OCCURRENCE, ETIOLOGY, CLINICAL FINDINGS, MANAGEMENT AND OUTCOMES OF MUSCULOSKELETAL LIMB CONDITIONS IN DOGS PRESENTED TO SELECTED CLINICS IN NAIROBI COUNTY, KENYA

A thesis submitted in partial fulfillment of the requirements for the award of the degree of Master of Veterinary Surgery of the University of Nairobi

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DECLARATION

This is my original work and has not been submitted for a degree in any other University

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DEDICATION

I dedicate my thesis work to my family that has supported me tremendously throughout this journey and my academic friends for the guidance and support that they offered. I would like to especially thank and dedicate my work to my father Dr. Zulfikar, without whose constant encouragment and patience this would not have been possible.

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ABSTRACT

A clinically healthy musculoskeletal system is paramount to the welfare and physical performance of dogs, which is interfered with by musculoskeletal disease conditions (Fossum, 2019). Information on musculoskeletal limb conditions affecting dogs in Kenya is scanty. This poses a challenge to veterinary professionals in making of diagnosis, drawing of prognoses and managing of these conditions. Therefore, access to this vital information would enhance veterinary professional handling of dogs with musculoskeletal limb conditions and improve the outcomes.

The objectives of this study were to determine 1) the occurrence of musculoskeletal limb conditions 2) the causes, clinical findings and diagnosis of musculoskeletal limb conditions 3) the treatment/management methods and outcomes of musculoskeletal limb conditions 4) the treatment methods for musculoskeletal limb conditions of dogs that influence outcomes in Nairobi County, Kenya from January 2009 to December 2018.

Records of all cases of dogs presented with musculoskeletal limb conditions to the designated veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018 were retrieved.

Data collected from the records included; demographic characteristics of the dogs, history, clinical findings, limbs affected, the affected anatomical structures, diagnostic methods, diagnoses, treatment methods, and outcomes. The data was entered into Microsoft® Office Excel 2007 (12.0.4518.1014) and imported into IBM SPSS statistics software (Build 1.0.0.1275, 64 – bit edition) for analysis.

Out of 4,000 cases, occurrence of musculoskeletal limb conditions was 40.0% (n=1,600). All the percentages of various occurrences were calculated out of 1,600 dogs that had

musculoskeletal limb conditions. Trauma was the most common cause recorded in 43.6% (n=698) of the cases of musculoskeletal limb conditions. A total of 50.5% (n=808) were adults and 22.4% (n=358) were puppies. Large breeds were 59.3% (n=948), and small breeds were 27.8% (n=445). Among the 1,600 dogs with musculoskeletal limb conditions, 82.1% (n=1,313) were pets and only 2.5% (n=40) were guard dogs.

A total of 77.1 % (n=1,234) of the dogs were lame; 48.0% (n=768) with hind limb lameness and 45.2% (n=723) with forelimb lameness. Soft tissues were affected in 66.5% (n=1,064), bones in 20.9% (n=335), and joints in 15.2% (n=244) of the dogs. Diagnosis using radiography was done in 27.7% (n=443) of the cases. Diagnosis in the rest of the cases was done through physical observation and manipulative palpation of the limbs. The most common musculoskeletal limb disorders diagnosed were soft tissue disorders in 66.5% (n=1,064), joint disease in 23.9% (n=382), and fractures in 10.4% (n=167) of the dogs. The least common musculoskeletal limb disorders diagnosed were neoplasia in 3.1% (n=49), metabolic/nutritional disorders such as vitamin/mineral deficiencies especially calcium deficiencies in 1.8% (n=28), and neurologic disorders such as radial nerve paralysis and hind limb paralysis in 1.2% (n=19) of the dogs.

Medical management included use of antibiotics in 74.7% (n=1,196, p=0.000), corticosteroids in 60.4% (n=966, p=0.000), non-steroidal anti-inflammatory drugs in 47.6% (n=762, p=0.000), multivitamins in 9.3% (n=149, p=0.000), calcium supplements in 5.2% (n=83, p=0.000), and glucosamine chondroitin in 3.2% (n=51, p=0.000) of the cases. Other therapies included confinement and limited leash exercises in 22.8% (n=365, p=0.000) and weight reduction in 1.1% (n=18, p=0.000) of the cases, which all significantly affected the outcome with more dogs recovering with their use. The surgical

management procedures included suturing in 10.4% (n=167), fracture repair in 3.1% (n=49), lancing/draining of abscesses/seromas in 2.3% (n=37) and lumpectomy in 1.4% (n=23) of the cases. Complications were observed in 15.1% (n=241) of the dogs and 87.3% (n=1,396) of the dogs recovered, 5.1% (n=81) were euthanized, 0.8% (n=12) died and 2.0% (n=32) had undetermined outcome in the case records.

The study concluded that the occurrence of musculoskeletal limb conditions in dogs was relatively high with a high percentage of lameness and having a high occurrence of soft tissue conditions followed by bone and joint conditions respectively. Trauma was the most common cause of limb conditions recorded. The use of radiography in diagnosis of these conditions was relatively low, the recovery rate was high, and a combination of drugs / therapies helped in the management of limb conditions enhancing the recovery of dogs. It is recommended that diagnostic methods and record keeping be improved, veterinary clinics to be more professional and allow students to access their records for research purposes, owners be educated on animal welfare and seeking veterinary help when necessary, and further research using control studies be carried out.

CHAPTER ONE

1.0 INTRODUCTION

A clinically healthy musculoskeletal system is paramount to the welfare and performance of dogs. However, this is interfered with by musculoskeletal disease conditions, which in most cases are multifactorial and may involve bones, joints or soft tissues including nerves (Fossum, 2019). The appendicular system is particularly essential for movement and performance of the dog. Conditions affecting this system may result in varying degrees of lameness (Slatter, 1993). Lameness is defined as an abnormal gait caused by a structural or functional disorder of the locomotor system (Mohsina *et al.,* 2014).

The general causes of lameness include heritable, congenital and developmental defects, structural disorders, neoplasia, trauma and infection (Scott and Witte, 2011). Regardless of the aetiology, diagnosis of lameness may be achieved by incorporating history, clinical signs and physical examination of the patient while at rest and during exercise (Piermattei *et al.,* 2006). Diagnostic imaging and other specialized procedures such as arthroscopy, arthrotomy, and arthrocentesis enhance confirmatory diagnoses (Cook and Cook, 2009). However, application of these advanced diagnostic procedures in developing countries is limited by cost, availability of the equipment and scarcity of specialized technical expertise.

Depending on the type of condition, musculoskeletal limb conditions in dogs may be managed either by conservative, medical, surgical or combination methods (Fossum, 2019).

In the UK, the prevalence of appendicular osteoarthritis was 2.5% (Anderson *et al.*, 2018). Mohsina et al. (2014) reported the incidence of lameness in canines in India as 56%. In Egypt, the prevalence of medial coronoid process disease was 20.8%, with Labrador and Golden retrievers most affected at 29.6% among the purebred dogs (Mostafa *et al*., 2018). Canine appendicular osteosarcoma is the most common primary bone tumors in dogs, accounting for almost 75% to 85% of these lesions (Chun and de Lorimier, 2003; Belda *et al*., 2016). The prevalence of cranial cruciate ligament rupture as one of the causes of hind limb lameness was 32% (Powers *et al*., 2005).

In Kenya the incidence of canine hip osteoarthritis was found to be 14.7% (Mande, 1993; Mande *et al.*, 2003), while that of appendicular bone fractures was also 14.7% (Rhangani, 2014). A retrospective study covering a period of 11 years (1998-2014) reported the prevalence of hip dysplasia for different dog breeds in Kenya as 67.0% for German Shepherds, 15.6% for Rottweilers, and 12.2% for Labrador Retrievers (Kimeli *et al.*, 2015). However, information describing research on the overall occurrence of limb conditions or lameness in dogs in Kenya is scanty in scientific literature. A systematic study is necessary in order to document the occurrence, clinical findings, management and outcomes of musculoskeletal limb conditions affecting dogs in Nairobi County, Kenya.

1.1 Problem statement

Information on musculoskeletal conditions and particularly those affecting the limbs of dogs in Kenya is scanty. This poses a challenge to veterinary professionals in making of diagnosis, drawing of prognoses and managing of these conditions. Access to this vital information would enhance veterinary professional handling of dogs with

musculoskeletal limb conditions and improve the outcomes. Hence the reason for carrying out this retrospective study to provide data on the status in Nairobi County, Kenya and extrapolate these findings to the rest of Kenya.

1.2 Hypothesis

The occurrence of musculoskeletal problems affecting the limbs and causing lameness in dogs in Nairobi County, Kenya is high and interferes with the performance and welfare of dogs.

1.3 Objectives

1.3.1 General objective

The general objective of the study is to determine the occurrence, etiology, clinical findings, management and outcomes of musculoskeletal conditions affecting the limbs of dogs presented to selected veterinary clinics in Nairobi County, Kenya.

1.3.2 Specific objectives

The specific objectives of this retrospective study were:

1. To determine the occurrence of musculoskeletal conditions affecting the limbs of dogs in Nairobi County, Kenya from January 2009 to December 2018.

2. To determine the causes, clinical findings and diagnoses of musculoskeletal conditions affecting the limbs of dogs in Nairobi County, Kenya from January 2009 and December 2018.

3. To determine the management/treatments and outcomes of musculoskeletal conditions affecting the limbs of dogs in Nairobi County, Kenya from January 2009 to December 2018.

4. To determine the treatment methods for musculoskeletal conditions affecting the limbs of dogs that influence outcomes in Nairobi County, Kenya.

1.4 Justification

Comprehensive and systematic evaluation of the occurrence, clinical findings, diagnoses, treatments, and outcomes of musculoskeletal limb conditions in dogs in Kenya is lacking in the available scientific publications. This made it necessary to conduct the current retrospective study and publish the data on the status of musculoskeletal conditions affecting the limbs of dogs in Nairobi County, Kenya, where most pet and guard dogs are presented for treatment. Availing this data will enlighten the veterinarians and facilitate in their diagnoses-and-prognoses making as well as in treatment of musculoskeletal conditions affecting the limbs of dogs. It will also give dog owners guidance on how to prevent occurrences of these conditions or what to do when dogs have musculoskeletal problems. The information obtained from the research may also contribute to the content that should be emphasized in training veterinary students and in veterinary Continuing Professional Development seminars and conferences to enlighten the practicing veterinarians.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of musculoskeletal conditions

Musculoskeletal problems in the dog affect bones, joints, tendons, muscles, and nerves of the appendicular skeleton. Some of them particularly those affecting appendicular skeleton, cause lameness, impair performance of the dog, interfering with their health due to pain and discomfort (Slatter, 1993). Musculoskeletal conditions are common and usually associated with pain, loss of function, soft tissue swelling/inflammation, muscle atrophy, bleeding, abnormal posture and gait, decreased range of motion as well as nervous system signs.

2.2 Anatomical features of the forelimb and hind limb

Appendicular skeleton comprises the bones and joints of the limbs with their connections to the axial skeleton (Dyce *et al.,* 2002). This is shown in Figure 2.1.

2.2.1 The Forelimb

The forelimb (thoracic or pectoral limb) begins from the scapula on the proximal end to the metacarpals and phalanges on the distal end. It is comprised of bones, joints, muscles, tendons, ligaments, nerves and blood vessels as shown in Figures 2.2 and 2.3

2.2.2 The Hind limb

The hind limb (pelvic limb) begins from the pelvis on the proximal end to the metatarsals and phalanges on the distal end. It is comprised of bones, joints, muscles, tendons, ligaments, nerves and blood vessels as shown in Figures 2.4 and 2.5.

