to heal than expected for the bone, fracture type, repair technique and age of the animal (Bradent *et al.*, 1995; Fossum, 2010).

2.8 OBJECTIVES

The general objective of the study was to determine the incidence, classification, management and complications of appendicular bone fractures in dogs in Nairobi County, Kenya, during the period of April 2007 to December 2013.

The specific objectives of this study as relating to dogs in Nairobi County, Kenya were;

2.8.1 To determine the incidence and associated risk factors of appendicular bone fractures.

2.8.2 To establish the types and frequency of occurrence of fractures of bones of the appendicular skeleton.

2.8.3 To determine the protocols for management of appendicular bone fractures, and associated complications and challenges.

2.9 JUSTIFICATION

Nairobi County has an emerging cosmopolitan society, with many families keeping pets (mainly dogs and cats) for companionship and security. These pets are prone to injuries, including those leading to fractures. One of the oldest small animal practices in Kenya is the Small Animal Clinic, Department of Clinical Studies, University of Nairobi established over 50 years ago. However, despite its large volume of archived data on among other things, fractures in dogs, this data is neither in the public domain nor published scientific literature. Furthermore, current data on the incidence, classification, methods of management and complications of appendicular bone fractures in dogs in Kenya remain scanty. Knowledge on the incidence, types and management of appendicular bone fractures is vital in improving existing expertise in Small Animal orthopaedics as a specialized discipline in Kenya. The information obtained in this study would be useful in reviewing curricula for undergraduate and postgraduate veterinary surgery training and designing appropriate continuing professional development (CPD) courses and developing standardized protocols for canine orthopaedic practice in Kenya.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Study area

The study was carried out at the University of Nairobi Veterinary Clinic which is located at the College of Agriculture and Veterinary Sciences, Upper Kabete Campus in Kiambu County, off Kapenguria Road, about 14 kilometres to the Northwest of Nairobi. The geographical coordinates in decimal degrees are, Latitude: 1.267 and Longitude: 36.717. The clinic has been in existence for 51 years offering services that include: ambulatory, laboratory, radiology and ultrasound diagnostic services, treatment on the farm and artificial insemination services. The clinic serves pet owners from several locations including Nairobi and Kiambu Counties and their environs, and the patients attended to are mainly farm animals, pets and other large animals.

Nairobi is the capital city of Kenya and occupies an area of approximately 696 square kilometres. It lies between 01^{0} 17'S latitude and 36^{0} 48' E longitudes. Nairobi has an estimated population density of over 3,017 persons per square kilometre (GoK, 2010).

3.2 Selection of veterinary practices

In addition to the University of Nairobi Veterinary Clinic, 10 small animal veterinary practices in Nairobi County were included in this study. To recruit small animal veterinary practices into the study, a list of all registered practitioners in Nairobi County was obtained from Kenya Veterinary Board. Formal requests to participate in the study were then made to the owners of all these practices through official communication. Only those who indicated their willingness to participate in the study were recruited.

3.3 Determination of incidence and associated risk factors

Information to fulfil this objective was obtained through a retrospective study of patient records of all dogs seen at the Small Animal Clinic, University of Nairobi and consenting small animal practices around Nairobi County. Data were obtained for a period of seven (7) years between April 2007 and December 2013. Complete records indicating diagnosis of fracture qualified for inclusion into this study. Details of each case that were obtained and recorded included the diagnosis, date, month and year of occurrence, breed, gender (and where possible; whether spayed or castrated), and age. Risk factors associated with fractures in affected dogs were deduced from the history presented at the time of admission and recorded on the animal record sheet. Data collected from these records were summarized on data collection sheets (Appendix 1).

The incidence of appendicular fractures was calculated using the formula (a/b X 100) expressed as a percentage;

where **a** represents the number of appendicular fractures, **b** represents the total number of cases of fractures reported to the clinic over the specific period.

3.4 Establishment of the types and frequency of occurrence of fractures of bones of the appendicular skeleton

The same records retrieved to establish incidence of appendicular fractures were used to establish the following parameters: type of fracture as diagnosed by the attending veterinarian; the limb affected; the bone affected; the description of the fracture based on any or a combination of the following characteristics/features: whether open or closed; extent of bone damage; number and position of fracture lines; direction of fracture lines; fracture location; forces acting on the fracture; stability of bone fracture; degree of soft tissue damage and age of fracture.

A questionnaire was designed and administered in order to establish the following parameters: how participating veterinarians diagnosed the fractures, how participating veterinarians confirmed diagnosis of the fractures, whether practicing veterinarians used any specific system of fracture classification or not and if they did, what system of fracture classification they used. Data on types of limb fractures encountered were recorded on data collection sheets as given in Appendix 1.

3.5 Establishment of the management protocols for appendicular bone fractures

To realize this objective, information on limb fracture management and complications associated with limb fracture management was obtained from qualifying patient records of all participating practices. Records were scrutinized to establish how each limb fracture was managed and if there were any complications based on entries in the records. Furthermore, a questionnaire was administered to consenting veterinarians in practices that willingly accepted to participate in the study. The data obtained were used to establish the following parameters: management techniques used to manage different types of limb fractures, complications encountered following management of limb fractures using the stated management techniques and, challenges practitioners faced in overall management of limb fractures in dogs (Questionnaire in Appendix 1).

3.6 Data management

The following parameters were calculated:

i) Overall incidence of appendicular fractures was calculated as a/b x 100

- Where: a- number of appendicular fractures, b- total number of fractures reported to the clinic over the specific period.

ii) Incidence of appendicular fractures according to specific category of dogs e.g. age group, sex and breed was calculated using the formula (a/b x 100) and expressed as percentages:

- where: a- number of appendicular fractures in a specific category,
- b- Total number of appendicular fracture cases reported to the clinic over the specific period.

iii) Incidence of specific limb (forelimbs / hind limbs) fractures was calculated as a/b x 100.

- Where: a- number of specific limb fractures, b- total number of appendicular fractures reported to the clinic over the specific period.

iv) Incidence of specific bone fractures was calculated as a/b x 100;

- Where: a- number of specific bone fractures, b- total number of appendicular fractures reported to the clinic over the specific time.

Data from questionnaires and records were collated to establish: types of fractures encountered; their diagnosis, conformation and classification; management protocols and techniques used to treat appendicular fractures and, complications and challenges encountered in management of these fractures. Outcomes of each aspect evaluated were expressed as a percentage of the total number of outcomes of the aspect from all administered questionnaires.

CHAPTER FOUR

4 RESULTS

4.1 Background of the findings

A retrospective study was undertaken to record the incidence and pattern of fractures in dogs in Nairobi County from year 2007 to 2013. A total of 402 records of dogs diagnosed with fractures were selected from X-ray records at the Small Animal Clinic, University of Nairobi, covering the period 2007 - 2013. Of these, 85% (343 out of the 402) of the dogs with appendicular bone fractures were brought to the Small Animal Clinic with the sole purpose of radiographic examination from private clinics and were treated by private practitioners at their respective clinics. A total of 59 cases with history and radiographically confirmed diagnosis of appendicular bone fractures were identified for this study from the 402 cases of fractures.

Questionnaires were administered to 18 veterinary practices selected from the list provided by the Kenya Veterinary Board. Only 10 practices consented and returned the filled questionnaires, representing a return rate of 55.6%. The duration of existence of practices ranged between 2 and 40 years. One practice indicated that they did not manage fractures in dogs while nine indicated that they managed fractures in dogs.

4.2 Incidence and associated risk factors of appendicular bone fractures

The overall incidence of appendicular fractures in dogs in Nairobi County was 14.7% (59/402). The incidence of forelimbs fractures in dogs in this study was 42.4% (25/59) while it was 57.6% (34/59) for the hind limbs.