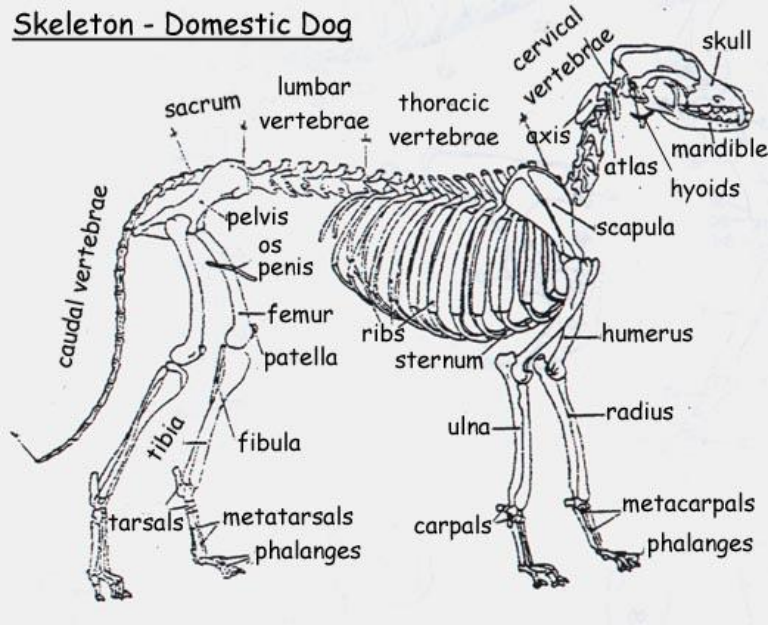

Figure 2.1: Skeleton of the domestic dog. (Mark A Smith) mydrawingcourse.com (visited February 23, 2018)

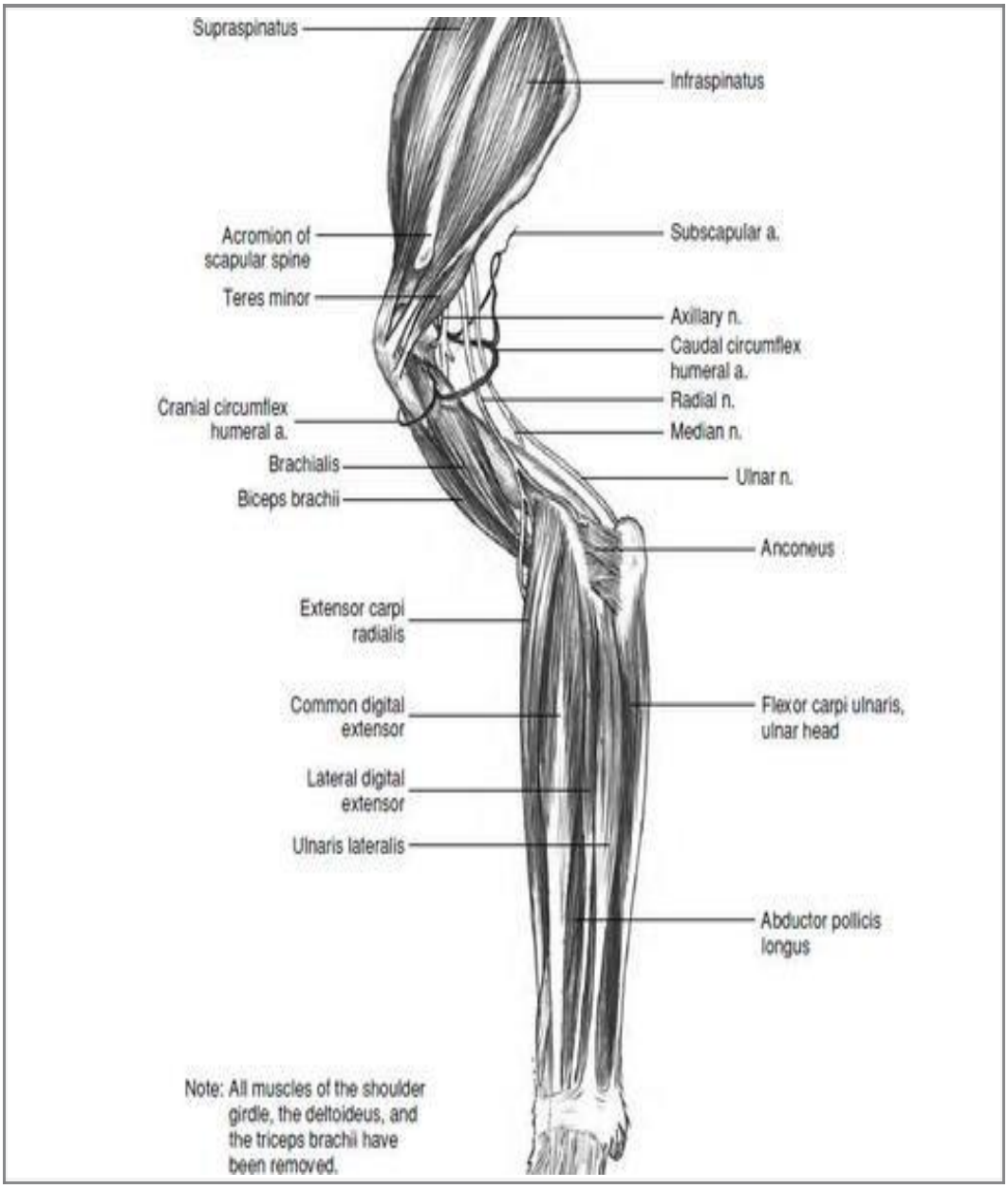

Figure 2.2: Deep musculature of thoracic limb (lateral view).

http://67.media.tumblr.com/tumblr_me47z2CEVO1r92jxh.jpg (visited February 23, 2018)

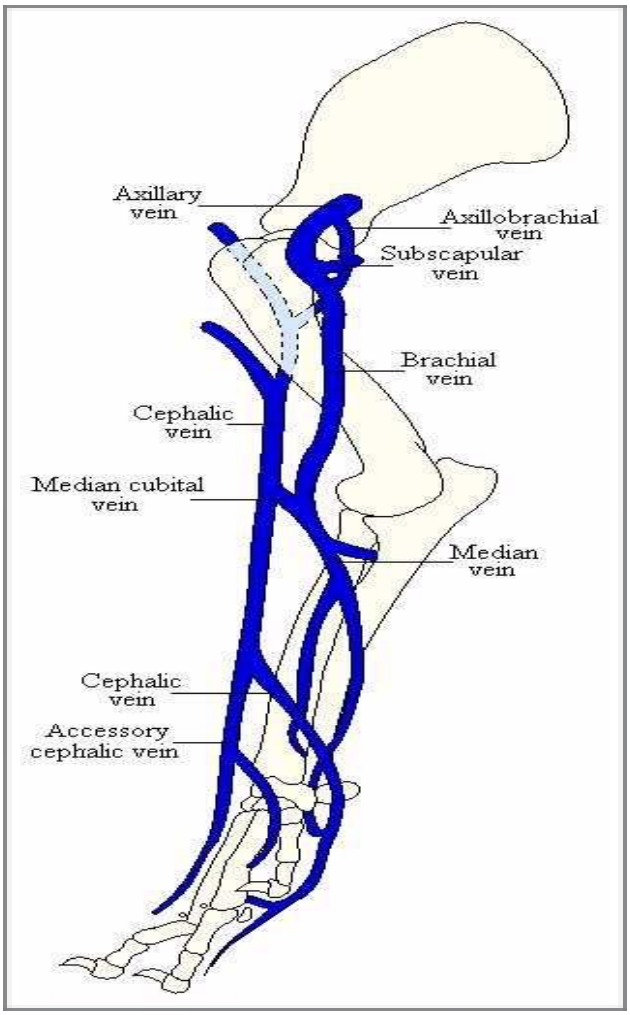

Figure 2.3: Blood supply of the forelimb.

http://137.222.110.150/Calnet/LFvasc/image/venous%20drainage%20of%20right%20forelimb-medial%20view.jpg (visited February 23, 2018)

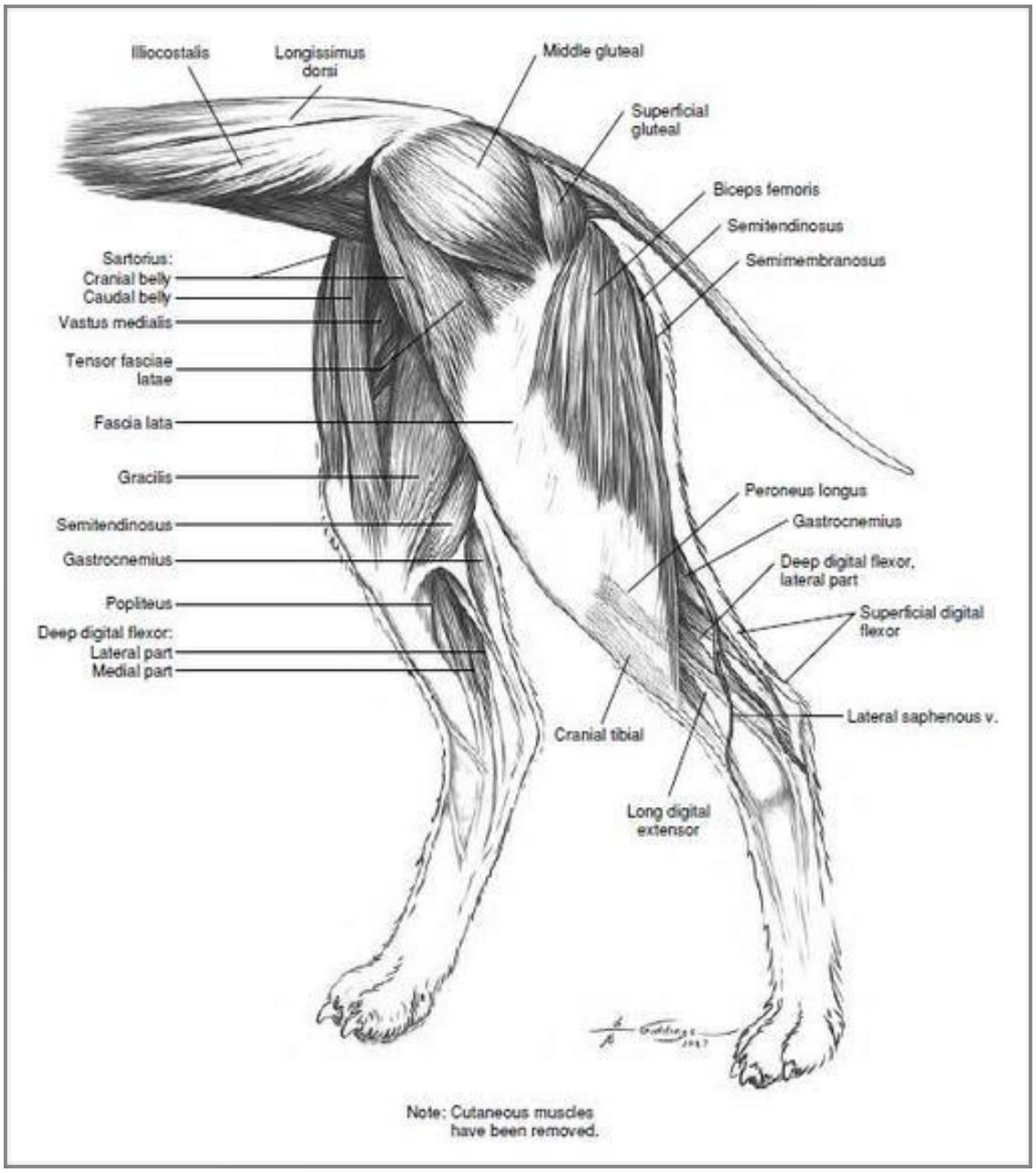

Figure 2.4: Subcutaneous musculature of the canine hindquarter

http://65.media.tumblr.com/tumblr_me482mXjep1r92jxh.jpg (visited February 23, 2018)

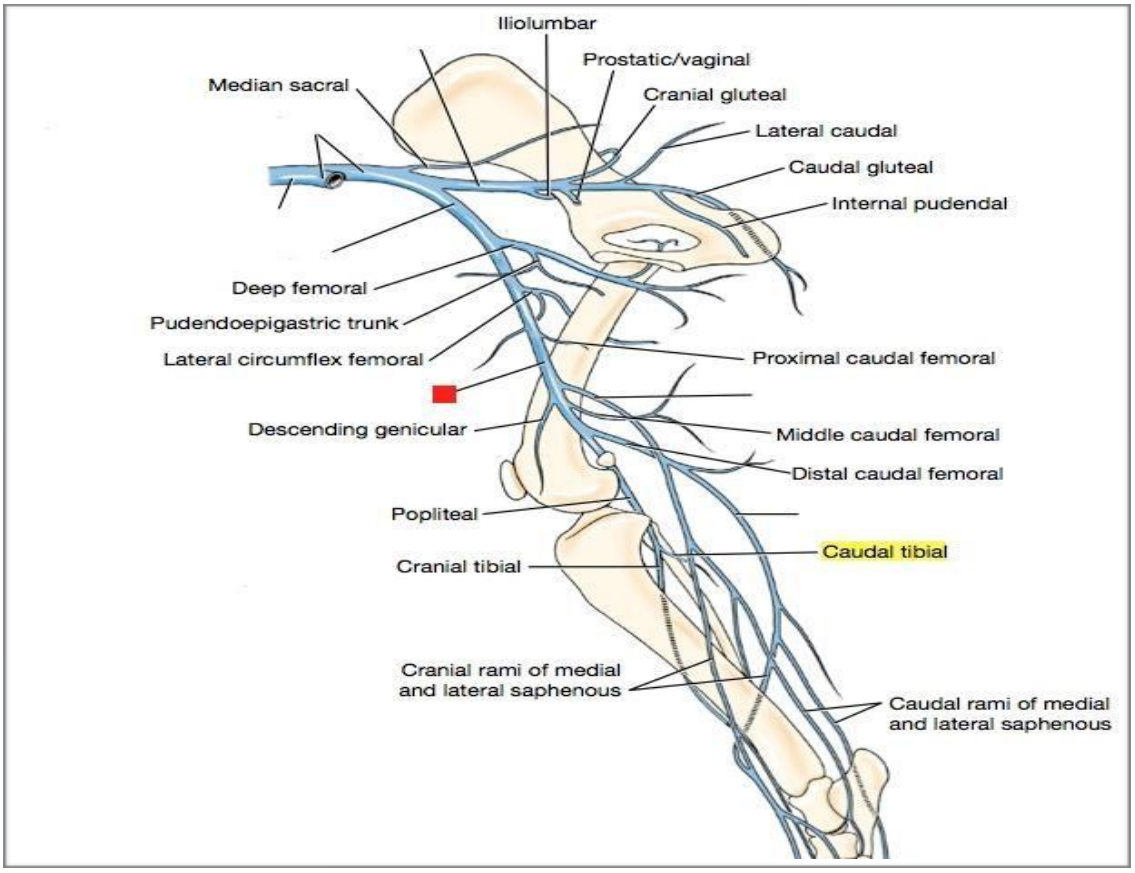

Figure 2.5: Blood supply of the hindlimb

https://classconnection.s3.amazonaws.com/838/flashcards/752838/jpg/femoral1321757027779.jpg (visited February 23, 2018)

Unlike the hind limb, the forelimb is attached to the axial skeleton by muscles rather than a socket and ball joint. Hence the importance of strong muscles in this part for proper coordination and functioning of the forelimb. The weight-bearing distribution in the dog is 60-65% on the forelimbs and 40-35% on the hind limbs (Edge-Hughes, 2004), hence predisposing the forelimbs to more incidences of lameness.

2.3 Musculoskeletal conditions affecting the limbs

Musculoskeletal conditions affecting the forelimbs and hind limbs of dogs can occur on any anatomical structure of the limbs. They could also be systemic problems such as nutritional and metabolic disorders.

2.3.1 Fractures

A fracture is a complete or incomplete loss of continuity of a bone resulting from exertion of excessive force (Fossum, 2019). The most common aetiology of fractures is traumatic causes, but occasionally can be non-traumatic (Adams *et al.*, 2010).

In one study, fractures of the forelimbs in dogs had highest incidence (36%) in young animals between 1.5 to 6 months of age, with male dogs being affected more (59%) than females and the radius and ulna being the most commonly fractured bones (65%) (Shiju *et al*., 2011). Ben Ali (2013) reported the incidence of femoral fractures in dogs as 37.5%. Others in their study reported the German shepherd dogs to be more prone to fractures than other breeds (Harasen, 2003; Senn *et al.*, 2004). The incidence of appendicular fractures found through a retrospective study in dogs in Nairobi County, Kenya was reported to be 14.7%, with the hind limbs being affected more often than the

forelimbs (Rhangani, 2014). This study found that unknown causes and motor traffic accidents were the most common causes of fractures in Nairobi County.

Evaluation of mechanical and biological factors is important for decisions on the repair of fractures. Other factors considered are the disposition of the dog with the fracture and the actual requirements of the techniques ultimately chosen for stabilization of the fracture (Shales, 2008). Biological assessment includes patient age, character, systemic illness, and nutritional status. The fracture environment factors that are considered include blood supply to the fragments, whether open or closed, absence or presence of foreign bodies, loss of bone and whether the fracture is recent or old (Komatsu and Warden, 2010).

Imaging, particularly radiography is useful for confirmatory diagnosis of fractures and assessment to give guidance for repair as well as prognosis. Radiography is also needed to monitor postoperative patient's progress. Radiographic views of the normal contra-lateral bone are useful for comparative purposes, particularly when dealing with severely comminuted fractures, in order to get guidance for the original dimensions and shape of the bone (Hobbs, 2012).

2.3.2 Joint conditions

Various conditions may cause joint disorders in dogs such as follows in the description below.

Elbow dysplasia, which denotes abnormal development of the elbow with clinical and radiographic manifestations of ununited anconeal process, fragmented medial coronoid process, osteochondritis dissecans, erosive cartilage lesions and elbow incongruity (Lust, 1997; Kirberger and Stander, 2007; Skurková and Ledecký, 2009). A study carried out in Egypt reported the incidence of elbow dysplasia as 8% with the German Shepherds being

the most affected breed (12.1%) and males (73.6%) being more affected than females (26.4%) (Shokry *et al.,* 2018). The overall prevalence of elbow dysplasia recorded in a study in Belgium by Coopman et al. (2008) was 19%, with the Bernese mountain dog (20%) being most affected and the Rhodesian Ridgeback (8%) being least affected. However, a study on the incidence of elbow dysplasia conducted in South Africa showed an incidence of 27% in dogs with Rottweilers having the highest incidence of 55%, and the Bullmastiff, Chow Chow, Boerboel and Golden retriever all with an incidence >38%. Males were more frequently affected than females and the left elbow (27%) was more frequently affected than the right elbow (25%) (Kirberger and Stander, 2007).

Hip dysplasia is a deformity of the coxofemoral joint characterized by shallow acetabulum, flattening of the femoral head, coxofemoral subluxation, or secondary degenerative joint disease (Lust, 1997; Skurková and Ledecký, 2009). Hip dysplasia is estimated to occur in about 30% of the dog population (Gladstein, 2010). Loder and Todhunter (2017) reported the overall prevalence of canine hip dysplasia in the USA and Canada to be 15.6% with females and working dogs being at a higher risk. The prevalence of hip dysplasia in Croatia was recorded to be 18.8% (Stanin *et al.,* 2011). According to Coopman et al. (2008), the overall prevalence in Belgium was recorded to be 20%, with the German Shepherds (23%) being the most frequently affected and the Old English Sheepdog (5%) being least frequently affected. Prevalence of hip dysplasia affecting different breeds in Kenya was seen to be 67% for German Shepherds, 15.6% for Rottweilers, and 12.2% for Labrador retrievers (Kimeli *et al.*, 2015).

Osteochondrosis is a focal disturbance of enchondral ossification with multifactorial aetiology, which includes hereditary factors, anatomic conformation (the two most cited

factors), rapid growth, trauma, and dietary imbalances (Ytrehus *et al.,* 2007). Mostly affecting the shoulder, elbow, stifle, and hock joints (Slatter, 1993) and seen mainly in humans, horses, pigs and dogs, being a common cause of lameness in young athletic horses and dogs (Ytrehus *et al.,* 2007). Degenerative Joint Disease (DJD/osteoarthritis) is a non-inflammatory, non-infectious degeneration of articular cartilage accompanied by bone formation at the synovial margins and by fibrosis of periarticular soft tissue. It is classified either as primary or secondary depending on the cause (Fossum, 2019).

In general across the domestic and pet animal species, its been recorded that dogs suffer from arthritis more due to injury, genetic predisposition and the excessive running or exercise they do (Bland, 2015). According to Bland (2015) in the USA one in four of 77.2 million pet dogs are diagnosed with some form of arthritis. Primary osteoarthritis is a disorder of the old dogs with cartilage degeneration occurring for unknown reasons. Secondary osteoarthritis occurs in response to abnormalities that cause joint instability, abnormal loading of articular cartilage, or in response to other recognizable joint diseases. Secondary osteoarthritis is more common than primary osteoarthritis in dogs and cats. The mean age for the onset of Primary osteoarthritis has been found to be 3.5 years in Rottweilers and 9.5 years in Poodles (Mele, 2007; Fossum, 2019). However, more than 50% of canine osteoarthritis cases have been noted to affect dogs aged between 8-13 years, with the males being more affected than females, and the large (45%), and Giant (>50%) breed dogs being most affected and the medium (28%) and small (27%) breed dogs being least affected (Mele, 2007). In the UK, the prevalence of appendicular osteoarthritis was 2.5% (Anderson *et al.,* 2018). The incidence of canine hip osteoarthritis in Kenya was 14.7% (Mande, 1993; Mande *et al.,* 2003).

Legg-Perthes Disease is a non-inflammatory aseptic necrosis of the femoral head that occurs in young dogs before closure of the capital femoral physis. It occurs bilaterally in 10% to 17% of affected dogs and toy breeds being most frequently affected (Denny and Butterworth, 2000; Yotsuyanagi *et al.,* 2009; Fossum, 2019). Degenerative joint disease (DJD) can affect any age and breed of dogs (Fossum, 2019), however, Osteochondrosis (Nečas *et al.,* 1999), Hip Dysplasia (Kimeli *et al.,* 2015), and Elbow dysplasia (Shokry *et al.,* 2018) mostly affect large breeds. Legg-Perthes Disease affects young small breeds of dogs. It has been noted that most dogs will have a history of exercise intolerance, particularly when multiple joints are affected. Diagnosis is achieved by radiography and arthroscopy can be done in some cases.

Patellar luxation is another common orthopaedic condition affecting both dogs and cats (Dona *et al.,* 2016) with a prevalence of 1.3% in a study conducted in England (O'Neill *et al*., 2016). A recent retrospective study carried out on 65 dogs by Kalff et al. (2014) revealed that lateral patellar luxation affected the large and medium breed dogs more frequently than small breed (10% - 6/65) dogs. However, medial patellar luxation is more common than lateral patellar luxation according to Roush (1993). However, in a study conducted in Chiang Mai, Thailand, it was found that small breed of dogs especially poodles (34.3%) were most frequently affected and 57.8% of the dogs affected were female. Uniluxation of the patellar amounted to 63% and biluxation 37% (Nganvongpanit and Yano, 2011).

Cranial cruciate ligament (CCL) injury is one of the most frequent causes of hind limb lameness in dogs, which renders the stifle unstable and predisposes to degenerative joint disease. Acute traumatic rupture of the CCL is less frequent (Johnson *et al.*, 1994;

Comerford *et al.*, 2011). An Epidemiological study in England found the prevalence of CCL disease to be 0.56% with the Rottweilers, West Highland Terriers, Golden Retrievers, Yorkshire Terriers, and Staffordshire Bull Terriers being most frequently affected. Increasing body weight increased the chances of CCL diagnosis, and neutered females were more affected than entire females (Taylor-Brown *et al.,* 2015). Another study carried out by Slauterbeck et al. (2004) showed the prevalence of Anterior Cruciate Ligament (ACL) injury as 3.48% with neutered females and males having a higher prevalence of ACL injury than non-neutered females and males.

Osteomyelitis can be caused by bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and Proteus species; or fungi through exogenous contamination particularly from open fractures with infection rate ranging between 4% - 64%, trauma such as puncture wounds, or other open wounds and occasionally haematogenous route in dogs. Prosthetic joint infection is a relatively new entity of chronic osteomyelitis with an incidence of 1.5-2.5% and an incidence of 20% with repeat surgery (Bojrab, 1990; Jorge *et al.*, 2010; Panteli and Giannoudis, 2016). A study carried out on 65 animals (51 dogs and 14 cats) by Slunsky et al. (2017) showed that the incidence of bacterial colonization of the removed plate implants (50.8%, n=33) was significantly higher ($P<0.01$) than the incidence of post-traumatic osteomyelitis cases (7.8%, n=5).

The clinical characteristics of osteomyelitis include local heat, pain, swelling and occasional intermittent lameness particularly when the condition is chronic. Discharging fistulas may be seen with purulent exudate and marked disuse muscular atrophy of the affected limb (Bojrab, 1990; Slunsky *et al.,* 2017). Apart from the clinical characteristics, confirmation of diagnosis can be done by radiography, in which acute osteomyelitis

shows bone destruction, and new bone both at varying degrees depending on the bacterial activity. The radiographic appearance in chronic osteomyelitis includes excess exostoses and bone remodeling. Presence of a foreign body or sequestrum should be sought carefully in the radiographs because these can influence the prognosis negatively if not missed out. Culture of bacteria confirms the causative agent (Bojrab, 1990). A leukocytosis with a degenerative left shift may be seen in acute osteomyelitis and mostly in chronic osteomyelitis (Bojrab, 1990; Fossum, 2019). A study conducted in rabbits in Greece, revealed positive response to treatment of osteomyelitis with a biodegradable system of lactic acid polymer releasing perfloxacin (Kanellakopoulou *et al.,* 2000).

2.3.3. Soft tissue injuries

The extent, severity and management of wounds may vary depending on their cause. In Ghana, it was found that the prevalence of wounds and trauma cases was the highest (41.0%) among the surgical conditions managed (Eyarefe and Dei, 2014). The study also revealed that the canine species was most affected (96.0%) and the local breed (mongrel) had the highest occurrence of surgical conditions (40.2%). It was also reported that male dogs were presented more for surgery (57.0%) as compared to females (35.0%). Wounds can either be penetrating (such as bullet wounds, bites and foreign bodies) or non-penetrating (such as burns, frost bite, electrical, radiation, chemical injuries, pressure sores and bruises).

Animals may appear stable initially. However, continuous deterioration of damaged tissue can lead to necrosis, infection, inflammation, sepsis, and death (Campbell, 2015). It has been noted that muscle contusions, sprains, and strains are diagnosed a lot in athletic dogs such as the racing grey hounds and field trial dogs and occurs during

strenuous activity. Management of wounds depends on the severity, cause, and type of injury, which will dictate whether it is surgical or conservative. Surgical exploration is needed to fully assess the extent of trauma caused by penetrating injuries. Thorough debridement of devitalized contaminated tissue is the only effective way to prevent or treat systemic inflammatory response syndrome (SIRS) or sepsis (Campbell, 2015). Conservative management of non-penetrating wounds involves antibiotic therapy, anti-inflammatory drugs, analgesics, confining the animal to rest the limbs, relieve weight bearing, restrict exercises and giving proper nutrition.