4.2.1 Incidence of appendicular bone fractures based on breed, gender and age of dogs

The distribution of appendicular fractures among the different breeds of dogs in this study is presented in Table 4.1. The most affected breeds were cross breeds (30.5%) and German shepherd dog (30.5%), Terriers (10.2%), Japanese Spitz (10.2%), Rottweiler (5.1%), unknown (5.1%), Labrador (3.4%), Maltese (1.7%), St Bernard (1.7%) and Springer (1.7%). Male dogs were affected (69%) more than female dogs (31%) as shown in Figure 4.1. Appendicular bone fractures were most frequently reported in dogs aged between 4 months to 10 years. The body weights of dogs that suffered appendicular fractures ranged from 4-26kg. Adult dogs (79%) suffered appendicular fractures more than puppies (21%).

Table 4.1 Frequency of breeds of dogs diagnosed with appendicular bone fractures in Nairobi County, Kenya between 2007-2013.

Breed of dog	**Number**	**Percentage**
Germen shepherd dog	18	30.5
Cross breed	18	30.5
Terrier	6	10.2
Japanese Spitz	6	10.2
Unknown	3	5.1
Rottweiler	3	5.1
Labrador	2	3.4
Maltese	1	1.7
St. Bernard	1	1.7
Springer	1	1.7
	59	**100.0**

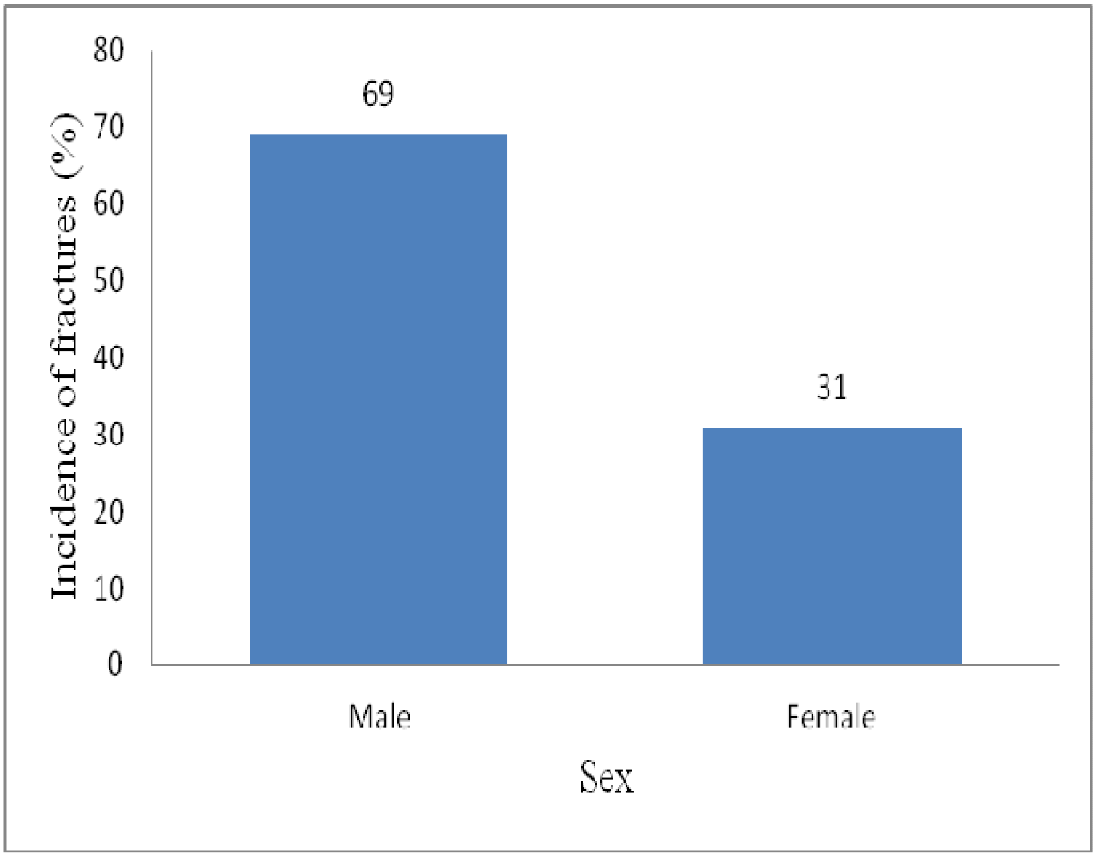

Figure 4.1 Distribution of fractures among male and female dogs.

4.2.2 Risk factors of appendicular bone fractures in dogs

Ninety percent (90%) of appendicular bone fractures affected entire males and females. Most of the presented fracture cases were caused by trauma. Unknown trauma (54.2%), road traffic accidents (20.3%), human abuse (11.9%), animal bites (5.1%), falling from a height (6.8%), and indoor trauma (1.7%), were the most common types of trauma (Table 4.2) and (Figure 4.2). Case records which had not indicated the type of the cause of trauma were classified as unknown traumatic injuries. Animals which disappeared from home and were later found with injuries were also classified as due to unknown causes of trauma.

Table 4.2. Distribution of the etiology of appendicular bone fractures diagnosed in dogs in Nairobi County, Kenya between 2007-2013;

Etiology of fracture	**Number**	**(%)**
Unknown traumatic injuries	32	54.2
Road traffic accident	12	20.3
Human abuse	7	11.9
Falling from height	4	6.8
Animal bite	3	5.1
Indoor trauma	1	1.7
TOTAL	**59**	**100**