Inflammation of the bone includes periostitis for periosteum, osteitis for cortical bone and osteomyelitis for the cortical bone and the medullary structures. Osteomyelitis generally includes not only inflammation but also infection resulting in bone destruction and sequestrum formation (Bojrab, 1990; Lew and Waldvogel, 2004; Conterno and Turchi, 2013; Panteli and Giannoudis, 2016). These can affect any age, breed, or sex of dogs (Fossum, 2019). Inflammation was the most prevalent (32.1%) pathophysiological process diagnosed in a study in UK (O'Neill *et al.*, 2014).

2.3.4 Neoplasia

Neoplasia is the uncontrolled, and abnormal growth of cells or tissues in the body, and the growth is called a tumor or neoplasm which can be either benign or malignant (Fossum, 2019). A study in Zimbabwe showed that 60% of recorded cases were tumors and 40% were non-neoplastic inflammatory or degenerative diseases; the 10 most common tumors comprising of 73.7% of all cutaneous neoplasms were mast cell tumors, squamous cell carcinomas, perianal gland adenomas, lymphomas, benign melanomas, hemangiosarcomas, sebaceous gland adenomas, fibrosarcomas, lipomas, and malignant

melanomas (Mukaratirwa *et al.,* 2005). According to the Swiss Canine Cancer registry, the most common skin cancer types were mast cell tumors (16.35%), lipomas (12.47%), soft tissue sarcomas (10.86%) and melanocytic tumors (8.63%) (Graf *et al.,* 2018).

Osteosarcoma is a primary malignant bone neoplasm of mesenchymal origin whose cells produce osteoid or tumorous bone (Pool, 1990). It is relatively rare among domestic animals but accounts for approximately 85% of skeletal malignancies in dogs affecting the appendicular skeleton, mainly humerus, radius, ulna, femur and tibia respectively (Cavalcanti *et al.,* 2004). The cause of osteosarcoma is unknown. However, it has been associated with fractures and metallic implants (Boudrieau *et al.,* 2005) and may also occur within radiation fields following radiation treatment of soft-tissue sarcomas (Fossum, 2019). Males are more frequently affected than females with neutered dogs being more at risk than non-neutered dogs. Large breed dogs are frequently affected with the Rottweiler, Greyhound, Deerhound and Irish Wolfhound having a high incidence (Ru *et al.,* 1998; Egenvall *et al.,* 2007; Mirabello *et al.,* 2009; Zhang *et al.,* 2016; Simpson *et al.,* 2017). Regardless of the treatment, the estimated survival time is 6 months to 1 year. Although some reports indicate that males are affected more frequently than females and others indicate the reverse and mostly middle aged dogs (Cavalcanti *et al.,* 2004).

Lipomas are relatively harmless fatty lumps / masses / benign tumors but may cause owners anxiety depending on their size, number and location in the body. The prevalence in the UK was 1.94% (O'Neill *et al.,* 2018). Melanoma is a malignant neoplasm that originates from melanocytes. Melanocytic neoplasms have been reported to affect men and most domesticated animal species, including dogs, cats, horses, and also in wild terrestrial and marine animals (Sweet *et al.,* 2012; Nishiya *et al.,* 2016). In a retrospective

study in Brazil, of the 1813 cases of neoplasms recorded in dogs, 58 were melanocytic neoplasms, accounting for 3% (Kimura *et al.,* 2012), whereas in a similar study in Brazil, of the 2154 neoplastic cases recorded, 193 (8.9%) were melanocytic neoplasms of which 96.4% (186) cases occurred in dogs and only 3.6% (7) cases in cats (Teixeira *et al.*, 2010).

The main reason for referral or presentation of dogs with primary bone neoplasia of the appendicular skeleton to the clinic for treatment is either lameness or localised limb swelling, which could be chronic and progressive (Fossum, 2019). Dogs affected by primary bone neoplasia require thoracic radiographs to confirm metastases to the lungs (Fossum, 2019). However, subclinical micro-metastases may be present but not detectable by radiographic examination of the lungs. These metastases develop during the first few months of occurrence of primary neoplasia. They are disseminated to the lungs by the haematogenous route (Cavalcanti *et al.,* 2004). Other imaging methods such as Computed tomography (CT), bone scintigraphy (Fossum, 2019) and Magnetic Resonance Imaging (MRI) (Wallack *et al.,* 2002) can also be used to determine the extent of the disease. Confirmation is by histopathology, which will indicate the type of neoplasia.

2.3.5 Neurological disorders: Paralysis / paresis of limbs

Neurologic diseases can cause lameness that mimics orthopedic disease in companion animals (McDonnell *et al.,* 2001). Paralysis is the complete loss of sensory and motor function to the affected extremity, while paresis is the partial loss of sensation, plus complete or partial loss of motor function to the affected extremity (Fossum, 2019). Nerve injury can arise due to mechanical or chemical trauma, neoplasia, infections such as Herpes virus; shingles in humans, or due to *Neospora caninum* infection (Dubey *et al.*,

1988; Schubert, 2016), metabolic or immune mediated disorders and results in a rapid and specific cascade of events leading to unique cellular, molecular, and micro-anatomic changes (Epstein, 2014).

Paralysis may arise due to damage to the brachial plexus, femoral nerves, or lumbar plexus. Disorders of the brachial plexus of dogs are an occasionally encountered problem in clinical practice with avulsion of the nerve roots of the brachial plexus being the most common neurologic condition in the forelimb (Wheeler *et al.,* 1986; Schubert, 2016). Persistent motor and sensory abnormalities after surgery may also affect the rehabilitation process of patients (Kornbluth *et al.,* 2003).

2.3.6 Metabolic and nutritional disorders

Association between canine obesity and musculoskeletal disorders has been reported in which obese dogs were said to be at a higher risk for humeral condylar fractures, rupture of cruciate ligaments and neoplasia (German, 2006; Lund *et al.,* 2006). Prevalence of combined overweight and obesity in domestic canine populations ranges from 23% to 41% (McGreevy *et al*., 2005). Lund et al. (2006) reported an overall prevalence of overweight and obesity of 34.1% in the adult dog populations seen in private practices across the United States. A study by German et al. (2012) also found that obesity affects the quality of dogs' life. They have lower vitality and are more emotionally distressed than lean dogs or dogs that have lost weight. Feeding semi-moist foods; canned, or homemade foods was associated with an increased risk of overweight and obesity due to the higher calorie density of these diets as compared to other commercial formulations. Various studies suggest weight reduction and regular exercise can lead to a substantial

improvement in the degree of lameness caused by hip osteoarthritis and other musculoskeletal disorders in dogs (German, 2006; Marshall *et al.,* 2009).

2.4 Management of musculoskeletal conditions affecting the limbs

Musculoskeletal limb conditions can either be managed conservatively (medical) or surgically depending on the type of condition and its severity.

2.4.1 Medical (conservative) Management

Generally, conservative (medical) management involves the use of antibiotic therapy based on culture and sensitivity tests and immunosuppressive medications for immune mediated joint disease. Regardless of the cause, for virtually all joint diseases there are five basic principles of medical management:

1. **Weight management** to prevent increased load on joints by excessive weight, which exacerbates concurrent joint disease such as degenerative joint disease (DJD), osteoarthritis and even hip dysplasia. Proper body weight management eventually decreases the need for anti-inflammatory medication and surgery (Kealy *et al.,* 2002), but also reduces the prevalence of Hip Dysplasia and Canine Osteoarthritis (Marshall *et al.,* 2009).

2. **Nutritional Supplementation:** Omega-3 fatty acids are nutritional supplements added to canine diets specifically for management of joint disease due to their anti-inflammatory effect when given at certain proportions. They work by replacing arachidonic acid (AA) in cell walls with eicosapentaeonic acid (EPA), which results in decreased pain and inflammation associated with joint injury or osteoarthritis. Osteoarthritis can

alternatively be managed by administering chondroprotective agents to slow cartilage degradation and promote cartilage matrix synthesis. Oral chondroprotective supplements provide supraphysiologic amounts of glucosamine and chondroitin sulfate to the joints, which act as precursors for synthesis of hyaluronic cartilage matrix. Pentosan polysulfate isolated from beechwood hemicellulose also provides protection against cartilage damage (Fossum, 2019).

3. **Exercise moderation:** For proper management of joint disease, the type and degree of exercise moderation depends upon the stage of the disease, the time relative to surgery (if any), and the function or use of the pet (Fossum, 2019).

4. **Physical rehabilitation therapy:** Is important in management of joint disease in affected dogs, with the primary targets of physical therapy being strengthening, endurance, and range of motion (Fossum, 2019).

5. **Non-steroidal anti-inflammatory drugs (NSAIDs) therapy and other medical therapies:** medical management of DJD often includes therapy with NSAIDs, which reduce pro-inflammatory mediators by inhibiting cyclooxygenase-1-and-2 pathways. Some examples of drugs include phenylbutazone, carprofen, ibuprofen, meloxicam and deracoxib (Fossum, 2019).

6. Other medical therapies include the administration of broad spectrum antibiotics due to infection, corticosteroids which help reduce synovial

inflammation, polysulfated glycosaminoglycans (PSGAGS) and hyaluronon (Fossum, 2019).

2.4.2 Surgical management

This varies with the condition and its severity and includes: Arthroscopy used to examine and treat joints. It may be indicated for either the diagnosis or treatment of joint disease such as Osteochondritis Dissecans (OCD), treatment of osteoarthritis in the shoulder, elbow, carpus, hip, knee, and tarsus, Fragmented Coronoid Process (FCP), and others. Arthrotomy is the surgical exposure of a joint using traditional surgical instrumentation. Arthroplasty is surgical replacement of a joint structure and Arthrodesis is surgical treatment leading to joint fusion. Fractures can be managed using either open or closed reduction techniques depending on the type of fracture (Fossum, 2019).

2.5 Prognoses of common limb conditions in dogs

Prognosis for fractures depends on the type and management of fracture, bone affected and size of the animal. For instance medium or large breed dogs have a good prognosis with external coaptation or surgical management of long bone fractures as compared to small or toy breeds (Harasen, 2003).

Another study suggested that prognosis for canine osteosarcoma is poor following diagnosis and treatment with about one year survival rates being recorded as less than 45% (Straw *et al.,* 1991; Moore *et al.,* 2007; Frimberger *et al.,* 2016; Simpson *et al.,* 2017). The animals bodyweight and location of the tumor have been suggested to have prognostic significance with dogs having a lower bodyweight having a longer survival time (Bergman *et al.,* 1996; Lascelles *et al.,* 2005; Amsellem *et al.,* 2014; Simpson *et al.,*

2017) and dogs with proximal humeral tumors having a shorter survival time (Boerman *et al.*, 2012; Simpson *et al.*, 2017).

Generally, prognosis of wounds depends on the type of animal affected, patient stability, location of the wound, time from injury, type of wound, status of wound; any presence of devitalized tissue, degree of contamination, amount of tissue tension and dead space, wound vasculature, use of antibiotics and anti-inflammatories and type of management technique used (Mickelson *et al.*, 2016).

However, gaps in timely and accurate diagnosis and controversies in treatment modalities present challenges in comprehensive management of limb conditions and therefore access to this vital information through a systematic study of these problems will enhance the handling of these cases and improve the outcomes. This study is designed to document current knowledge, status and practice in management of limb conditions in dogs in Kenya.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

The study was carried out using records from 5 randomly and purposively selected Veterinary Clinics, which are located in different parts of Nairobi County. The Veterinary Clinics were designated as C1, C2, C3, C4 and C5 in order to conceal ownership of the clinics as was the preference of the clinic management. Nairobi is the capital city of Kenya and lies between 01° 17'S latitude and 36° 48' E longitude, with an approximate population of over 4.3 million people according to the 2019 census (Kenya National Bureau of Statistics, 2019). It is 696 square kilometers in size. These clinics treat dogs for clients from urban and peri-urban areas of Nairobi County.

3.2 Study design

A retrospective study was conducted covering a 10 year period between January 2009 and December 2018 both years included. The study was based on case records of dogs presented with limb conditions and treated in these clinics (coded C1-C5). Only relevant information related to these dogs was obtained for analysis as outlined below.

3.3 Selection of the veterinary clinics and sample size determination

3.3.1 Selection of the veterinary clinics

Selection of the veterinary clinics for inclusion in the study was purposive, focusing on the ones that are known to attend to a large number of cases and whose owners were willing to allow the investigator access their facilities to scrutinize case records for retrieval of information. The inclusion criteria was clinics that were registered for

practice by the Kenya Veterinary Board (KVB) and were in regular operation for at least the last 10 years within the period from January 2009 to December 2018. A list of clinics registered with the Kenya Veterinary Board (KVB) was obtained from which only those clinics that had been operational for at least the past 10 years or more were considered for recruitment into the study with consent of the owners.

3.3.2 Sample size (Number of dogs)

Assuming a prevalence of 67% (Kimeli *et al.*, 2015) for dogs affected with limb conditions, the number of dogs to be sampled for the study as per Martin et al. (1987) was calculated to be:

$$n = \frac{Z^2_{\alpha} pq}{L^2}$$

Where, n = the required sample size, Zα = 1.96, the standard normal deviate at 5% level of significance, p = the estimated prevalence, q = 1 – p, and L = the precision of the estimate. Setting p = 0.67, and L at 5%, the required sample size was therefore at least 340 dogs.

3.4 Data collection

Records of all the dogs presented to the selected veterinary clinics and diagnosed with musculoskeletal conditions affecting the limbs from January 2009 to December 2018, were retrieved. Each retrieved individual case record was scrutinized for specific detailed information related to the dog patient and the musculoskeletal conditions of the limbs, which included: breed, age, sex, neuter status, weight of animal, history on presentation, clinical symptoms such as inflammation, pain, limping, bleeding, purulent exudate, abnormal gait and posture, limb(s) affected, type of structure affected, diagnostic

methods used including any specialized diagnostic procedures such as radiography, and/or ultrasonography and blood tests; diagnoses made such as fractures, neoplasia, joint conditions, soft tissue injuries, infections, metabolic and nutritional disorders, and neurological disorders; causes of the limb conditions, treatments employed, prognoses and outcomes of the limb conditions and the cases. The information retrieved for each case was recorded in serialized individual data collection sheets (Appendix I and II). The total number of cases was dependent on the available case records in the designated veterinary clinics. It was also determined by the information available in the case records. There are some case records that were available but with no information relevant to the objectives of the study.

3.5 Data management and analysis

The retrieved information was assigned numerical codes for purposes of entry into Microsoft Excel Sheets. Each code represented either a single variable or a group/category of similar variables. The data was entered into Microsoft Office Excel 2007 (12.0.4518.1014). It was verified and validated to ensure correctness of entries as per the data collection sheets. It was then imported into IBM SPSS statistics software (Build 1.0.0.1275, 64 – bit edition) for analysis.

Descriptive statistics of the cases with limb conditions and the various factors related to limb conditions was done and proportions determined for categorical variables. The ranges, means, standard deviations and medians were determined for continuous variables (Bartolucci *et al.,* 2015). Note that the sample size was dependent on the number of cases whose records were available in the selected veterinary clinics.

Hypothesis tests were done to determine the proportions between outcomes and various medical treatments with significance level at $p < 0.05$.

The overall occurrence of musculoskeletal conditions affecting the limbs was calculated using the formula:

$$\text{Overall Occurrence} = \frac{\textit{Total number of cases with musculoskeletal limb conditions}}{\textit{Total number of cases presented to the clinics}} \times 100$$

$$\text{Annual Occurrence} = \frac{\textit{Number of cases with limb conditions each specific year}}{\textit{Total number of cases presented to the clinics}} \times 100$$

The following parameters were calculated:

The occurrence of limb conditions in each category (age, breed, sex, weight, dog use, limb status, limb affected, clinical finding, diagnosis, structures affected) was calculated using the formula below:

$$\text{Occurrence for each category} = \frac{\textit{Number with limb conditions in each category}}{\textit{Total number with limb conditions in 10 years}} \times 100$$

The frequency of each treatment and management type (each medical treatment, each surgical treatment) was calculated with the following formula:

$$\text{Frequency of each treatment} = \frac{\textit{Number of cases under each treatment}}{\textit{Total number of cases with limb conditions}} \times 100$$

Frequency of each outcome (recovered or died) was calculated using the following formula:

$$\text{Frequency of each outcome} = \frac{\textit{Number of cases under each outcome}}{\textit{Total number of cases with limb conditions}} = x\ 100$$

CHAPTER FOUR

4.0 RESULTS

4.1 The occurrence of musculoskeletal conditions of the limbs in dogs

The total number of cases recorded in the veterinary clinics included in the retrospective study was 4,000. Among these, the occurrence of dogs that had musculoskeletal conditions affecting the limbs was 40.0% (n=1,600). The lowest occurrence was 4.6% (n=73) in 2009 and the highest 15.4% (n=246) and 16.8% (n=269) in 2014 and 2018 respectively, with a yearly mean of 4.0% (n=160) (Table 4.1). The monthly occurrence among the 1,600 cases of musculoskeletal limb conditions ranged from 7.2% (n=113) to 9.7% (n=155) with a monthly mean of 8.3% (n=133). The monthly occurrence of musculoskeletal limb conditions is presented in Table 4.2.

Table 4.1: Occurrence of cases of dogs recorded with musculoskeletal limb conditions presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Year	Number of cases	Percentage (%) (n=1600)
2009	73	4.6
2010	82	5.1
2011	78	4.9
2012	125	7.8
2013	130	8.1
2014	246	15.4
2015	191	11.9
2016	188	11.8
2017	218	13.6
2018	269	16.8
Total	1600	100.0

Table 4.2: Monthly occurrence of cases of dogs recorded with musculoskeletal conditions of the limbs in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Month	**Number of cases**	**Percentage (%) (n=1600)**
January	155	9.7
February	122	7.6
March	131	8.2
April	115	7.2
May	131	8.2
June	136	8.5
July	138	8.6
August	131	8.2
September	121	7.6
October	144	9.0
November	141	8.8
December	135	8.4
Total:	1600	100.0

4.2 The causes, clinical findings and diagnosis of musculoskeletal limb conditions in dogs

The study revealed that trauma was the most common cause of musculoskeletal limb conditions recorded in 43.6% (n=698) of the cases as presented in Table 4.3. A high percentage (47.4%, n=759) of the dogs with musculoskeletal limb conditions weighed between 20kg and 40kg, while a low percentage (8.5%, n=136) weighed between 40kg and 50kg as presented in Table 4.4. Of the dogs recorded with musculoskeletal conditions of the limbs, 57.2% (n=915) were males, while 42.8% (n=685) were females as presented in Figure 4.1. Over 82.5% (n=1,321) were intact (un-neutered), 16.5% (n=264) neutered and 1.0% (n=15) had their neuter status unknown. Regarding the use of the dogs, 82.1% (n=1,313) were pets, 2.5% (n=40) were guard dogs and 15.4% (n=247) were both pet and guard dogs as shown in Figure 4.2. The age distribution of dogs affected by musculoskeletal conditions of the limbs included 50.5% (n=808) adult dogs, 22.4% (n=358) puppies, 17.9% (n=286) senior dogs and 9.2% (n=148) geriatric dogs as shown in Tables 4.5, 4.6.

Large breeds were the most affected at 59.3% (n=948) followed by small breeds (27.8%) (n=445), medium breeds (11.3%) (n=180) and rarely the giant breeds (1.7%) (n=27). The German Shepherd breed had the highest occurrence at 22.7% (n=363) and the lowest recorded occurrence was Saint Bernard at 0.3% (n=5). The occurrence of various breeds as recorded is shown in Tables 4.7, 4.8, 4.9.

Only 77.1% (n=1,234) of the cases registered in the case records were recorded as lame and 21.0% (n=335) had no lameness, while 1.9% (n=31) were recumbent. The occurrence of musculoskeletal conditions was higher in the hind limb than in the

forelimbs at 48.0% (n=768) and 45.2% (n=723) of dogs respectively. The distribution of the conditions for the left and right limbs was 40.8% (n=653) and 40.6% (n=650) respectively of which the left hind limb (36.0%) (n=576) and right hind limb (33.7%) (n=540) were more affected than the right forelimb (30.3%) (n=486) and left forelimb (27.8%) (n=446).

Out of the 1,600 cases recorded with musculoskeletal limb conditions in the five veterinary clinics, 44.8% (n=717) had clinical findings indicated in the case records. Of these, the most occurring clinical finding was presence of pain at 42.5% (n=305), swelling at 25.5% (n=183) and inflammation at 17.3% (n=124). The least occurring clinical finding was muscle atrophy at 1.4% (n=10). The rest of the findings are presented in Table 4.10. Soft tissues were affected in 66.5% (n=1,064) of the cases, bones in 20.9% (n=335) and joints in 15.2% (n=244) of the cases as registered in the case records as seen in Table 4.11. The soft tissues affected included muscles, cruciate ligament and nerves in 10.3% (n=164), 1.5% (n=24) and 0.7% (n=11) of the cases respectively. The femur and pelvic bones were the most frequently affected bones at 4.3% (n=69) and 4.2% (n=67) respectively, while the scapula was the least frequently affected at 0.1% (n=2). The distribution of the other affected bones are presented in Table 4.12. The hip joint was the most frequently affected joint at 8.6% (n=138), while the least frequently involved joint was the tibiotarsal joint with a frequency of 0.1% (n=1). The frequencies of the rest of the joints are shown in Table 4.12.

Among the soft tissue injuries, 38.2% (n=406) were wounds, 18.2% (n=194) were muscle injuries, and 8.2% (n=87) were infections/inflammatory conditions. Other conditions are presented in Tables 4.13, 4.14. Whereas the most frequent joint condition was hip

dysplasia at 20.4% (n=78), while the joint condition with the lowest frequency was tendon rupture at 0.3% (n=1). The distribution of the joint conditions affecting the musculoskeletal system of dogs in the study is presented in Table 4.15.

The occurrence of fractures was higher on the hind limb compared to the forelimb at 6.4% (n=103) and 2.7% (n=44) respectively. Femoral, pelvic, and tibial fractures were more common fractures of the hind limbs, while radius, ulna, humerus and metacarpus were the bones involved in fractures of the forelimb. The percentages of occurrence of fractures in the various bones of the hind limbs and forelimbs are shown in Table 4.16.

The occurrence of neoplasia was 3.2% (n=49) of which osteosarcoma (1.1%) (n=17), papilloma (0.2%) (n=3) and lipoma (0.2%) (n=3) respectively were the most common tumors recorded Table 4.17. The occurrence of metabolic / nutritional disorders was of a low percentage (1.8%) (n=28) of which calcium deficiency (60.7%) (n=17) and vitamin / mineral deficiency (32.1%) (n=9) being the most common types of metabolic / nutritional disorder recorded whereas eclampsia and osteomalacia being the least common each with an occurrence of 3.6% (n=1) respectively.

Neurologic conditions had the lowest occurrence (1.2%) (n=19) compared to the other conditions, of which hindlimb paralysis (47.3%) (n=9), radial nerve paralysis (21.1%) (n=4) and hindlimb paresis (21.1%) (n=4) were the most common types of neurologic disorders recorded. The frequency of diagnosis accomplished using radiography was seen in 27.7% (n=443) of the cases as compared to the 72.3% (n=1,157) where radiography was not used.

Table 4.3: Occurrence of the causes of musculoskeletal limb conditions affecting the dogs presented to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Cause	Number of cases	Percentage (%) (n=1600)
Trauma	698	43.6
Neoplasia	49	3.1
Infection	7	0.4
Unspecified causes	846	52.9
Total	1600	100.0

Table 4.4: The weight range (kg) distribution among the cases of dogs presented with musculoskeletal limb conditions in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Weight range (kg)	Mean weight (kg)	Number of cases	Percentage (%) (n=1600)
0 – 5	3.15	79	4.9
5 – 10	7.36	316	19.7
10 – 15	11.4	133	8.3
15 – 20	17.2	129	8.1
20 – 25	22.0	133	8.3
25 – 30	27.3	173	10.8
30 – 35	31.9	242	15.1
35 – 40	36.4	211	13.2
40 – 45	41.4	96	6.0
45 – 50	46.5	40	2.5
50 – 55	51.4	20	1.3
55 – 60	56.4	7	0.4
60 – 65	61.5	9	0.6
> 65	80	1	0.1
Unknown	0	11	0.7
Total		1600	100.0

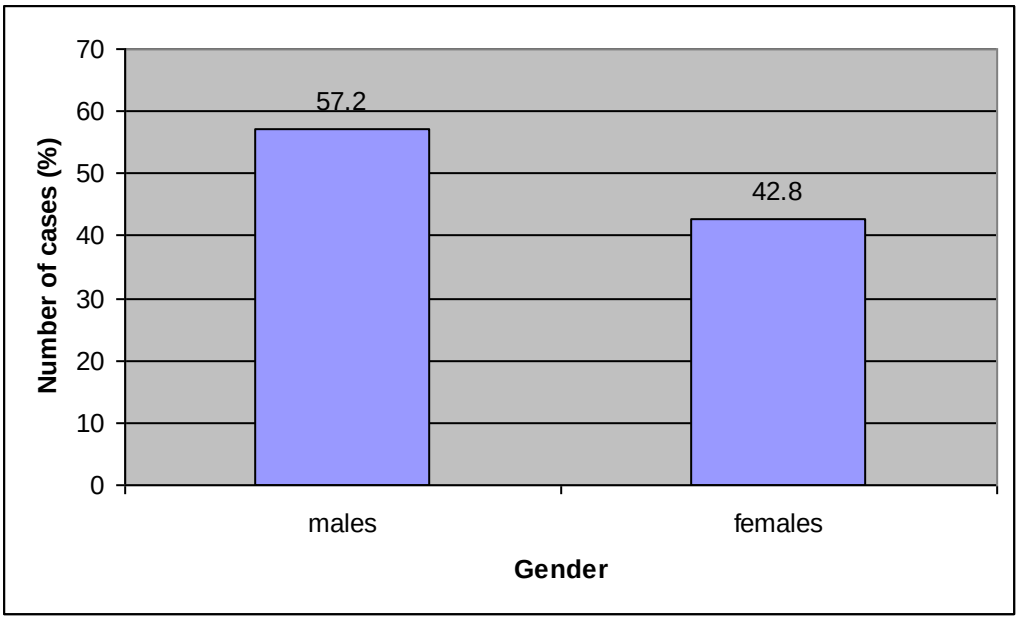

Figure 4.1: Occurrence of the gender of the dogs affected with musculoskeletal limb conditions presented to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