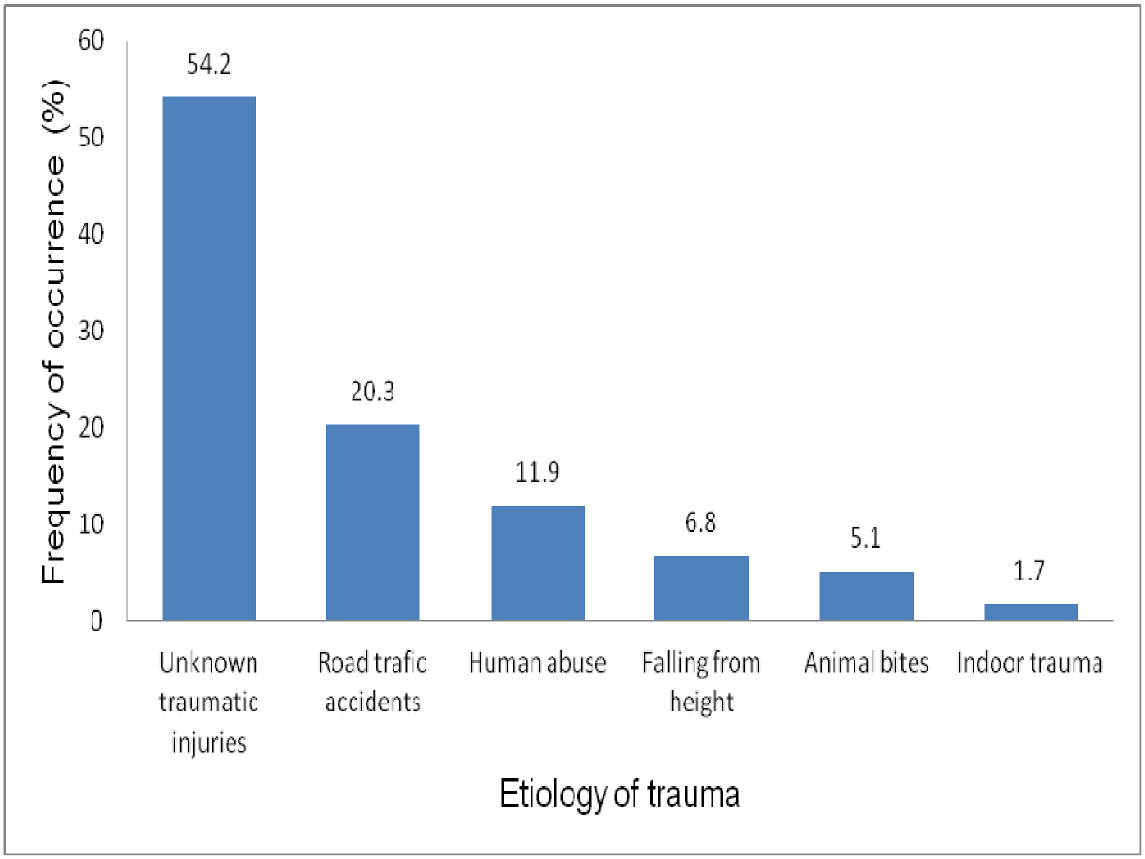

Figure 4.2 Different forms of trauma causing appendicular fractures in dogs

4.3. Incidence and types of appendicular bone fractures

4.3.1. Incidence of fractures of appendicular bones

The incidence of fractures in different bones and sites of these fractures is illustrated in Figure 4.3 and given in Table 4.3. Femoral fractures in dogs had an incidence of 30.5%. The most common sites of fractures of the femur were the shaft (diaphysis) and distal metaphysis (Figure 4.4). Tibial fractures (Figure 4.5) had an incidence of (18.6%), whereas humeral fractures (Figure 4.6) had an incidence of 13.6%. A humeral condylar fracture was documented in one dog. Fractures of the radius and ulna (Figure 4.7) had an incidence of 22%. Fractures of the metacarpals (Figure 4.8) and metatarsals (Figure 4.9) had an incidence of 6.8% each. Diaphyseal femoral and tibial fractures were common in mature dogs (12 months-10 years).

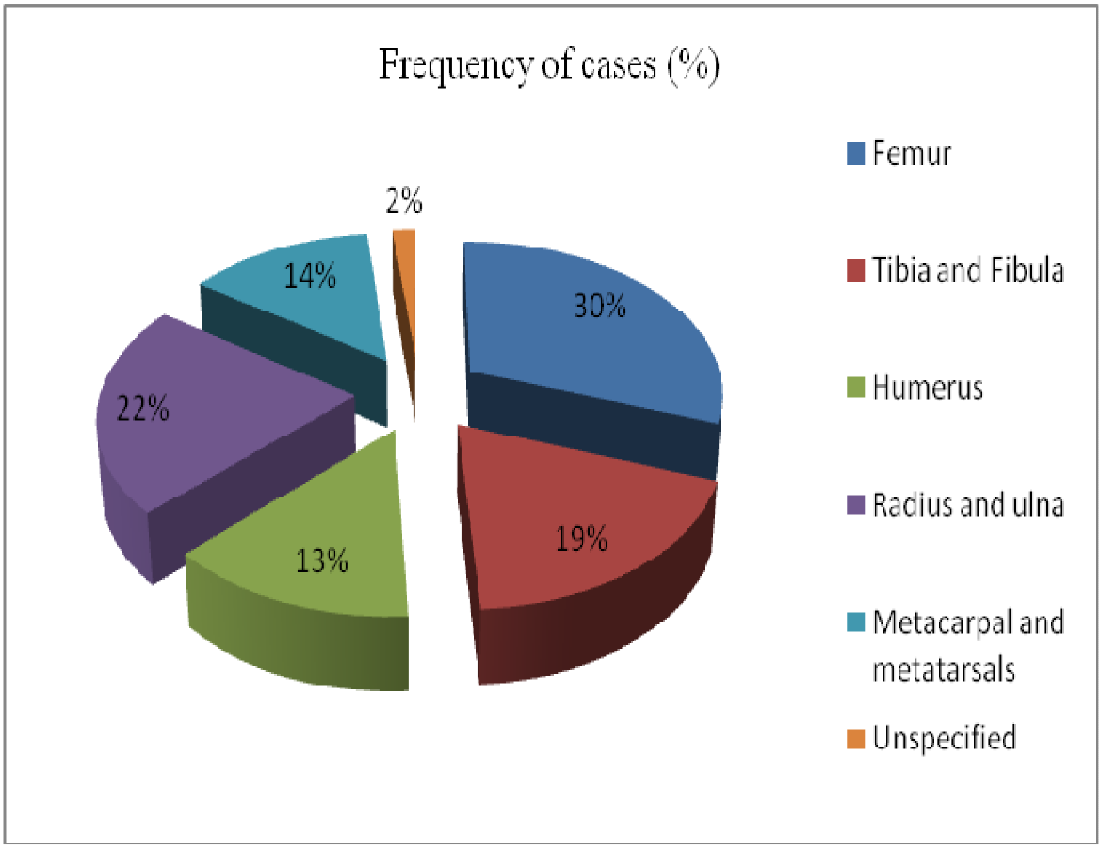

Figure 4.3 Distribution of fractures in different appendicular bones in dogs presented at the Small Animal Clinic University of Nairobi.

Figure 4.4 Mediolateral radiographic image view of complete, oblique, overriding fracture of femur.

Figure 4.5 Mediolateral and craniocaudal radiographic image view of complete, oblique diaphyseal tibia and fibula fracture in a dog.

Figure 4.6 Mediolateral radiographic image view of complete, wedged diaphyseal humeral fracture with large fragment in a dog presented to the Small Animal Clinic for management.

Figure 4.7 Craniocaudal and mediolateral radiographic image view of complete, transverse diaphyseal fracture of radius and ulna in a dog.

Figure 4.8 Craniopalmar view radiograph with a complete oblique mid-diaphyseal fracture of metacarpal bone III.

Figure 4.9 Mediolateral view radiograph showing planteromedial displacement of fractured metatarsal bone on the right hind limb and soft tissue swelling.

4.3.2 Types of appendicular bone fractures in dogs

The distribution of the types of fractures encountered and classified on the basis of direction of the fracture line is presented in Figure 4.10. The data revealed that the most common type of fracture was complete simple transverse (64.4%) followed by oblique (15.3%), comminuted (6.8%), incomplete (6.8%) and multiple (6.8%). Analysis of data from the questionnaires on how practicing veterinarian's classified fractures revealed that one out of the ten participating practitioners (10%) did not classify fractures in their practice. The other nine (90%) of the participating practitioners classified fractures in dogs based on the following criteria; as per the cause of the fracture; whether the fracture was open or closed; the extent of bone damage; the number and position of fracture lines; direction of fracture lines; fracture location; forces acting on the fracture; stability of bone fracture; degree of soft tissue damage and age of fracture (based on description of presenting characteristics). All participating practitioners further indicated that they lacked a specific fracture classification system.

4.3.3 Diagnosis and confirmation of fractures in dogs

All practitioners who participated in the study indicated that diagnosis of fractures in dogs presented to them was arrived at on the basis of history and relevant clinical examination. In addition, all practitioners indicated that they routinely used radiography to confirm diagnosis of appendicular fractures in dogs presented for management.