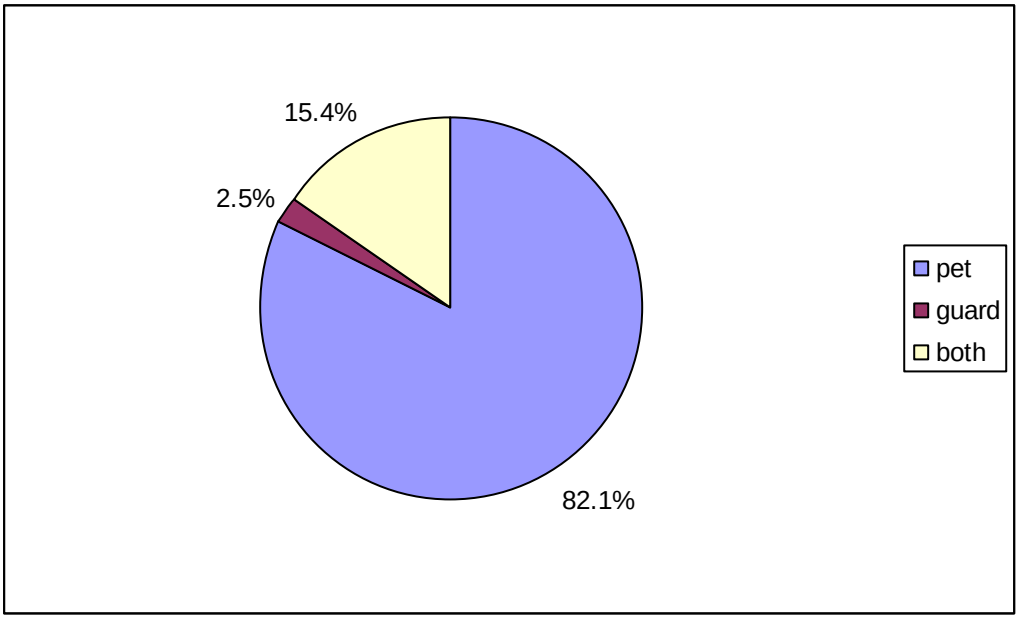

Figure 4.2: Occurrence of the use of the dogs affected with musculoskeletal limb conditions presented to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Table 4.5: The age grouping for dogs as adopted for use in this study. Borrowed from *Pet health network: how old is your dog in people years.* www.woofpurrpetsit.com.

Age range	Weight (Ibs)	Weight (kg)	Stage
0 – 18 months	All weights	All weights	Puppy
3 – 8 years	1 – 20 20 – 50	1 – 10 10 – 23	Adult
3 – 5 years	50 – 90 > 90	23 – 41 > 41	Adult
9 – 13 years	1 – 20	1 – 10	Senior
9 – 11 years	20 – 50	10 – 23	Senior
6 – 9 years	50 – 90 > 90	23 – 41 > 41	Senior
14 – 25 years	1 – 20	1 – 10	Geriatric
12 – 25 years	20 – 50	10 – 23	Geriatric
10 – 22 years	50 – 90	23 – 41	Geriatric
10 – 18 years	> 90	> 41	Geriatric

Table 4.6: Occurrence of musculoskeletal limb conditions per age category of dogs in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Age category	Number of cases	Percentage (%) (n=1600)
Puppy	358	22.4
Adult	808	50.5
Senior	286	17.9
Geriatric	148	9.2
Total	1600	100.0

Table 4.7: The table categorizing the dog breeds to their corresponding weight ranges, which was adopted for the current study. Borrowed from *www.dogtime.com*, *www.cuteness.com*.

Breed category	Weight (kg)	Specific Breeds
Small	1 – 10	Basenji, Chihuahua, Dachshund, Maltese, Poodle, Shitzu, Japanese spitz, Yorkshire terrier, Cavalier King Charles spaniel, Pug, Pomeranian, Lhasa Apso, French bulldog, Papillon, Jack Russell terrier
Medium	10 – 23	Spaniels, Staffordshire terrier, Welsh corgi, Standard schnauzers, Standard poodle, Siberian Husky, American pitbull
Large	23 – 41	Boxer, Collies, German Shepherd, Golden retriever, Labrador retriever, Rhodesian ridgeback, Dalmatian, Weimaraner, Visla, Rottweiler, Dobermann pinscher, Belgian shepherd, Swiss white shepherd
Giant	>41	Russian mountain dog, Great Dane, South African Boerboel, Saint Bernard, Pyrenean mountain dog, Caucasian shepherd

Table 4.8: The occurrence of musculoskeletal conditions of the limbs according to dog breed categories presented for treatment in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Breed category	Number of cases	Percentage (%) (n=1600)
Small breed	445	27.8
Medium breed	180	11.3
Large breed	948	59.3
Giant breed	27	1.7
Total	1600	100.0

Table 4.9: Occurrence of musculoskeletal limb conditions per specific breeds of dogs presented to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Specific breed	Number of cases	Percentage (%) (n=1600)
German Shepherd	363	22.7
German Shepherd cross	66	4.1
Cross breeds	197	12.3
Labrador Retriever	116	7.3
Labrador Retriever cross	17	1.1
Terrier and crosses	158	9.9
Jack Russell	83	5.2
Japanese Spitz	84	5.3
Japanese Spitz cross	46	2.9
Rottweiler	73	4.5
Rottweiler cross	23	1.4
Rhodesian Ridgeback	64	4.0
Golden Retriever	48	3.0

South African Boerboel	46	2.9
Dachshund	37	2.3
Great Dane	15	1.0
Dobermann Pinscher	14	0.9
Cocker Spaniel	12	0.8
Border Collie	9	0.5
Boxer	9	0.5
Pitbull	9	0.5
Lhasa Apso	8	0.5
Springer Spaniel	8	0.5
German Pointer	6	0.4
Pug	5	0.3
Saint Bernard	5	0.3
Unknown cases	79	4.9
Total	1600	100.0

Table 4.10: Occurrence of clinical findings presented by dogs affected with musculoskeletal limb conditions presented for treatment in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Clinical findings	**Number of cases**	**Percentage (%) (n=717)**	**Percentage (%) (n=1600)**
Pain	305	42.5	19.0
Swelling	183	25.5	11.4
Inflammation	124	17.3	7.8
Crepitation	49	6.8	3.1
Weak limbs	27	3.8	1.7
Irritation	19	2.7	1.2
Muscle atrophy	10	1.4	0.6
Total	**717**	**100.0**	**44.8**
Unspecified findings	883	0	55.2
Total	1600	0	100.0

Table 4.11: Occurrence of Musculoskeletal conditions involving different anatomical structures of the limbs of dogs that were presented for treatment in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Structure affected	**Number of cases**	**Percentage (%) (n=1600)**
Soft tissue	1064	66.5
Bone	309	19.2
Joint	244	15.2
Other structures	54	3.4
Other non limb structures	26	1.6
Unspecified structures	26	1.6
Total	1723*	107.7*

***Some of the cases had more than one anatomical structures involved in the limb conditions, hence total number exceeding the actual number of 1600 cases and also exceeding 100%.*

Table 4.12: Occurrence of musculoskeletal conditions in the specific anatomical structures of the limbs of dogs presented for treatment in the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Specific structure affected	**Number of cases**	**Percentage (%) (n=1600)**
Soft tissues		
Muscle	164	10.3
Cruciate ligament	24	1.5
Nerve	11	0.7
Tendon	3	0.2
Medial collateral ligament	2	0.1
Unspecified soft tissues	860	53.7
Soft tissues total	**1064**	**66.5**
Bones		
Femur	69	4.3
Pelvic bones	67	4.2
Tibia	35	2.2
Ulna	29	1.8
Radius	26	1.6
Humerus	26	1.6
Phalanges	23	1.4
Fibula	10	0.6
Metacarpus	7	0.4
Carpal bones	6	0.4
Metatarsus	5	0.3
Tarsal bones	4	0.3
Scapula	2	0.1
Bones total	**309**	**19.2**
Joints		

Hip joint	138	8.6
Stifle joint	32	2.0
Shoulder joint	29	1.8
Elbow joint	23	1.4
Carpal joint	15	0.9
Metacarpophalangeal joint	2	0.1
Sacrococcygeal joint	2	0.1
Hock joint	2	0.1
Tibiotarsal joint	1	0.1
Joints total	**244**	**15.2**
Other structures		
Nail	42	2.6
Dew claw	12	0.8
Other structures total	**54**	**3.4**
Other non limb structures		
Spinal cord	18	1.1
Shoulder	8	0.5
Other non limb structures total	**26**	**1.6**
Unspecified structures	26	1.6
Total	**1723***	**107.7***

***Some of the cases had more than one anatomical structures involved in the limb conditions, hence total number exceeding the actual number of 1600 cases and also exceeding 100%.*

Table 4.13: Occurrence of musculoskeletal conditions affecting limbs of dogs presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Musculoskeletal limb conditions	**Number of Cases**	**Percentage (%)(n=1600)**
Soft tissue conditions	1064	66.5
Joint disease	382	23.9
Fractures	167	10.4
Neoplasia	49	3.1
Metabolic / Nutritional disorders	28	1.8
Neurologic conditions	19	1.2
Unspecified conditions	14	0.8
Total:	1723*	107.7*

** Some cases had more than one musculoskeletal condition hence the number exceeding the actual total 1600 cases and more than 100%.*

Table 4.14: Occurrence of various soft tissue conditions affecting limbs of dogs presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Soft tissue conditions	**Number of cases**	**Percentage (%) (n=1064)**	**Percentage (%) (n=1600)**
Wounds			
Fight / bite wounds	103	9.7	6.4
Cut	59	5.5	3.7
Septic wounds	30	2.8	1.9
Puncture wounds	28	2.6	1.7
Foreign body	16	1.5	1.0
Laceration wounds	8	0.8	0.5
Pressure sores	6	0.6	0.4
Abrasion wounds	4	0.4	0.3
Burn	1	0.1	0.1
Unspecified wounds	151	14.2	9.4
Total	**406**	**38.2**	**25.4**
Muscle injury			
Muscle sprain / strain	190	17.8	11.8
Traumatic injury	4	0.4	0.3
Total	**194**	**18.2**	**12.1**
Infectious / Inflammatory			
Abscess	37	3.4	2.3
Seroma	12	1.1	0.7
Hygroma	7	0.7	0.4
Cellulitis	7	0.7	0.4
Hematoma	6	0.6	0.4
Myositis	5	0.5	0.3
Bursitis	5	0.5	0.3

Cyst	4	0.4	0.3
Tendonitis	2	0.2	0.1
Periostitis	1	0.1	0.1
Epiphysitis	1	0.1	0.1
Total	**87**	**8.2**	**5.4**
Other conditions			
Nail injury	54	5.0	3.4
Eczema	53	5.0	3.3
Allergic reaction	5	0.5	0.3
Pododermatitis	5	0.5	0.3
Unspecified injuries	260	0.2	16.3
Total	**377**	**11.2**	**23.6**
Total	**1064**	**100.0**	**66.5**

Table 4.15: Occurrence of various joint conditions affecting limbs of dogs presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Joint condition	**Number of cases**	**Percentage (%) (n=382)**	**Percentage (%) (n=1600)**
Joint disease			
Hip dysplasia	78	20.4	4.8
Arthritis	68	17.9	4.3
Hip degeneration	25	6.5	1.6
Spondylosis	4	1.0	0.3
Osteochondritis Dissecans	3	0.8	0.2
Legg-Perthes disease	2	0.5	0.1
Spondylitis	2	0.5	0.1
Total	**182**	**47.6**	**11.4**
Soft tissue injury			
Joint injury	85	22.3	5.3
Anterior cruciate ligament damage	23	6.0	1.4
Digit injury	14	3.6	0.9
Traumatic injury	5	1.3	0.3
Medial collateral ligament damage	2	0.5	0.1
Posterior cruciate ligament damage	1	0.3	0.1
Tendon rupture	1	0.3	0.1
Total	**131**	**34.2**	**8.2**

Dislocations			
Hip dislocation	28	7.3	1.7
Patella luxation	10	2.6	0.6
Shoulder dislocation	4	1.0	0.25
Femoral head dislocation	4	1.0	0.25
Carpal dislocation	2	0.5	0.1
Elbow dislocation	2	0.5	0.1
Phalangeal dislocation	1	0.3	0.1
Sacrococcygeal joint dislocation	1	0.3	0.1
Metacarpophalangeal joint dislocation	1	0.3	0.1
Total	**53**	**13.8**	**3.3**
Bone involvement			
Bone infection – osteomyelitis	7	1.8	0.4
Bone cyst	1	0.3	0.1
Total	**8**	**2.1**	**0.5**
Other conditions			
Spinal cord degeneration	2	0.5	0.1
Intervertebral disc prolapse	1	0.3	0.1
Unspecified injuries	5	1.3	0.3
Total	**8**	**2.1**	**0.5**
Total	**382**	**100.0**	**23.9**

Table 4.16: Occurrence of fractures of various bones of the limbs and the adjoining trunk of the dogs that were presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Fracture	**Number of cases**	**Percentage (%)(n=167)**	**Percentage (%)(n=1600)**
Hindlimb			
Femur	43	25.7	2.6
Pelvis	32	19.2	2.0
Tibia	20	11.9	1.3
Tibia/Fibula	4	2.4	0.25
Metatarsus	4	2.4	0.25
Total	**103**	**61.6**	**6.4**
Forelimb			
Radius and ulna	15	8.9	0.9
Humerus	11	6.6	0.7
Ulna	7	4.2	0.4
Radius	5	3.0	0.3
Metacarpus	5	3.0	0.3
Carpal bones	1	0.6	0.1
Total	**44**	**26.3**	**2.7**
Other fractures			
Phalanges	7	4.2	0.4
Coccygeal vertebrae	2	1.2	0.1
Shoulder	1	0.6	0.1
Lumbar vertebrae	1	0.6	0.1
Sacrococcygeal	1	0.6	0.1

joint			
Total	**12**	**7.2**	**0.8**
Unspecified fractures	8	4.7	0.5
Total	**167**	**100.0**	**10.4**

Table 4.17: Occurrence of the types of neoplasms affecting the limbs of dogs presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Neoplasia and Tumour growths	**Number of cases**	**Percentage (%) (n=49)**	**Percentage (%) (n=1600)**
Osteosarcoma	17	34.7	1.1
Papilloma	3	6.1	0.2
Lipoma	3	6.1	0.2
Mast cell tumor	2	4.1	0.1
Melanoma	1	2.0	0.1
Polyp	1	2.0	0.1
Unspecified growths	22	44.9	1.4
Total	49	100.0	3.1

4.3 Treatment/management and outcomes of musculoskeletal limb conditions in dogs

The study findings revealed that the frequency for use of antibiotics was 74.7% (n=1,196), use of corticosteroids 60.4% (n=966) and non-steroidal anti-inflammatory drugs 47.6% (n=762). Other medical and conservative therapeutic interventions used included confinement with limited exercise in 22.8% (n=365) of the cases, and injectable multivitamin and supplements in 9.3% (n=149) of the cases. The treatment modalities are presented in Table 4.18. The most frequently used corticosteroid was Dexamethasone at 55.3% (n=884) of the cases. The most frequently used NSAID was phenylbutazone at 30.4% (n= 487) of the cases. The other corticosteroids and NSAIDs used are presented in Table 4.19.

General anesthesia and sedation were the most frequently used protocol during surgery as compared to local / regional anesthesia. Surgical preparation of wounds mostly involved cleaning and shaving, which entailed either aseptic surgical preparation or wound management.

The surgical procedures carried out in dogs diagnosed with musculoskeletal limb conditions involved suturing in 10.4% (n=167) of the cases, fracture repair and fixation in 3.1% (n=49) of the cases using bone plates / screws and IM pins / cerclage wires, lancing / draining of abscesses and seromas in 2.3% (n=37) of the cases and lumpectomy in 1.4% (n=23) of the cases. Other less frequent surgical procedures carried out in the study are presented in Table 4.20.

Complications were reported in 15.1% (n=241) of the cases with musculoskeletal limb conditions. In contrast, 78.7% (n=1,259) of dogs with musculoskeletal limb conditions in the study had no complications. In 6.2% (n=100) of the cases, there was no information

in the medical records indicating whether complications were encountered or not. Certain hindrances to effective management of musculoskeletal limb conditions found registered in the case records included aging dogs (5.9%) (n=94), non-compliant dog owners (2.7%) (n=44), non-confinable dogs (2.5%) (n=40) and recurrence (1.9%) (n=31) as seen in Table 4.21.

The findings of this study established that 87.3% (n=1,396) of cases diagnosed with limb conditions recovered following treatment. In contrast, 7.8% (n=125) did not recover and were either euthanized or died as presented in Table 4.22.

Table 4.18: Occurrence of the various drugs used in the medical / conservative management of dogs affected with musculoskeletal limb conditions that were presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Treatment	**Number of cases**	**Percentage (%) (n=1600)**
Antibiotic	1196	74.7
Corticosteroids	966	60.4
NSAIDs*	762	47.6
Confinement / limited exercise	365	22.8
Multivitamin supplementation	149	9.3
Hot fomentation	93	5.8
Calcium supplementation	83	5.2
Glucosamine chondroitin	51	3.2
Weight control	18	1.1
Euthanasia	81	5.1
Total	3764*	235.2*

***Some of the cases used more than one drug in the management of the condition hence total number exceeding the actual number of 1600 cases and also exceeding 100%.*

** NSAIDs – Non-steroidal anti-inflammatory drugs*

Table 4.19: Occurrence of the various Corticosteroids and NSAIDs used in the medical / conservative management of dogs affected with musculoskeletal limb conditions that were presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Drug	**Number of cases**	**Percentage (%) (n=1600)**
Corticosteroid		
Dexamethasone	884	55.3
Prednisolone	116	7.3
Total	**1000**	**62.6**
NSAID		
Phenylbutazone	487	30.4
Carprofen	403	25.2
Meloxicam	104	6.5
Flunixin meglumine	27	1.7
Mefenamic acid	13	0.8
Firocoxib	8	0.5
Diclofenac	5	0.3
Total	1047	65.4

***Some of the cases used more than one drug in the management of the condition hence total number exceeding the actual number of 1600 cases and also exceeding 100%.*

Table 4.20: Occurrence of the different surgical procedures used in the surgical management of dogs affected with musculoskeletal limb conditions that were presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Surgical procedure	**Number of cases**	**Percentage (%) (n=1600)**
Wounds sutured	167	10.4
Fracture repair using IM pins/cerclage wires, bone plates/screws	49	3.1
Abscess / seroma lanced and drained	37	2.3
Lumpectomy / growth excision	23	1.4
Dew claw amputation	17	1.1
Limb / digit amputation	12	0.8
Cruciate ligament / tendon repair	12	0.8
Femoral head excision	11	0.7
Foreign body removal	11	0.7
Dislocation replaced	10	0.6
Other surgeries	10	0.6
Not surgically managed	1230	76.9
Unspecified cases	11	0.6
Total	1600	100.0

Table 4.21: Occurrence of the cases of dogs with musculoskeletal limb conditions that encountered any hindrances in effective management when presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Hindrances to effective management of the cases	**Number of cases**	**Percentage (%) (n=1600)**
Old age	94	5.9
Non-compliant dog owners	44	2.7
Non-confinable dogs	40	2.5
Condition recurrence	31	1.9
Wound / suture dehiscence	4	0.3
Non tolerating of casts / bandages	4	0.3
Over tight casts / bandages	3	0.2
Post operative infection	2	0.1
Other hindrances	2	0.1
Unknown hindrances	98	6.1
No hindrances	1488	93.0
Total	1810*	113.1*

***Some of the cases had multiple hindrances in the management of the condition hence total number exceeding the actual number of 1600 cases and also exceeding 100%.*

Table 4.22: The outcomes of dogs affected with musculoskeletal limb conditions that were presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Outcomes	**Number of cases**	**Percentage (%) (n=1600)**
Recovered	1396	87.3
Euthanized	81	5.1
Died	12	0.7
Not recovered	32	2.0
Not specified	79	4.9
Total	1600	100.0

4.4 The treatment methods for musculoskeletal limb conditions of dogs that influence outcomes

With significance level at $p < 0.05$, the study revealed that recovery of dogs with musculoskeletal limb conditions was significantly influenced by treatment with antibiotics (p=0.000), corticosteroids (p=0.000), NSAIDs (p=0.000), multivitamins (p=0.000), calcium injectable/supplement (p=0.000), and Glucosamine chondroitin (p=0.000). Other management protocols that significantly influenced recovery of dogs with musculoskeletal limb conditions are shown in Table 4.23.

Table 4.23: Hypothesis test to determine the proportions between the various drugs/treatment methods used that influence the outcomes of musculoskeletal limb conditions in dogs presented for treatment to the five veterinary clinics in Nairobi County, Kenya from January 2009 to December 2018.

Drug	**Outcomes**			**z - value**	**p - value**
	Cases recovered	**Cases not recovered**	**Total**		
Antibiotics	1114	46	1160	113.62	0.000
Corticosteroids	891	45	936	91.40	0.000
NSAIDs	675	47	722	66.99	0.000
Multivitamin injectable/supplement	115	23	138	14.86	0.000
Calcium injectable/supplement	71	5	76	21.59	0.000
Glucosamine chondroitin	39	9	48	7.84	0.000
Hot fomentation	89	1	90	62.57	0.000
Limited exercise	344	6	350	98.42	0.000
Overweight	13	5	18	2.98	0.0029
Not overweight	1381	120	1501	84.86	0.000

Significance level at $p < 0.05$

CHAPTER FIVE

5.0 DISCUSSION

This is the first descriptive study carried out to determine the occurrence, etiology, clinical findings, diagnosis, management and outcomes of musculoskeletal conditions affecting the limbs of dogs seen in selected veterinary practices in Kenya.

The sample size of 1,600 dogs with musculoskeletal limb conditions was smaller than the 3,884 dogs in a study in England (O'Neill *et al.,* 2014) and 471,690 dogs in a study in New York (Johnson *et al.,* 1994). This may probably be attributed to a smaller dog population in the study area, Nairobi County, Kenya, lack of awareness and keenness in seeking veterinary professional services for dogs by their owners and incomplete record keeping encountered in the veterinary practices.

The occurrence of 40.0% musculoskeletal limb conditions in dogs in the current study using data over a 10 year period was higher than the 11.8% in England over a 5 year period (O'Neill *et al.,* 2014), 6.8% in Bangladesh over a one year period (Tarafder and Samad, 2010) and 24.0% in New York over a 10 year period (Johnson *et al.,* 1994). Speculative reason for this is probably the negligence for good care of the dogs including nutrition, housing conditions coupled with failure to offer prompt veterinary attention. This may increase the percentage of dogs developing musculoskeletal limb conditions, hence higher numbers presented to the veterinary clinics. As a result of increased need for access to security services and pet dogs in the urban Nairobi City County with improved awareness of their care, it evidently resulted in a higher number of dogs being taken to the veterinary clinics for treatment in the latter years. Hence highest percentages recorded for 2014 and 2018.

The relatively higher occurrence of limb conditions in 2014 and 2018 than the other years in the current study period may probably be due to a higher caseload of dogs presented to the veterinary clinics during these two years. Hence a higher likelihood of more dogs with limb conditions than the other years with lower caseload.

The finding of a higher occurrence of trauma (43.6%) as the cause of musculoskeletal limb conditions in the current study agrees with a previous study in Santa Maria, Brazil (Libardoni *et al.,* 2016) whereby 72.2% of the cases of appendicular fracture were caused by car accidents as was also seen in a study by Rhangani (2014) whereby 54% of fractures were caused by unknown trauma and 20% by road traffic accidents, and in New York (Johnson *et al.,* 1994) whereby 75% of the fractures or bone diagnoses were caused by traumatic injuries as well. This could be because of many dogs disappearing and getting into fights, getting run over by cars, and falling or slipping when running. Neoplasia (3.1%) was one of the least common causes of limb conditions in the current study which may be comparable to the findings by Johnson et al. (1994) who reported the incidence of neoplasia to be 6.5 cases per 1000 dog patients. This could be because of fewer cases being recorded at the veterinary practices and owners unwilling to pay for specialized diagnostic tests for confirmation of neoplasia hence lesser cases recorded.

The observation in the current study of pet dogs having a higher occurrence (82.1%) of limb conditions than guard dogs (2.5%) contrasts previously reported incidences of lameness and musculoskeletal disorders in other countries in which police dogs were observed to have a high incidence. These incidences included 36–44% in New York and Pennsylvania respectively (Fox *et al.,* 2008; Parr and Otto, 2013), 28% in UK (Caron-Lormier *et al.,* 2016) and 20–25% in New Zealand (Baltzer, *et al.,* 2019). The low

prevalence (6.81%) of musculoskeletal disorders in pet dogs in Bangladesh (Tarafder and Samad, 2010) also contrasts the high occurrence in pet dogs in the present study. The higher occurrence of pet dogs with limb conditions could be explained by the higher population and concern for pet dogs than guard dogs by the Nairobi County dog owners, hence presenting their pet dogs to the clinics than guard dogs. However, despite the countries cited above having higher population of pet dogs, the police and guard dogs get more injuries by the nature of their use compared to pet dogs, which receive tender care in the homes, hence lower incidence of conditions that would cause lameness.