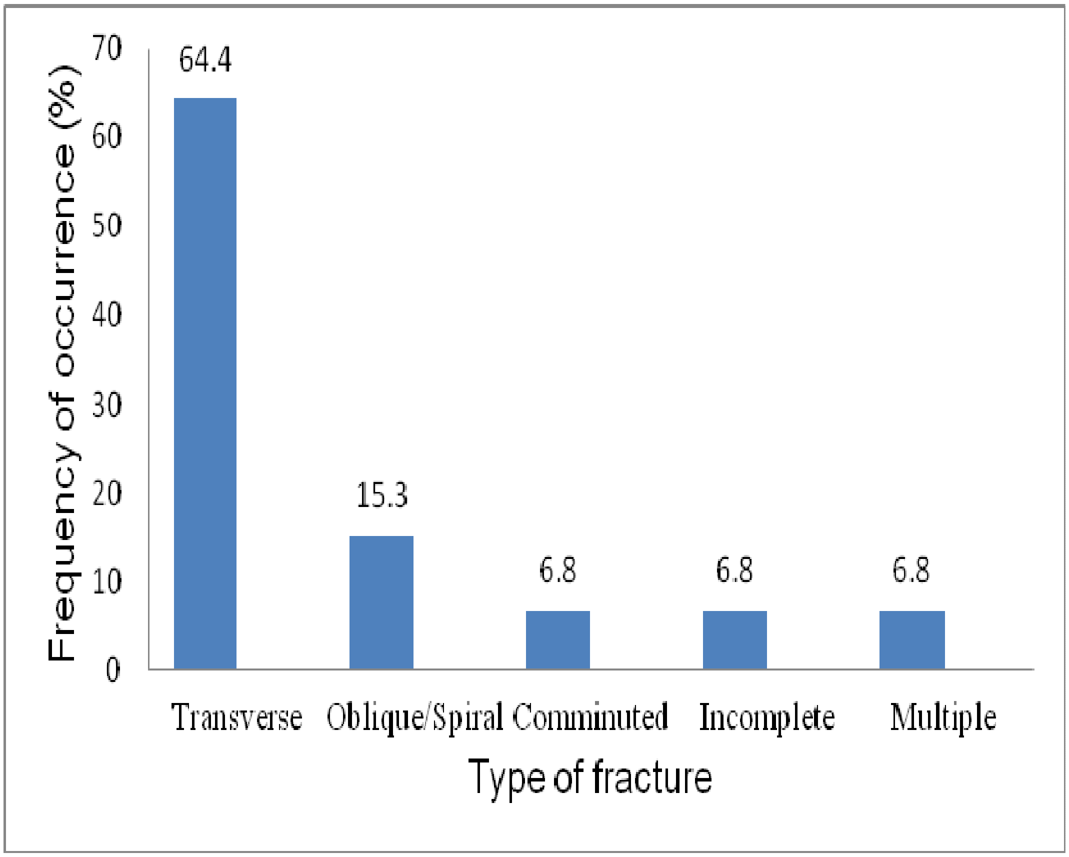

Figure 4.10 Frequency of the different types of appendicular bone fractures in dogs based on the direction of fracture line.

Table 4.3 The incidence of fractures in different bones and different types of fractures in dogs recorded in University of Nairobi Small Animal Clinic from 2007 to 2013

Affected bones	Number of cases	Sites of fracture	Types of fractures
Femur	18 (30.5%)	Shaft, Supracondylar, Neck-femur, Metaphyseal	complete diaphyseal overlapping, complete supracondylar comminuted, complete without displacement, simple metaphyseal transverse
Tibia and Fibula	11 (18.6%)	Shaft, Metaphysis, Supracondylar, Condylar	complete diaphyseal overlapping, complete metaphyseal comminuted, complete overlapping
Humerus	8 (13.6%)	Shaft, Condyles	complete diaphyseal, simple condylar
Radius and Ulna	13 (22%)	Metaphysis, Shaft	complete metaphyseal oblique, complete simple transverse
Metacarpal and Metatarsals	8 (13.6%)	Metaphysic, shaft	Complete diaphyseal oblique, complete metaphyseal oblique
Unspecified	1 (1.7%)	Unspecified	Unspecified
Total	59		

4.4 Outcome of fracture management options

4.4.1 Protocols for management of fractures

The various protocols used by participating practitioners to manage appendicular bone fractures in dogs are presented in Table 4.4. This study established that internal fixation techniques and devices were the preferred modes of treatment of fractures in dogs. These involved use of cerclage wire and intramedullary pin, bone plates and screws or a combination of both approaches in addition to external fixation. This was a common approach to management of fractures of long bones, especially those of femur, humerus, radius and ulna, and tibia and fibula. Other techniques used for management of appendicular bone fractures in this study, although to a smaller extent included use of Robert Jones bandages, box rest, use of Plaster of Paris (POP) cast / Gypsona or adhesive bandages.

Table 4.4 The different surgical approaches used by various participating practitioners to manage appendicular fractures in dogs

Fractured bone	External fixation				Internal fixation			Combination of internal and external fixation		
	Box rest	Robert Jones bandages	Adhesive bandages	Plaster of Paris (POP) Gypsona	Amputation	Plate and bone screws	Cerclage wire and pin	plate and bone screws, cerclage wire and pin, Robert Jones bandages	Euthanasia	Total
Femur	2	-	-	-	-	-	7	7	2	18
Tibia and Fibula	-	-	-	-	-	-	2	9	-	11
Humerus	1	-	-	-	-	-	7	-	-	8
Radius and Ulna	2	3	-	1	1	5	1	-	-	13
Metacarpals /metatarsals	-	3	2	2	-	1	-	-	-	8
Unspecified	-	-	-	-	-	1	-	-	-	1
Total	5	6	2	3	1	7	17	16	2	59

4.4.2. Outcomes following management of fractures

Evaluation of the data on the outcomes following management of appendicular fractures in dogs in this study showed that results were : good in 48% of the cases, satisfactory in 11% of the cases and unsatisfactory in 41% of the cases Figure 4.11.

Out of 18/59 (30.5%) femoral fractures Table 4.3, two 2/18 (11%) cases were treated using external fixation techniques and gave satisfactory results, two (11%) cases were euthanized, seven (39%) cases were treated using internal fixation techniques and 3 gave good results while 4 gave unsatisfactory results; seven cases were treated using internal and external fixation techniques and 5 gave good results while two gave unsatisfactory results. Two of the 11 dogs 2/11 (18.2%) with fractured tibia/fibula treated with both internal and external fixation techniques gave good results, one (9.1%) gave satisfactory results while 8 (72.7%) gave unsatisfactory results. The use of external and internal fixation techniques such as intramedullary pins and cerclage wires together with Robert Jones bandages or Plaster of Paris (POP) (Gypsona), provided effective stabilization to complete oblique femoral fractures and tibial/fibula fractures. External coaptation with cast and adhesive tape bandages gave good results in some cases of fractured radius and ulna as well as most cases of fractured metacarpal and metatarsal bones. Humeral fractures 7/8 (88%) were effectively managed with intramedullary pinning and cerclage wires. On the other hand, 5/13 (38.5%) of fracture of the radius/ulna benefitted from use of bone plates and screws Table 4.4.

From the questionnaires, cage rest with external coaptation such as POP (Gypsona), Robert Jones bandages and Thomas splint emerged as techniques routinely used for external fixation of fractures in puppies and those fractures involving short bones. Practitioners indicated that for long bone such as femur with simple complete transverse fractures they used intramedullary pinning with bone plates and screws for their management while for complete oblique fractures, intramedullary pinning and cerclage wires were used. Femoral head / neck fractures were managed by femoral head excision.

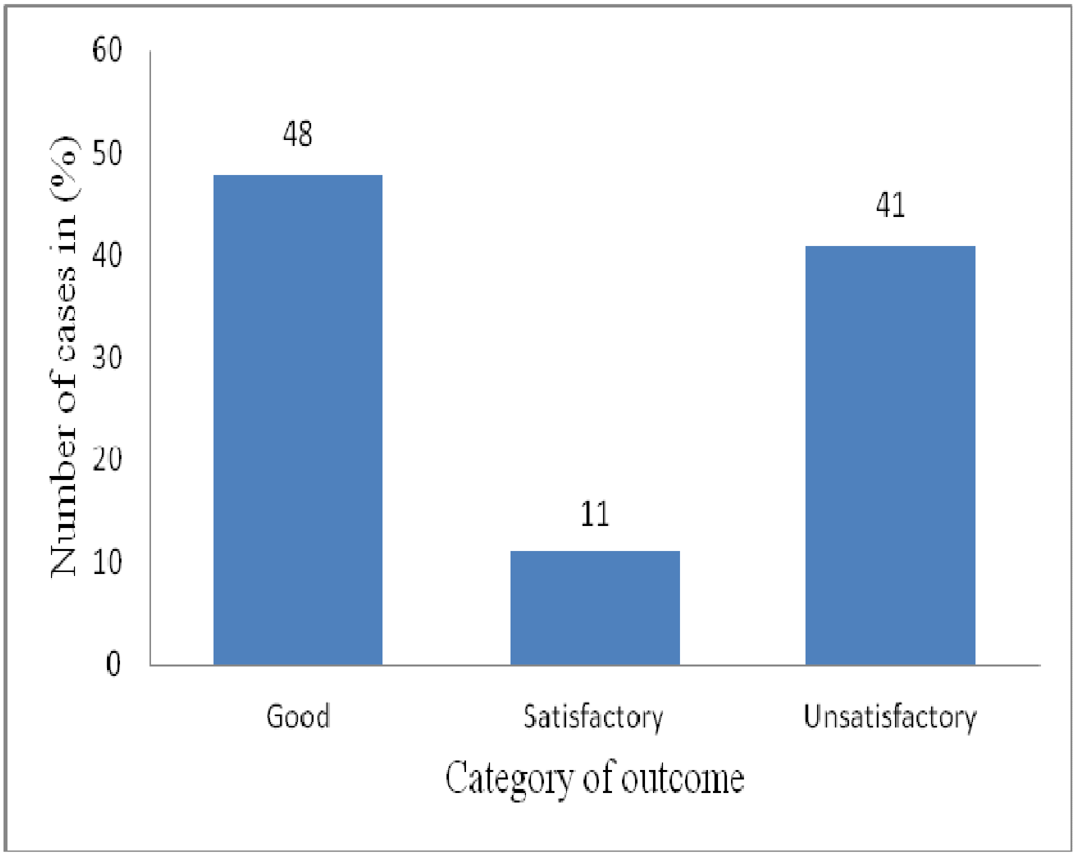

Figure 4.11 Outcomes of fracture management in dogs with appendicular fractures.

4.4.3 Complications associated with management of appendicular bone fractures in dogs

Data from the records on evaluation of the outcomes of management of 59 dogs with appendicular fractures in this study is presented in Figure 4.12. No complications were reported during the healing process of fractures managed in 13 (22%), while complications were observed in 26 (44%) of the cases in this study. There were no records on the outcome of 20 (34%) of the cases of appendicular fractures following their management. Eleven 11/59 (17%) of the patients suffered soft tissue wound infections following fracture treatment, 5 (8.5%) suffered osteomyelitis while 5 (8.5%) had implant migration which was seen in cases with unstable comminuted fractures. Other complications included implant failure 4 cases (6.8%), non-union 3 cases (3.5%), muscle atrophy 2 cases (3.4%), delayed union 1 case (1.7%) and arthritis 1 case (1.7%), and these outcomes were encountered in fractures that experienced lesser reduction or fixation. Euthanasia or death 5 cases (8.5%) were the outcome of severe infection or complete lose of limb function.

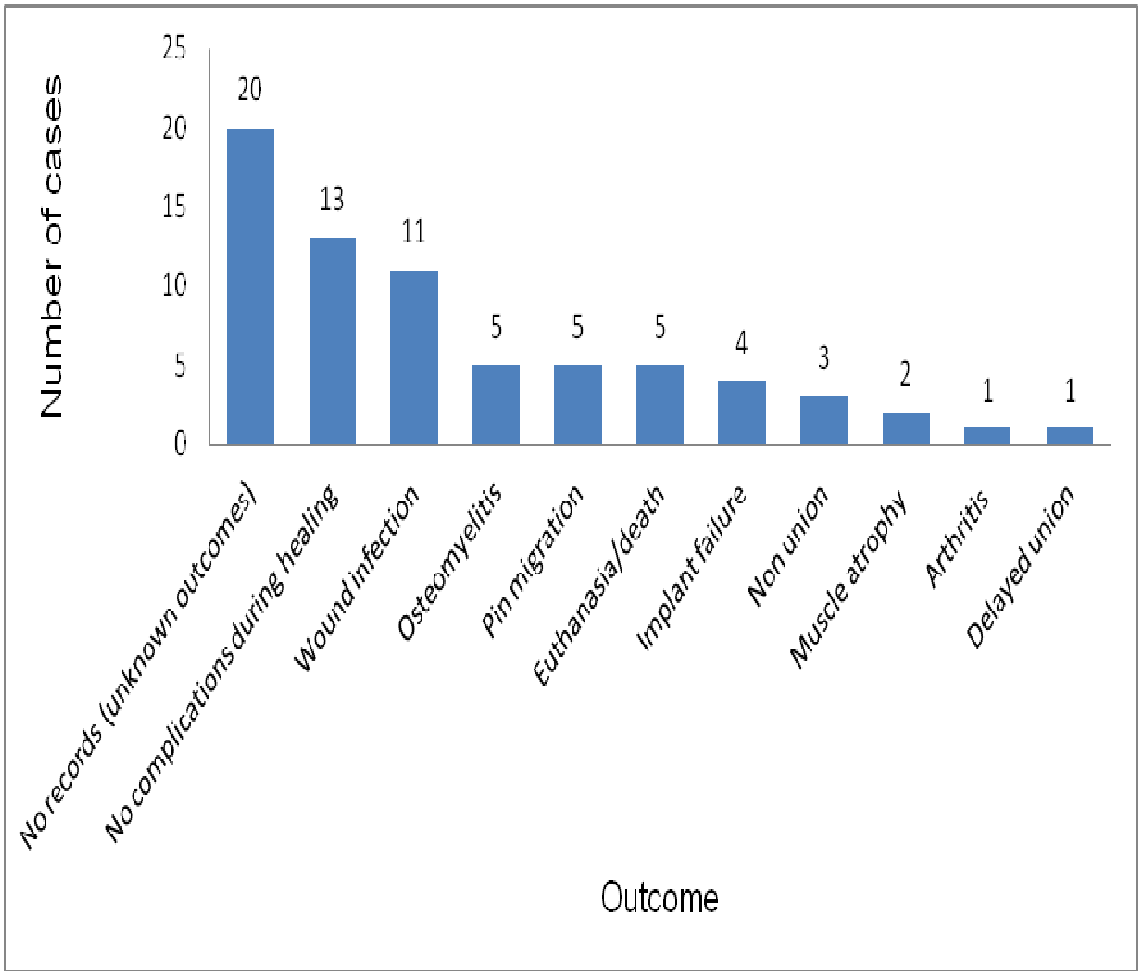

Figure 4.12 Different outcomes associated with management of appendicular bone fractures by practitioners in Nairobi County, Kenya, 2007-2013.

4.4.4 Challenges encountered among practitioners in managing appendicular bone fractures in dogs

Data generated by evaluating questionnaires revealed that majority of practitioners encountered various challenges following management of appendicular fractures. These included noncompliance by the owners, limitation of resources, lack of appropriate equipment, and inadequate expertise/ surgical skills were the main challenges to adequate management of appendicular fractures in dogs in Nairobi County. A major challenge faced by the researcher during this study was improperly kept or inadequate record keeping by most of the practices sampled.

This study relied on records of the X-ray section of the Small Animal Clinic, University of Nairobi where practitioners referred their patients for radiographic examination and confirmation of fractures. These cases were identified from the records, then followed to the referring practices where they were managed. However, most (data) records could not be traced at the practices for comprehensive follow up of these cases. This was largely attributed to the process initiated by most practices of migrating the records from manual (hard copy records) to digital (soft copy) records. This has resulted in some hard copy records getting lost/destroyed or uploading inadequate/ insufficient information on the soft copies. Moreover, most practitioners indicated that they kept their records primarily for accounting purposes and not necessarily for monitoring in patient progress. Need for standards and guidelines policy on medical records required for Small Animal practice.

CHAPTER FIVE

5. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 DISCUSSION

The general objective of the study was to determine the incidence, classification, management and complications of appendicular bone fractures in dogs in Nairobi County, Kenya. This study fulfilled this objective. The response rate of 55% for the questionnaires survey in this study was higher than what has been reported for studies of similar nature in veterinary practices (Nicholson and Watson, 2001; Macgregor and Cocks, 1994). This may be attributed to the fact that the practices were purposively selected from a list provided by the registering authority (Kenya Veterinary Board) and that the questionnaires were distributed personally by the investigator

The sample size of 59 appendicular fractures in dogs in this study was small compared to what is reported in other studies (Shiju *et al.*, 2010; Shiju *et al.*, 2011; Ben Ali, 2013). This may be due to the fact that 85% of the cases with appendicular bone fractures were treated by referring practitioners which indicates adequate expertise in Nairobi County Kenya, poor record keeping encountered in this study and also maybe due to a smaller dog population in the study area, Nairobi County. The incidence of appendicular bone fractures in dogs in the current study (14.7%) is similar to that reported in other studies (Ben Ali, 2013). These other studies reported an incidence of 17.8% in dogs and cats among other surgical afflictions. The main difference between the two results could be due to the fact that all bone fractures in dogs and cats were considered in this other study while in the current study, only fractures of the appendicular skeleton were considered.

In the current study, the incidence of appendicular fractures was higher in adult (79%) as compared to the young dogs (21%). This is contrary to what has been reported by (Shiju *et al*. 2010) and Shiju *et al.* (2011) who observed higher incidence of appendicular fractures in young dogs (1.5-6months) for both pelvic and pectoral limbs. The current study established that cross breeds and German shepherd dogs suffered the highest incidence of appendicular fractures. These findings are similar to what has been reported by (Harasen, 2003a; Senn *et al*., 2004).

Most of the fractured dogs encountered in the study were entire males and females. This could reflect that neutering, under our circumstances, was not a routine practice for population control. Consequently, intact pet animals, wandering outdoors in mating seasons may be subjected to traumatic fractures, similar to observations in another study reported elsewhere (Senn, 2004). The observation in this study that more male (69%) dogs sustained appendicular bone fractures than females (31%) is consistent with reports by other researchers in other parts of the world (Kolata *et al*., 1974; Aithal *et al*., 1999b; Dvorak *et al*., 2000). This is probably because male dogs are metabolically more active than their female counterparts.

In the current study, unknown trauma (54%), road traffic accidents (20%), human abuse (12%), falling from a height (7%) and animal bites (5%) were the most common risk factors of the appendicular fractures in dogs. This finding is different from the findings of Kumar *et al*., (2007) who reported that falling from a height was the most common (40%) cause of trauma causing fractures in dogs. On the other hand, unknown causes ranked highly (34%) when compared to 24% reported in the study by Kumar *et al*. (2007). However, the finding in the current study that road traffic accidents were the cause of fractures in 20% of the cases compares with 15% reported by Kumar *et al.* (2007). The variations between the results of the two studies might be due to the fact that the studies were carried out in two different continents and in different socio- economic settings, which might influence the pet handling management systems. Unknown trauma (34%) recorded in the current study could be that animals were found after disappearing from home and had sustained trauma when they returned and therefore information of traumatic injury could not be provided during consultation.

In the current study, femoral fractures on the pelvic limb recorded the highest incidence (30.5%) followed by the tibia and fibula (18.6%). Conversely, on the pectoral limb, the highest incidence of fractures was recorded on the radius and ulna (22%), followed by the humerus (13.6%). Similar findings have been reported in previous studies in dogs (Aithal *et al*., 1999a; Shiju *et al*., 2011). In the current study, the most common types of fractures encountered in both fore and hind limbs were complete simple transverse (65%) followed by oblique (15%) and comminuted (5%) fractures. This is similar to what has been reported in previous studies (Shiju *et al*., 2010; Shiju *et al*., 2011; Ben Ali, 2013).

It was interesting to note that in this study, the incidence of fractures on hind limbs (57.6%) was higher as compared to that on the fore limbs (42.4%). These results are similar to what has been reported by Harasen, (2003b). During impact, animals protect their forelimbs as they move the head away from the cause of trauma. They tend to expose their hindquarters to the major force of the impact.

An important observation in this study was the fact that participating practitioners used surgical techniques comprising external coaptation and internal fixation including intramedullary bone pinning, bone plates and screws and cerclage wires to manage the fractures. These approaches have been described and widly used by several authors (Harari, 2002; Denny, 1993; Francuski *et al.*, 1986; Whitney and Shrader, 1987; MacLaughlin, 1999; Oakley, 1999). The adopted surgical techniques achieved satisfactory results following fracture treatment and were in agreement with findings in other studies (Denny, 1993; Farag, 2002).

The findings of this study revealed that using the various management protocols enabled practitioners to treat the fractures with different levels of success. Healing without complications was achieved in about 20% of the cases, despite the challenges encountered. This might be attributed to the existence of a reasonable level of technical competence in orthopaedic practice among practitioners sampled in the County and Country.

Complications following fracture management were recorded in 44% of the cases in this study. Surgical wound infection and osteomyelitis following fracture treatment in dogs recorded have been reported in other studies (Kumar *et al.*, 2007). An important finding (outcome) of this study was the fact that more dogs that suffered complications after fracture treatment than there were those without complications. However, it was not be possible to ascertain the true picture of the proportion that suffered complications and those that did not, given that the records of the outcomes following treatment of fractures in up to 34% dogs were not available.

Practitioners in this study outlined the challenges they faced, including noncompliance by owners, lack of appropriate surgical equipment, inadequate expertise/ skills, and limitation of resources. These challenges could have contributed heavily to surgical outcomes encountered in this study, including the many complications recorded. Limitations of resources is qualified as a challenge given that many practitioners referred dogs to the University Clinic because of less cost / availability of modern medical imaging equipment at the facility which most practitioners lacked. On the other hand, lack of appropriate equipment, coupled with poor skills in orthopaedic surgery would affect even uncomplicated fractures.

An important observation from this study was the occurrence of challenge of inadequate record keeping in a number of the practices. This posed a major challenge in access to adequate data to establish the accurate picture of the incidence of appendicular bone fractures in dogs in Nairobi County. The results that were obtained were therefore based on data from available records. This limitation must be born in mind while interpreting the results, and should inform formulation of recommendation for improvements by standardising veterinary clinical data management.

5.2 CONCLUSIONS AND RECOMMENDATIONS

5.2.1 CONCLUSIONS

a) The study concluded that the incidence of appendicular bone fractures in dogs in Nairobi County was low, male dogs were affected more than female dogs and hind limb fractures were more frequent than fore limb fractures.

b) Unknown trauma and motor traffic accidents were the two most common causes of fractures. Unknown trauma resulted from either unspecified cause of trauma or animal was found with traumatic injury no seen therefore biodata and proper animal management is recommended.

c) The most common types of fractures encountered in both fore and hind limbs were complete simple transverse, followed by oblique and comminuted fractures.

d) The most commonly used surgical techniques for managing appendicular bone fractures comprise external (fixation) /coaptation and internal fixation including application of intramedullary pins, bone plates and screws and cerclage wires.

e) The outcomes of managed appendicular fractures were not satisfactory and post-management complications were not uncommon. Whereas the necessary materials for fracture management may be readily available, their use is constrained by high cost, limited surgical skills and lack of appropriate surgical equipment.

f) The challenges faced by small animal practice include inadequate records keeping, noncompliance by owners, and lack of appropriate surgical equipment, inadequate expertise / skills, and limitation of resources.

5.2.2 RECOMMENDATIONS

a) Further investigation on risk factors is recommended because most of trauma was due to human causes. This can be addressed through educating the owners, awareness campaigns for pet protection, and encouraging neutering and good pet care.

b) There is need to improve technical competence in small animal orthopaedics for better surgical outcomes in fracture management, through targeted training of veterinarians, scientific journal publications, seminars and workshops.

c) It is recommended to invest in state of the art orthopaedic instrumentation and equipment at the Small Animal Clinic University of Nairobi where most orthopaedic cases are referred for specialised diagnostic and surgical interventions.

d) Adequate record keeping is recommended in private practices and Small Animal Clinic in Nairobi County, the use of soft ware and digital computerised method of record keeping that will aim at improving accounting related issues and patient monitoring.

e) It is recommended to adopt digital patient identification system through micro chipping, to facilitate computer based recording and traceability.

CHAPTER SIX

6. REFERENCES AND APPENDICES

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6.2 APPENDICES

APPENDICES

Appendix 1: The questionnaire

Part I: Types and classification of fractures in dogs in small animal veterinary practices in Nairobi County

Practitioner Identification (Name /Code) ____________________________________

For how long have you been a small animal practitioner?

____

Have you managed fractures in dogs before? Yes / No

How do you arrive at a diagnosis of a fracture in a presented patient?

Based on history

Based on clinical examination

Based on both history and clinical examination

How do you confirm diagnosis of a fracture in your patients?

____

____

____

____

How do you classify fractures in dogs? Do you use any specific system to classify fractures in dogs?

Using the following table, kindly indicate the types of fractures you have come across in dogs presented to you:

FORELIMB FRACTURES	HIND LIMB FRACTURES

Part II: Management protocols for fractures and associated complications (and challenges) in dogs in small animal veterinary practices in Nairobi County

Kindly use the following table to indicate the management protocols you use for the different types of fractures you have encountered in dogs, the associated complications and challenges faced.

TYPE OF FRACTURE	MANAGEMENT PROTOCOL / TECHNIQUE	COMPLICATIONS	CHALLENGES

Appendix II

Data recording sheet

Practice ID	Date	Case number	Breed	Age	Sex	Fracture diagnoses	Limb affected	Bone affected	Facture description	Management techniques	Complications	Challenges	Risk factors	Facture cause

Appendix III

Completed data sheet

N0.	Age	Sex	Breed	Type of fracture	Fracture description	Management	complication	Cause
1.	A	M	Cross	Fracture of right femur	Complete mid shaft fracture	Retrograde IM pining	implant migration, swelling at trochanteric/ gluteral asspects and palpable, reaction limits extention of R/hip joint	Unknown
2.	Puppy	M	GSD	Femur fracture R	Not specified	Conservative, Box rest	Poorly mineralized bone	Unknown
3.	A	M	Cross	Humerus fracture L	surgery report not found	Report not found	Report not found	Unknown
4.	A	M	Cross	Femur fracture L	Oblique fracture	Im pin and cerclage wire	Not mentioned	Hit by car
5.	A	M	GSD	Fracture metatarsals bones	3rd and 4th metatarsals fractures	Robert Johns Bandages	alceration of dorsal aspects / betwwen the paws	Unknown
6.	A	M	Cross	Fracture Tibia/fibula R	Complete mid shaft fracture	direct pinning through the knee joint and RJ	pin migration upwards to stifle joint CTVT	Unknown

7.	Puppy	M	Roltt weiller	Lateral and 3rd metacarpal	Greenstick fracture R/F	Robert Johnes Bandages	Not provided	Fall from height
8.	n/a	n/a	Labrador	Fracture metacarpal	MC 3,4	Gypsona, POP cast	Not mentioned	Car door/ Motor traffic accident
9.	A	M	GSD	Femur fracture L/H	Hair line fracture of lateral cortex	Euthanasia	Euthanasia because is working dog	Overworking
10.	A	M	Cross	Fracture R humerus	Signs of radial nerve paralysis	No surgical report	No further records	Unknown
11.	A	F	GSD	Tibia/Fibula fracture	L/H mid fracture	IM pin and circlage wires, Robert Johnes bandages	muscle atrophy, smelling vulvar discharges, pyometra ruled out	Exercises / human abuse
12.	Puppy	F	St. Bernard	Fracture L femur	Transverse mid shaft fracture of mid femur	Retrograde IM pinning	seroma at dorsal fractuture, thin cortex pin reaction	Falling from moving vehicle / motor traffic car accident
13	A	F	Cross	Fracture radius and ulna	Both fore limb radius fracture more proximal	Retrograde IM pinning	No records	Dog fall from height double deck
14.	A	M	Maltese	Calcaneous fracture R/H	Evulsions calcaneous fracture	No surgical report	No further records	No records / unknown
15.	Puppy	M	Cross	Fracture humerus	Transverse fracture of distal humerus	Box rest, and provide diet rich in prtein	No reocrds	Unknown

16.	A	?	Terrier	Metatarsals fracture L/H		Robert Johnes bandages,	No reords	Hit by car
17.	A	?	Terrier	Fracture L humerus	Transverse mid shaft fracture	IM pin	discharges from the wound, cyst formation, osteamyletis	Human abuse
18.	Puppy	?	Japanese Spitz	Fracture R humerus	Complete midshaft fracture	IM pin	Non union, wound discharging, pin migration	Animal bites
19.	A	M	GSD	Fracture Radius /Ulna	Mid shaft fracture	Robert Johnes bandages, Gypsona POP	No complication	Animal bites
20.	A	M	Cross	Fracture R femur	Mid shaft fracture	IM pin retrograde	No complications	Unknown
21.	Puppy	F	Labrador	Fracture metacarpal bone	simple comminuted fracture of the distal part of the firth metacarpal	No surgical reports	No records	Unknown
22.	A	M	Alsation	Fracture alecroneon	Slight fracture	Box rest, conservative	No records	Unknown
23.	A	M	Cross	Fracture femur L/H	oblique midshaft femur fracture with a large fragment	IM pin and cerclage wire	Callus breakage	Hit by car
24.	A	M	Alsation	Fracture R/H metatarsal	fracture with severe soft tisue swelling	Bone plate and screws, modified RJ	No complication	Fall from height

25.	Puppy	M	Alsation	Fracture R/H femur	Separation of growth plate distal	Box rest, conservative	No further records	Unknown
26.	A	M	Japanes Spitz	Fracture R/F radiua/ulna	complete oblique fracture	Bone plate, screws, RJ	Wound infection	Unknown
27.	A	F	?	Fracture R Tibia/Fibula	Tibia fracture with a large oblique fragment	IM pin, cerclage wire	No further records	Hit by car
28.	A	F	?	Fracture femur		IM pin	IM pin migration, surgery redone	Unknown
29.	A	M	?	Fracture R humerus	midshaft fracture that is transverse and has overided	IM pin retrograde	Wound infection	Human abuse
30.	A	M	GSD	Fracture L Tibia	transverse fracture of tibial diaphysis	IM pin, Kishner wires,RJ bandages	Cross infection Parvo enteritis	Unknown
31.	Puppy	M	Japanes Spitz	Fracture L radius/ulna		RJ, Box rest	Not mentioned	Unknown
32.	A	M	Japanes Spitz	Fracture L humerus	Complete overriding fracture	IM pin, hemicerclage, cerclage wires retrograde approach	Osteomilyetis, non union	Unknown
33.	A	F	Japanes Spitz	Fracture radius /ulna	Transverse fracture	Bone plate, screws	Not provided	Unknown

34.	A	M	Terrier	Fracture radius/ulna	Complete distal transverse fracture with overiding fragments	Bone plate, screws, RJ bandages	Implant failure broken bone plate	Run over by car
35.	Puppy	F	Cross	Fracture L radius /ulna		External splints	Cross infection Parvo enteritis, puppy died	Unknown
36.	Puppy	M	GSD	Fracture R femur old	Old distal femoral fracture	Bone plate,screws,RJ bandages	Implants failure increased frcture gap	Hit by car
37.	A	M	Cross	Fracture radius		Amputation	Infection	Gun wound / human abuse
38.	A	F	Terrier	R/H limb	Not provide	Bone plate removal	Not provided	Unknown
39.	A	M	Cross	Fracture L femur	Mid shaft fracture with fragmant	IM pin, RJ bandages	Oesteomyelites fracture disease, pin migration, haemorrhagic gastric entiritis, death	Unknown
40.	A	M	Cross	Fracture radius/ulna	Complete mid shaft fracture	Plate ,screws, RJ bandages	Not provided	Unknown
41.	A	M	GSD	Fracture tibia/fibula	Oblique fracture fragments at two points	Bone plate, screws, RJ bandages	senous discharge, alick granuloma, most distal screws loosened, seroma	Human abuse
42.	A	M	GSD	Fracture R femur	Oblique fracture	Bone plate, cerclage wires, screws	No complication	Hit by car
43.	A	M	Cross	Fracture of alecreneon base	Incomplete fracture	Bone plate, screws, RJ bandages	No complication	Animal bite

				L				
44.	A	F	Cross	Fracture R femur	fracture distal part epiphysis/metaphys	Bone plate, screws, RJ bandages	No complication	Unknown
45.	A	F	Terrier	Fracture R tibia	Displaced tibial fracture	IM pin, RJ bandages	Disrapture of fracture site	Unknown
46.	A	F	GSD	Fracture tibia/fibula	Complete mid shaft fracture	Bone plate, screws, RJ bandages	Endotracheal tube swallowing, mastitis, oestemyelitis	Unknown
47.	A	F	GSD	Fracture tibia L/H	Distal physial fracture	IM pin, RJ bandages	wound exuding serum	Injured during training / human abuse
48.	A	M	GSD	Fracture tibia L	Mid shaft fracture	Records not available	Records not available	Unknown
49.	A	M	Terrier	Fracture femur	Distal 1/3 fracture	IM pin, cerclage wire, RJ bandages	Not mentioned	Hit by car
50.	Puppy	M	GSD	Fracture L/H femur	comminuted fracture of mid shaft with small fragments fracture line spiral in nature	IM pin, Box rest	No complication	Hit by car
51.	A	M	Rolt weiler	Fracture L/H tibia/fibula	complete mid shaft fracture	IM pin, bone plate, screws	wound exuding serum, muscle atrophy, osteomyelitis	Indoor trauma
52.	Puppy	F	Spitz	Fracture R/F radial /ulna	Fracture radius/ulna	Gypsona POP, reinforced with	No complication	Unknown

						splits		
53.	A	M	Cross	Fracture R/H femur	mid shaft oblique fracture	IM pin, modified RJ bandages	No complication	Unknown
54.	A	F	Cross	Fracture L/H femur and R/H femoral head	complete distal fracture of the left femur and fracture of the right femoral head	Euthanasia	Euthanasia	Road traffic car accident
55.	A	?	Rolt Weiler	Fracture ulnar	Distal fracture of ulna with callus formation	Box rest	No complication	Unknown
56.	A	?	GSD	Fracture L/H femur	closed fragmented fracture	removal of fragments, fixation with plate and screws, cerclage wires	No complication	RTA / motor traffic accident
57.	A	?	Springer	Fracture R/F metacarpus	Stable fracture of 3rd metacarpus and hairline fracture of 2nd metacarpus	Fibre cast	Autolised limb from elbow down by the time of cast removal/ Euthanasia	Unknown
58.	A	?	GSD	Fracture tibia	Complete mid shaft fracture tibia/fibula	Steinmann pin, cerclage wires, adhesive bandages	dog removing stitches for day 1,2,3 and inerdemal stitches applied	Unknown
59.	A	F	Cross	Fracture R/F humerus	Dicondular T fracture of distal humerus	Steinmann pin, bone screw	No further records	Unknown traumas

Appendix IV

On part two of the questionnaires

Types of fractures	Management protocol technique	Complications	Challenges
Midshft/proximal fractures of humerus/radius/ulna/femur	Intramedullary pinning	Slippage of IM pins due to dogs running around	Availability 0f materials
Epiphyseal fractures	Bone palte and screws		Client finance
Oblique shaft fractures	Intramedullary pin with stainless steel wire	Rejection/reaction to fixation device used	No comment
Proximal shaft fracture of tibia	Intramedullary pin with Thomas splint	Infection sometime	No comment
Radius/ulna/tibia fracture	Plaster of Paris	Chewing of patient	No comment
Scapular fractures, mandibular (proximal/distal fractures	Bone screws	Self destruction by patient	No comment
Mandibular fractures	Stainless wire	No comment	No comment
Simple complete fracture of humerus	POP	Self mutilation	Non compliance buy owner less confirnment
Oblique fracture of phalanx	IM pin and cerclage wires	Pin migration and infection	No confinrnent
Simple fracture of the phalanx	POP	None	Dampness /cast wetness
Distal fracture of humerus	Plates and screws	Infections	Technical challenges of fixing the pin
Simple juvenile	Support dressings/rest	Deformity, progression to worse	Location, owner non-compliance
Simple adult	External fixation	Malunion/deformity/pressure sores	Same
Directional fractures(oblique, transverse, spiral)	Open reduction with internal fixation	Secondary infection, malunion	Lack of proper equipment/competence, poor accessibility

Pelvic fracture/vertebrae	Painkillers and rest	Deformity, interference with physiology function	same
Central femur/humerus	IM pins	Pin migration	Failure to confirm
R/Ulna carpal fracture	Plates and screws	Osteomyelitis	Too many fragments
Femur fracture distal	Resin cast	Cast cut into patient causing lacerations	No comment
Radial /Ulna fracture	POP	Wetness post discharge	Messy and heavy
Patella fracture	K-wire and plate	Arthrodesis	No comment
Humerus	Bone plates	No comment	No comment
Radius and ulna	Bone plates	SSInfection	Less skin and tissue
Femur	IM pins (single, double)	Rotation	Immobilisation
Tibial	Bone plates	no comment	No comment
Femoral head fracture	Femoral head excision	Haemorrhage	No comment
Femoral/ Humeral	Double pinning/ plates	Delayed union/ osteomyelitis	No comment
Radius/ulna/tibia/fibula	Plates and screws	Same	No comment
Metacarpal /metatarsal	Casting/plates	No comment	No comment
Coronoid process fracture	Casting	No comment	No comment
Ununited aconeal process	Casting	No comment	No comment