The observation of high occurrence of limb conditions in adult dogs (51.0%) and in puppies (22.0%) tend to be similar to a previous study in which most of the dogs affected with musculoskeletal disorders were either less than one year old or more than 6 years old (Mohsina *et al.*, 2014). Conversely, it is higher than the low prevalence found in pet dogs in Bangladesh where it ranged from 1.36% to 3.90% in dogs from 6 months old to those older than 36 months (Tarafder and Samad, 2010). The adult dogs and puppies have a life full of activity compared to senior and geriatric dogs, hence the likelihood of limb injuries and developing of other limb conditions.

The finding of higher occurrence of limb conditions in males (57.2%) than females (42.8%) and that of entire dogs (82.5%) higher than neutered dogs (16.5%) agree with a previous study carried out in the UK where prevalence of disorders in dogs for females was 47.0%) and for neutered dogs was 44.7% (O'Neill *et al.*, 2014). Similarly, a study by Mohsina et al. (2014) reported that in all breeds except Labradors, males had a higher prevalence than females. The higher occurrence in males than females may probably be attributed to more males being kept by Nairobi County residents as a matter of

preference. Most of these male dogs are left entire due to belief that when neutered they would become docile, thus similarly more population of entire males. Male dogs, especially entire males are also more aggressive and fight among each other than females especially during the mating season, hence prone to injuries.

The preference for large breed dogs especially the German Shepherds for keeping by the Nairobi County residents is the most likely reason for higher occurrence of limb conditions in the large breeds than the various small breeds observed in the current study. This differs from the study done by Mohsina et al. (2014) that recorded the incidence of musculoskeletal disorders being high in Mongrels at 37% followed by German Shepherds (29%), Spitz (20%), and other breeds (14%) especially during the period of their rapid growth up to two years of age. The reason for this being preference of breeds for keeping similar to the Nairobi County situation. The report in a study done in Bangladesh on musculoskeletal disorders is similar but with very low incidences reported in Local breeds (2.6%), German Shepherds (1.4%), Lhasa Apso (0.7%), Dobermann (0.4%), Samoyed (0.3%), Japanese Spitz (0.3%), Boxer (0.3%), Poodle (0.2%), Spaniel (0.1%), and Dachshund (0.1%) (Tarafder and Samad, 2010).

In this study, the occurrence of lameness was found to be 77.1%, which is higher than the prevalence reported previously in other places as 56.0% in India (Mohsina *et al.,* 2014) and 17.5% in United Kingdom (O'Neill *et al.,* 2014). The reason for the higher occurrence is probably low level of care of dogs by the owners in Nairobi County compared to those developed countries where dog owners have much value for them. However, the occurrence of limb conditions in the hind and fore limbs as well as right

and left limbs closely compares with the one found by these previous authors (Mohsina *et al.,* 2014; O'Neill *et al.,* 2014).

Pain, swelling and inflammation symptoms found in the case records of dogs gave an indication that most of the limb conditions affecting the dogs presented to the veterinary clinics in Nairobi County involved an element of trauma. This was similar to previous reports, which had the same nature of symptoms of inflammation and swelling (O'Neill *et al.,* 2014). Other authors have cited specific conditions that were manifested by dogs but whose symptoms involve inflammation as part of their pathogenesis (Egenvall *et al.*, 2000; Schmidli *et al.,* 2018).

The finding that limb conditions had a high involvement of the soft tissues (66.5%), bones (20.9%) and Joints (15.4%) in that order, was similar to previous reports in which the same anatomical structures were involved but the frequencies of involvement for the various tissues was different. In the previous reports, the frequencies were 47%, 39% and 14% for joints, bones and soft tissues respectively (Johnson *et al.*, 1994).

The soft tissue conditions included mainly wounds, inflammation and infection in muscular tissue and the skin, which is also similar to a previous study except that the frequencies of occurrence of the conditions on the muscles and skin was low (Johnson *et al.,* 2014). The difference between the high frequency of soft tissue involvement in the present study, which is mainly injuries and the low frequency in previous reports, suggests better care for dogs in countries where previous studies were done than in Nairobi County.

For the joint conditions, the finding of involvement of hip dysplasia, hip degeneration and osteoarthritis with occasional joint sprain and anterior cruciate ligament damage,

corroborates previous reports of similar involvement of the specific joint structures (Johnson *et al.*, 1994; Mohsina *et al.*, 2014).

For bone involvement, the occurrence of fractures (10.4%) was closely comparable to a previous study specifically on fractures of dogs in Nairobi City County that found a prevalence of 14.7% (Rhangani, 2014). The prevalence of fractures was much lower than 29% found by Johnson et al. (1994) in New York. However, the findings of the current study and the two previous studies mentioned above, all agree with the observation that the hind limbs had higher frequency of fracture occurrence than the forelimbs, with higher frequency of involvement of femur and pelvis than the other bones. It can be speculated that the high frequency of fractures of the proximal bones of the hind limbs is associated with probable causes of the fractures, such as accidents in which dogs may be hit on the rear limbs while trying to escape from the accident cause.

Neoplasia had a low occurrence of 3.1% of the dogs, which may be comparable to the findings by Johnson et al. (1994) who reported the incidence of neoplasia to be 6.5 cases per 1000 dog patients. These authors stated that neoplasia is the second most common musculoskeletal disorder with osteosarcomas (65%) being the most common neoplasm recorded in dogs. Additionally, another study recorded the most prevalent neoplasm in Kennel Club registered dogs to be lipomas (4.3%) (Wiles *et al.*, 2017). The low occurrence of neoplasia could be due to a small random sample size recorded from the 5 veterinary practices, as well as dog owners unwilling to pay for further diagnostic tests to confirm neoplasia hence more unspecified diagnoses are recorded.

Similar to the findings by Mohsina et al. (2014) of low incidence (1.2%) of metabolic/nutritional disorders and neurologic conditions affecting musculoskeletal

system of dogs, the current study recorded a very low occurrence (1.8%) for these disorders. The low occurrence may probably be contributed by failure to conclusively diagnose the problems as a result of not taking and testing the needed samples.

Radiography was used for diagnosis in 27.7% of the cases according to the case records. This low frequency of use of radiography may be due to absence of X-ray facilities in the number of veterinary clinics where the retrospective study was carried out and also the unwillingness of both the veterinarians and dog owners for referral to the other places for radiography. Mohsina et al. (2014) suggested that radiography and blood parameters are reliable methods of diagnosing skeletal, muscular and nervous problems. In a study done in 180 dogs, it was suggested that computed tomography (CT) and arthroscopy are reliable non-invasive methods to complement radiography in making diagnosis of musculoskeletal conditions (Villamonte-Chevalier *et al.,* 2015). Although ultrasonography is significantly faster than CT and radiography in diagnosing bone problems especially fracture union (Risselada *et al.,* 2018), shortage of specialized imaging facilities in the Veterinary Clinics of the Nairobi County might have explained the observed lack of its use in the current study.

In the current study the high use of antibiotics to treat limb conditions was similar to findings by other investigators in Spain who reported frequent use of antibiotics to treat musculoskeletal conditions. However, these previous researchers reported a high use of human medicines such as beta-lactams, amoxicillin and clavulanic acid, and aminoglycosides (Gómez-Poveda and Moreno, 2018).

The frequent use of corticosteroids in the current study is contrasted by previous reports that use of dexamethasone impairs or affects the inflammatory phase of the skeletal

muscle regeneration more than the repair phase of regeneration therefore reducing the regenerating capacity of the skeletal muscles and therefore the drug should be used based on a risk-benefit assessment (Otrocka-Domagala *et al*., 2019).

The use of non-steroidal anti-inflammatory drugs (NSAIDs) in the management of musculoskeletal limb conditions in the current study agrees with another study by Monteiro et al. (2019) which reported that reduced-doses of ketoprofen can be used in the treatment of osteoarthritis with or without tramadol as it provides adequate analgesia and is safe to use alone. The use of NSAIDs is important in the management of osteoarthritis in dogs and the use of Firocoxib provides a high level of analgesia as compared to grapiprant which is a new NSAID (Alcalá *et al.,* 2019). Canine obesity is associated with chronic inflammation which plays a role in the development of various conditions such as osteoarthritis in dogs and therefore managing obesity would help in reducing the occurrence of certain obesity-associated diseases and therefore the management costs associated with these conditions (Sanderson, 2012).

Furthermore, rehabilitation therapy for musculoskeletal and spinal diseases helps restore normal tissue physiology and biological function. Employing exercises as was observed in the present study is an important therapeutic method for restoration of musculoskeletal/nervous conditions. This was similarly recommended by Owen (2006). This author recommended a variety of therapeutic exercises including posture exercises, controlled leash activities, negotiating stairs and obstacles, dry treadmill locomotion, dancing and wheel-barrowing, controlled playing with obstacles, reaching for toys/food and aquatic therapy (swimming and walking in water). Other recommended forms of

therapy for restoration of musculoskeletal function in the dogs include cryotherapy, heat therapy, and electrical stimulation (Owen, 2006).

The need for alternative methods of management such as use of acupuncture and herbal extract mixtures as described by Silva et al. (2017) and Comblain et al. (2017) can help reduce pain and improve wellness and quality of life in dogs suffering from various limb conditions. It was noted that a combination of drugs / therapies helped in the management and recovery of dogs affected with musculoskeletal limb conditions in the present study.

The limitations in the current study included; inaccessibility to records of certain veterinary practices for research purposes due to professional rivalry, inadequate record keeping in the veterinary practices and incomplete records therefore posing a challenge to establish a more precise occurrence of limb conditions in dogs in Nairobi County. The results obtained were therefore purely based on data available from the records retrieved as recorded by the attending practitioners, and unaltered by the investigator. Keeping this limitation in mind, veterinary clinic data management should be standardized and computerized to improve record keeping. Non compliance of owners, lack of adequate; expertise/skills, diagnostic equipment / limited resources in some veterinary practices affected proper diagnosis of some cases as well.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The following are the main conclusions made from this study:

a) The occurrence of limb conditions in dogs in Nairobi County, Kenya is relatively high with the number of dogs being affected having increased over the years.

b) Trauma was the most common recorded cause of musculoskeletal limb conditions whilst neoplasia, and infections were the least common and the rest of the cases had unspecified causes.

c) The occurrence of limb conditions is higher in adult dogs and puppies, males than females and in entire dogs than neutered dogs with pet dogs being more affected than guard dogs.

d) Large breed and small breed dogs were the most affected breeds.

e) Most dogs affected with limb conditions had lameness and the hind limbs were more frequently affected than the forelimbs.

f) The most common limb conditions were soft tissue injuries of which wounds were most common, joint conditions of which canine hip dysplasia was commonest and fractures.

g) The use of radiography in diagnosis of limb conditions was low. Most cases were diagnosed through physical observation and manipulative palpation of the limbs.

h) Surgical procedures done mostly for suturing of soft tissue injuries and fixing fractures. Whereas Medical/conservative management of limb conditions involved the use of; antibiotics, corticosteroids, Non-steroidal anti-inflammatory drugs, multivitamins, calcium supplements, glucosamine chondroitin, hot fomentation, and occasionally physical rehabilitation through confinement and limited leash exercises which all significantly affected the outcome with more dogs recovering with their use. A combination of these drugs / therapies helped in the management of dogs with limb conditions enhancing their recovery.

i) Most of the cases recovered and only a few either died or were euthanized.

j) One of the major challenges encountered was inaccessibility to some selected clinics and their records due to professional competition between private practitioners and poor record keeping in the veterinary clinics.

6.2 RECOMMENDATIONS

The following are the recommendations made from the study:

a) The veterinary clinics should invest on improving diagnostic methods by acquiring specialized diagnostic facilities such as X-ray equipment, Ultrasound systems and arthroscopic facilities.

b) Record keeping should be improved in the veterinary clinics and the records should capture all the relevant history, clinical findings, management and outcomes of the patients.

c) Veterinary clinics to be more professional and allow access to their records to students for research purposes regardless of professional rivalry as the research benefits all veterinary professionals and students.

d) Educating dog owners on welfare and the need of seeking veterinary professional attention for their dogs especially when they show sickness. This will avoid neglecting sick dogs or taking them to the clinic too late.

e) Further investigation using control studies will bring a better understanding, better diagnosis and management of musculoskeletal conditions.

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8.0 APPENDICES

8.1 Appendix I: Data Collection Sheet I

Practice ID:	Case number:	Age:	Sex:	Breed:	Weight:	Use of animal:	Cause:	Limb affected:	Structure(s) or region affected:	Clinical signs:	Diagnostic aids used:	Diagnosis:

8.2 Appendix II: Data collection sheet II

Practice ID:	Case number:	Diagnosis:	Management technique:		Complications:	Outcome:		
			Conservative:	Surgical:		Recovered:	Died:	Euthanized: