UNIVERSITI PUTRA MALAYSIA

A RETROSPECTIVE STUDY OF ELBOW OSTEOARTHRITIS (OA) IN CATS AT THE UNIVERSITY VETERINARY HOSPITAL, UNIVERSITI PUTRA MALAYSIA (UVH-UPM) FOR YEAR 2015 TO 2020.

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CERTIFICATION

It is hereby certified that we have read this project paper entitled "A Retrospective Study of Elbow Osteoarthritis (OA) in Cats at the University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) for year 2015 to 2020" by Nurdarina Zahar and in my opinion, it is satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirement for the course VPD 4999-Final Year Project

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DEDICATIONS

The project paper is dedicated to all ailurophiles and small animal practitioners

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Abbreviations	Meaning
%	Percentage
BCS	Body condition score
BW	Body weight
CM	Castrated male
DLH	Domestic Long Hair
DSH	Domestic Short Hair
F	Female
M	Male
OA	Osteoarthritis
SF	Spayed female
SSB	Supinator Sesamoid Bone
UPM	Universiti Putra Malaysia
UVH	University Veterinary Hospital
IL-1 & IL-6	Interleukin-1 & Interleukin-6
TNF- alpha	Tumour Necrosis Factor-alpha

KAJIAN RADIOLOGI RETROSPEKTIF OSTEOARTRITIS (OA) SENDI SIKU FELIN DI HOSPITAL VETERINAR UNIVERSITI , UNIVERSITI PUTRA MALAYSIA (UVH-UPM) UNTUK TAHUN 2015 HINGGA 2020

ABSTRAK

Kajian ini bertujuan untuk menentukan prevalens dan faktor risiko sendi siku Osteoartritis (OA) pada kucing. Radiografi digital dan rekod klinikal kucing di Hospital Veterinar Universiti (UVH-UPM) dari tahun 2015 hingga 2020 telah diambil. Radiografi dada yang merangkumi pandangan lateral sendi siku telah dipilih. Ciri-ciri radiografi yang dinilai merangkumi osteopit, peningkatan radio-kelegapan di bawah takik semilunar ulnar, kehadiran tulang sesamoid supinator, kehadiran enthesopit di luar sendi, mineralisasi tisu lembut yang tidak normal, efusi sinovial, perubahan ruang sendi dan pembentukan semula sendi. Sebanyak 100 kucing dimasukkan. Keseluruhan prevalens OA sendi siku adalah 52% (52/100). Pembentukan osteopit, peningkatan radio-kelegapan di bawah takik semilunar ulnar dan kehadiran tulang sesamoid supinator adalah ciri biasa. Enthesopit dan pembentukan semula sendi, bagaimanapun, tidak biasa. Purata umur (SD) kucing dengan OA adalah 8.5 (3.9) tahun. Perbezaan usia antara OA dan kucing normal adalah signifikan ($P<0.05$). Purata berat badan (SD) kucing dengan OA adalah 3.9 (1.0). Tidak ada perbezaan yang ketara dalam berat badan antara OA dan kucing normal ($P>0,05$). Pada kucing OA 67% adalah domestik bulu pendek, 2% adalah domestic bulu panjang dan 31% adalah kucing pedigri. Enam kucing OA adalah jantan, 16 kucing jantan kembiri, 12 kucing betina dan 18 kucing betina mandul. Prevalens OA sendi siku tidak berbeza mengikut keturunan X^2 (18, N = 100) = 16.3 ($P>0.05$) dan jantina X^2 (8, N = 100) = 7.20 ($P> 0.05$) masing-masing. Kesimpulannya, terdapat prevalens OA sendi siku yang tinggi dan berkait dengan usia.

Kata kunci: osteoartritis, sendi siku, prevalens, faktor risiko, kucing.

A RETROSPECTIVE RADIOLOGICAL STUDY OF ELBOW OSTEOARTHRITIS (OA) IN CATS AT THE UNIVERSITY VETERINARY HOSPITAL, UNIVERSITI PUTRA MALAYSIA (UVH-UPM) FOR YEAR 2015 TO 2020

ABSTRACT

This study aimed to determine the prevalence and risk factors of elbow OA in cats. The digital radiographs and clinical records of cats presented to the University Veterinary Hospital (UVH), UPM from 2015 to 2020 were retrieved. Chest radiography that included a lateral view of the elbow joint was selected. The assessed radiographic features include osteophytes, increased radio-opacity beneath the ulnar semilunar notch, presence of supinator sesamoid bone, presence of extra-articular enthesophytes, abnormal soft tissue mineralization, synovial effusion, changes of joint space and joint remodeling. A total of 100 cats were included. The overall prevalence of elbow OA was 52% (52/100). Osteophytes formation, increased radio-opacity beneath the ulnar semilunar notch and presence of supinator sesamoid bones were common features. Enthesophytes and joint remodeling, however, were uncommon. The mean (SD) age of cats with OA was 8.5 (3.9) years. The age difference between the OA and normal cats was significant ($P<0.05$). The mean (SD) bodyweight of cats with OA was 3.9 (1.0). There was no significant difference in bodyweight between the OA and normal cats ($P>0.05$). In the OA cats 67% were Domestic Short Hair, 2% were Domestic Long Hair and 31% were pedigree cats. Six OA cats were male, 16 cats were castrated male, 12 cats were female and 18 were spayed female. The prevalence of elbow OA did not differ by breed X^2 (18, N=100) = 16.3 ($P>0.05$) and sex X^2 (8, N=100) =7.20 ($P>0.05$) respectively. In conclusion, there was a high prevalence of elbow OA, which was associated with age.

Keywords: osteoarthritis, elbow joint, prevalence, risk factors, cat.

CHAPTER 1

INTRODUCTION

1.1 Background

Osteoarthritis (OA), particularly in older patients, is very common. Cats, however, have largely not been acknowledged for their medicinal relevance for this disease until recently. As with other animals, OA sometimes needs special care to increase the quality of life of the animal. The majority of patients seem to have primary or idiopathic OA. For the clinician, it is necessary for their practice community to specifically take attention for these cases.

Osteoarthritis (OA) is defined as pathological alteration of the synovial joint marked by degradation of the articular cartilage, development of osteophytes, bone remodeling and changes in periarticular tissue (Bennett et al., 2012a). Osteoarthritis (OA) is a chronic degenerative disease that causes pain and can affect the quality of life for both the cat and the owner (Bennett et al., 2012b). The disease is a common finding in cats, particularly in older cats. Clinical sign of OA in cats described as being unable or unwilling to jump, skipping shorter distances, reduced play activity by more sleeping, reduced grooming behavior, stiffness and lack of activity (Slingerland et al., 2011). The

radiographic features associated with elbow OA include osteophytes, enthesiophytes, areas of abnormal mineralization, synovial effusion and joint remodeling (Ariffin, 2015).

1.2 Problem Statement

Osteoarthritis is known as common disease with multiple risks. This disease can affect the quality life of the cats and also the owner and it was hardly recognized by clinician because the behavior of the cats that tends to hide the pain. Thus cause owner not acknowledge their cats may/not may sick because it seem normal to them.

1.3 Objectives

1. To determine the prevalence of elbow OA in cats attended at the University Veterinary Hospital (UVH), UPM.
2. To determine the risk factors that contributes to elbow OA.

1.4 Hypothesis

The purpose of this retrospective study is therefore to investigate the hypotheses of the prevalence of elbow OA in cat presented to the University Veterinary Hospital (UVH), UPM was range from 5% to 20% and age, sex, breed, body weight and neuter status are associated with the occurrence of the elbow OA in cat.

CHAPTER 2

LITERATURE REVIEWS

2.1 Anatomy of feline elbow joint

The elbow is a hinged joint which requires only one plane to travel through. It also allows the movement of the ante brachium to prone or supine. The bones in the joint are separated by a joint cavity of synovial fluid. Synovial fluid produce by synovial membrane found in joints lubricates to enable the friction-free movement. The joint consists of the distal humeral condyle and the lateral ulna head and trochlear. The distal humeral condyle is comprised of layer or articular cartilage medially and laterally (Engelke et al., 2011). The joint cartilage is a flexible connective tissue that minimizes friction and allows movement to glide without pain and wrapped in a joint capsule. Joint capsule made of fibrous tissue holds the bones together to protect the joint. Bands of ligaments of strong and fibrous tissue come in varying types and sizes binding bones together at joints which limit the range of mobility and minimize dislocation. Three major ligaments are secured and maintained by the side collateral ligament, the media collateral ligaments and the ring ligament (Ariffin, 2014).

2.2 Definition of feline OA

Osteoarthritis (OA) means the degenerative changes to a synovial articulation accompanied by articular cartilage degradation, osteophytosis, bone remodeling,

periarticular tissue mineralization and relatively low-grade non-purulent inflammation (Bennett, 2010). Although OA is often used synonymously with the term degenerative joint disease (DJD) (Kellgren and Lawrence, 1957; Hough, 1993), OA is a disease that only cover of synovial joints , while DJD covers pathology of non-synovial joints such as spondylosis and degenerative joint lesions that are not part of OA, such as traumatic enthesiopathies (Ryan, 2013).

2.2.1 Classification of feline osteoarthritis (OA)

The primary and secondary OA hypotheses are well-known in human OA (Kellgren and Moore, 1952). The principle has also been used for canine OA (Tirgari and Vaughan, 1973; Bennett and May, 1995). Most forms of feline OA tend to be primary which the disease development does not have specific causes (Hardie et al., 2002; Bennett and Clarke, 2004; Clarke et al., 2005; Godfrey, 2005; Clarke and Bennett, 2006; Lascelles et al., 2010). Generally, primary OA refers to a disorder where there is no clear reason for joint deterioration, whereas secondary OA is linked to other disorder involving the joint and supporting tissues (Rychel, 2010). Primary OA generally occurs as a late-onset condition without a clear predisposing factor, including joint injury or developmental defects (Ariffin, 2015).

Joint trauma secondary OA is well known (Morgan, 1999; Clarke et al., 2005; Godfrey, 2005; Clarke and Bennett, 2006). Clarke et al. (2005) indicated that nearly

25.0% of OA cases were caused by trauma. The incidence of joint damage during a single animal's life is very difficult to confirm.

2.3 Prevalence of feline elbow OA

Several studies have reported on the prevalence of feline OA in the appendicular skeleton. Hardie et al. (2002) conducted a retrospective study from 1994 until 1997 in 100 cats which were more than 12 years of age. The total prevalence of appendicular joint OA was 64 % with the elbow joint most severely affected. Pacchiana et al. (2004) reported that 16 of 52 cats had radiographic evidence of OA in at least one joint with the elbow joint (21.0%) being most frequently affected. Clarke et al. (2005) conducted a retrospective study on 218 cats of all ages (median age 10 years, range 0.6-16 years); they examined archived radiographs at the University of Glasgow Veterinary School between July 1998 and October 2003. They reported that 33.9% (74 cats) of the population had OA affecting the appendicular and axial skeletons.

A retrospective radiological study of 292 cats carried out by Godfrey (2005) showed 22 % (63 cats) had radiographic signs of OA. According to his study, the elbow joint was the most frequently affected and the pathology was bilaterally symmetrical in 41 cats (73 %). In a research by Slingerland et al. (2011) at University of Utrecht, the appendicular joint of 100 cats were radiographed without any clear selection parameter except the cats being older than 6 years and all the patient were send to the teaching hospital mostly for condition that unassociated with musculoskeletal system. 61% of OA

have been reported just only at one joint and 48% had more than one joint affected. Ariffin (2015) prospectively reported the prevalence of OA in the appendicular of 60 cats. Of 696 joints examined, 389 (55.9%) had radiographic OA. The radiographic prevalence was highest in the elbow (23.9%). They are few risks that may influence cats to have osteoarthritis such as age, gender, weight and status of neutering.

In older cats, Bennet et al. (2004) has seen a higher incidence of osteoarthritis than in younger cats. The Burmese breed proposed to be predisposed to OA. Godfrey (2007) stated that nine of the 86 Burmese cats had elbow OA. The recent study included 5 pedigree cats including one Burmese; 4 had OA in at least one joint. In the research done by Ariffin (2015) OA was comparatively greater in females (10 female and 26 spayed female) than in males (16 castrated male).

2.4 Radiological features of feline elbow OA

Osteophyte is the common features for OA (Peter, 2006). It is appear on the edges of the joint most frequently, initially as cartilage outgrowths. Osteophytes tend to develop and grow in size over time with a progression of the disease (Marshall, 1969). Osteophyte forming is a process by which the joint changes its shape (remodeling).

A supinator sesamoid bone (SSB) is an OA sign in the elbow joint, even though there is no radiographically visible SSB in certain OA joints (Ariffin, 2015). It is circular or oval and is in the original tendon of the supinator muscle. The supinator muscle tendon also includes regions of chondro-osseous metaplasia, suggesting that in order to maintain

an anatomic structural structure of the humeroradial joint, particularly during stretching, extensions, supination and pronation; it can be altered as a result of the excessive mechanical stress in the tendon (Meyer et al., 1964; Wood et al., 1995). The SSB will become a focus of new deposition in the bone in arthritic joints, thereby making it more noticeable on the radiograph (Ariffin, 2015). Altered gait or conformation due to painful OA can also increase the mechanical tension on the supinator tendon, which promotes SSB growth (Ariffin, 2015). Age advanced and the occurrence of articular cartilage injury was related to the presence of an SSB (Ariffin et al., 2012). Cats with noticeable SSBs are older than without and articular cartilage modifications appear to be more serious in that joints (Ariffin, 2015).

Abnormal mineralization is a distinct region which appeared separate from the bone and could be seen at 80 percent of the boundary and least partly superimposed on the bones of the joints (Ariffin, 2014). Clarke et al. (2005) and Godfrey (2007) have confirmed that abnormal mineralization was primarily observed in the elbows and stifles.

A term used for describing increased bone opacity in OA joints is subchondral bone sclerosis (Morgan, 1999). It typically takes place in stress-prone regions of the joint (Marshall, 1969). Sclerosis in extreme osteophytosis is recorded more commonly (Clarke et al., 2005), but it was hypothesized that this may be viewed as sclerosis due to superimposed osteophytes (Jewell et al., 1998). The term subchondral sclerosis is used frequently to mean more thickened osseous trabeculae, leading to an increasing bone density and rigidity under the joint surface (Burr and Schaffler, 1997). In description of

radiographic feature of joints, the words sclerosis, increased radio density and increased radio-opacity are often used interchangeable. However this can be put into doubt. The pathology of sclerotic means tissue hardening (Ariffin, 2015). The term radio-opacity should be used to characterize bony radiographic changes, instead of radio-density, as recommended by Thrall (2005).

On non-weight bearing surface areas enthesiophytes shape and are inserted into adjacent ligament or capsular attachments (Marshall and Olsson, 1971; Sokoloff, 1980; Carrig, 1997; Morgan, 1999).

Damage of the articular cartilage is generally seen as a narrowing of the joint area between opposite bone surface (Owens, 1982). Narrowing of the joints with heavy weight bearing radiographs may be more accurately shown (Morgan, 1969; Leach et al., 1970), but in small animal patients these are not done regularly and can hardly be accomplished in the cat. In detecting early joint cartilage loss, the accuracy and precision of this aspect have been debated (Brandt et al., 1991; Fife et al., 1991). Brandt et al. (1991) conclude that the joint space narrowing measurement does not provide evidence on the severity of OA articular cartilage injury.

2.5 Management and treatment of feline osteoarthritis (OA)

Non-steroidal anti-inflammatory medication (NSAIDs) is a significant component of the medications used to cure other groups of other species, and there are several evidence to consider their efficacy in cats (Clarke and Bennet, 2006; Bennet and Morton, 2009; Lascelles et al., 2010; Lascelles et al., 2007; Lascelles, Hardie and Robertson, 2007; Thoulon, 2009). NSAIDs play a large role by avoiding prostaglandin inflammatory effects by inhibiting cyclo-oxygenase (COX) breakdown of arachidonic acid (Bennet, 2012). There are two major forms of COX: an endogenous form, COX-1, and a COX-2 that can be induced. COX-1 plays a major part in inflammatory processes and the perception of pain, and COX-2 is essential for inflammatory resolution, can be present in some normal tissues, such as kidneys and CNS (Bergh and Budsberg, 2005), and oddly can help to avoid and/or treat duodenal injury (Lascelles, Hardie and Robertson, 2007; Wolfe et al., 1999; Wooten et al., 2009). Meloxicam has been widely beneficial for the treatment of chronic pain in cats arthritis (Clarke and Bennet, 2006; Bennet and Morton, 2009; Lascelles et al., 2001; Lascelles et al., 2007; Lascelles, Hardie and Robertson, 2007; Gunew et al., 2010; Gowan et al., 2011). The liquid composition of the meloxicam makes precise dosage reasonably simple (Bennet et al., 2012). The metabolism of meloxicam is understood to be oxidative pathways, and the comparatively low potential in cat for hepatic glucuronidation is therefore a less issue (Court and Greenblatt, 1997). The dosage is steadily lowered is always best practice. Administered by either dose reduced or increased the dose interval (Bennet et al., 2012). Since the cats are mostly older and suffer from OA, regular blood or urine checks are advised before

beginning NSAID therapy for liver and kidney disease assessment; blood pressure screening is also advisable because COX inhibition can intensify hypertension in the kidneys (Bergh and Budsberg, 2005; Khan, 1998).

As for the dog, omega-3 fatty acid diets are advised for cats with OA mostly present in fish oil (Bennet et al., 2012). An omega 3-rich diet in cats with degenerative joint disease was tested in a study by Lascelles et al. (2010) that found cats had increased activity levels in contrast to cats fed a control diet, as their owners had evaluated. Nonetheless, there were no variations in activity levels with neck mounted activity monitors.

Glucosamine and chondroitin are involved in cartilage matrix metabolism and their use was always explained as they may aid cartilage repairs, or even slow down osteoarthritic joint deterioration (Bennet et al., 2012). However, there are indirect reports that these medications can alleviate OA discomfort, an effect often recorded over the span of 6-8 weeks, indicating that they are anti-inflammatory in some manner. A randomized double-blind clinical trial has recently been conducted for cats with OA that contrasts meloxicam efficacy and glucosamine/ chondroitin supplement. The nutraceutical cats improved over time, but it took some time and the change was not the same as in the meloxicam class. These drugs are very safe and can be used alone or with NSAID in which case the non-steroidal dosage can be reduced (Bennet et al., 2012).

Around 14% of older cats with OA are obese (Clake and Bennet, 2010). Weight reduction was useful in management of OA. A research done by Bissot et al. (2010) has demonstrated that the use of low-calorie diets was effective in customers' cats, although the weight loss rate was slower than expected.

A very useful study of environmental enrichment done by Ellis (2010) stated steps or ramps for cats with OA that are not able or unwilling to jump are provided for quick access to bedding, sofas, window ledges, etc. She also reported it is vital that the cat has quick access to food and water and their litter tray. At least one litter tray should be available for each cat in the household and the litter should be deep enough. Litter trays must be generous for cats with mobility issues, and 'useful' trays will also help to do this. More than one food and water bowl should be available. Besides, she also said big disturbances in the area of the cat, such as adding new animals, can induce fear and stress and make it much harder to deal with chronic pain. The changes if possible should be slowly implemented.

CHAPTER 3

MATERIALS AND METHODS

3.1 Data collection

The data collection comprise of digital radiograph and patient record of (age, breed, sex and body weight) of cats aged above 1 year old was taken from database at University Veterinary Hospital (UVH), UPM within 5 years period of 2015-2020. The evaluation of digital radiograph (Castream Vue Motion) was conducted by selecting chest radiograph with diagnostic view of elbow joint with clear, unrotated and un-superimposed criteria. Individual elbow joints from each cat included only once.

3.2 Radiographic scoring

The severity of elbow radiographic changes was scored based on changes on periarticular bone and soft tissue with reference on scheme described by Ariffin (2015) (Table 1). A combination of osteophytes, increased radio-opacity beneath the ulnar semilunar notch, the presence of the supinator sesamoid bone, synovial effusion, changes in joint space, joint remodeling, and abnormal soft tissue mineralization characterized feline elbow OA are noted. The total radiographic was determined by summing the individual score. A global score was determined based on overall assessment of the severity of the radiographic changes.

3.3 Statistical analysis

The statistical analysis was performed using Graph Pad Prism 8.0. The prevalence of OA was calculated in percentage of cats had radiographic changes. Descriptive statistics in the form of frequency distributions were used to describe the study sample. Continuous variable (age and BW) was analyzed by using Mann-Whitney *U* test which to determine the significant differences in age and BW with the prevalence of OA. Meanwhile, the Chi-square test was used to determine the association between risk factors and OA prevalence. All tests were considered significant at $P<0.05$.

Radiographic feature	Score	Description
Osteophytes	0	Absent : No abnormality
	1	Mild* : < 2 mm
	2	Moderate* : 2-5 mm at one or more locations
	3	Severe* : > 5 mm at one or more locations
Extra-articular enthesiophyte	0	Absent : No abnormality
	1	Mild* : < 1 mm
	2	Moderate* : 1-3 mm
	3	Severe* : > 3 mm
Increase radio-opacity	0	Absent
	1	Present
Supinator sesamoid bone	0	Absent : No abnormality
	1	Present* : < 3 mm
	2	Present* : ≥ 3 mm (with additional mineralization on the surface
	3	of the SSB Present* : ≥ 3 mm (with additional area(s) of mineralization in the region of the SSB
Areas of abnormal mineralization	0	Absent : No abnormality
	1	Mild : Single area
	2	Moderate* : Several areas but none greater than 10 mm
	3	Severe* : Several areas and including at least one greater than 10 mm
Synovial effusion	0	Absent
	1	Present
Joint space	0	Even joint space
	1	Increase joint space
	2	Decrease joint space
Joint remodeling	0	Absent
	1	Present
Global score	0	No abnormality (total radiographic score 0)
	1	Mild (total radiographic score (1-5)
	2	Moderate (total radiographic score(6-11)
	3	Severe (total radiographic score (12-17)

Table 3.1: OA radiographic scoring for feline elbow joint. *Measurement was made at greatest dimension.

CHAPTER 4

RESULTS

4.1 Elbow OA population

The overall prevalence of OA was 52% (52 of 100 cats). Of 52 cats with 54 elbow joints assessed with radiographic changes, 3 cats had unilateral and 1 cats had bilateral elbow involvement with the rest of 48 cats had only one visible elbow on radiograph (15 on the left and 39 on the right) (Table 4.1). The mean total radiographic score of left and right elbow joints was 3.8 and 2.7 respectively. The median total radiographic score of left and right elbows was 2. The minimum score recorded for the left and right elbow joints was 1. The maximum score recorded for the left and right elbow joints was 12. Of 115 elbow joints, 61 were given a Global score of 0, 51 a Global score of 1 and 3 a Global score of 3 (Table 4.2).

Population	Number of cats	Percentage (%)
OA	52	52
Normal	48	48
Total	100	100

Table 4.1: Showing the number and percentage of the elbow OA and normal cats.

4.2 Comparative analyses of signalment, body weight and body condition score between elbow OA and normal cats

4.2.1 Signalment

The mean age of the elbow OA was 8.5 years (SD 3.6) with a minimum age of 1 year and a maximum of 15 years (Table 4.3). The median age was 9 years. The mean age of the normal cats with normal elbow joints was 6.9 years (SD 3.9) with a minimum age of 1 year and a maximum of 17 years. The median age was 6 years. The age difference between the elbow OA and normal cats was significant ($P<0.05$) (Figure 4.1). Six cats with OA were M, 16 were CM, 12 cats were F and 18 cats were SF. Fifteen of the normal cats was M, 8 cats were MC, 10 cats were F and 15 were SF (Figure 4.2). In the elbow OA group 48% were DSH, 20% were DLH and 41% were pedigree cats. In the normal group 52% were DSH, 80% were DLH and 27% were pedigree cats (Figure 4.3). There was no significant difference ($P>0.05$) in sex and breed between the OA and normal cats

4.2.2 Body weight

The mean BW of elbow OA cats was 4.0 kg (SD 1.0) with a minimum weight of 1.9 kg and a maximum of 6.8 kg. The median BW was 3.8 kg. The mean BW of the normal cats was 3.9 kg (SD 1.1) with a minimum weight of 1.6 kg and a maximum of 5.7 kg. The median was 4.1 kg. The difference between elbow OA and normal cats for BW was not significant ($P=0.75$) (Figure 4.1).

4.3 Distribution of radiographic features among OA population

Fourty-seven (87.0%) of the 54 elbow joints had osteophytes. Osteophytes were seen at the distal humeral condyle (Figure 4.4A) and head of radius (Figure 4.4B). Severity was graded mild in 27/54 joints (50%) (7 on the left and 20 on the right), moderate in 13/54 joints (24.1%) (4 on the left and 9 on the right) and severe in 7/54 joints (13.0%) (2 left and 5 right). The mean osteophyte size in mm ± SD for mildly affected joints was 1.7 ± 0.1, for moderately affected joints was 3.0 ± 1.0 and for severely affected joints was 8.3 ± 5.1.

The SSB was present in 26 (48.1%) of 54 elbow joints, (9 on the left and 17 on the right) (Figure 4.5). In all cases there were also osteophytes and an increased radio-opacity beneath the semilunar notch. In 22 joints the sesamoid bone was less than 3 mm in size; in 3 it was 3 mm or greater with additional mineralization on the surface of the sesamoid bone and in 1 joint there was additional areas of mineralization in the region of the sesamoid bone. The mean SSB size in mm ± SD for Score 1 was 1.7 ± 0.6, for Score 2 was 3.6 ± 0.7 and for Score 3 was 5.2 ± 0.8.

Twenty-five (46.3%) of the 54 elbows were scored as having an increased radio-opacity beneath the semilunar notch (Figure 4.6). One cat had unilateral changes with the rest of 24 cats that have presence of SSB can only be scored of one elbow because the others elbow not visible on radiograph (6 on the left and 19 on the right).

Areas of abnormal mineralisation were present in 6/54 joints (11.1%), unilaterally in 6 cats (2 on the left and 4 on the right). In one elbow joints this was graded mild, moderate in 4 and severe in one (Figure 4.7).

Extra-articular enthesiophytes were present in 1/54 joints (1.8%), unilaterally. It was graded mild. Enthesiophytes at the attachment of the extensor carpi radialis muscle were identified in 7 joints (Figure 4.8).

Changes in joint space were identified in 5/54 joints (9.3%), unilaterally (3 on the left and 2 on the right). Decrease in the humero-ulnar joint space particularly the caudal part (Figure 4.9).

Joint remodeling were present in 3/54 joints (5.6%), unilaterally (2 on the left and 1 on the right) (Figure 4.10).

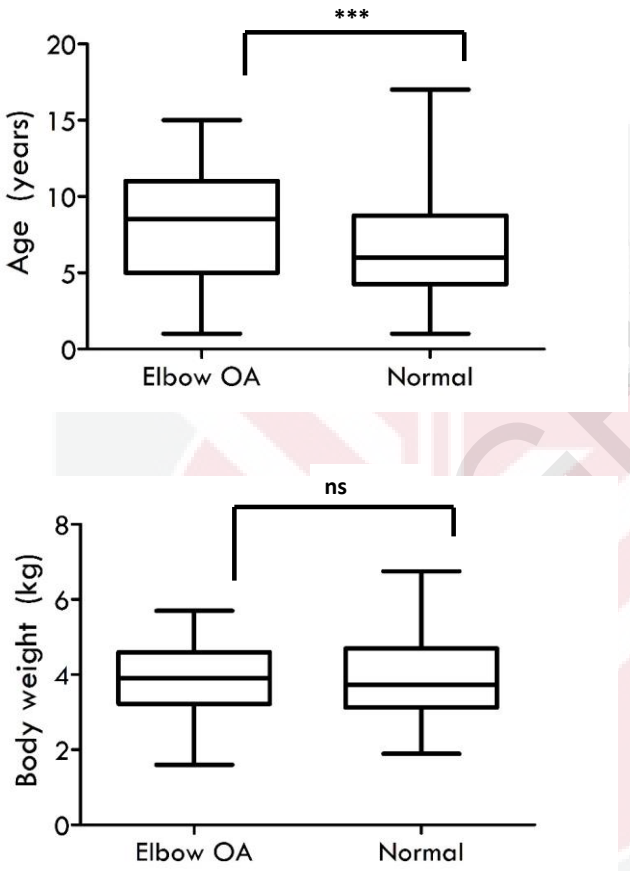

Figure 4.1: The comparative analysis of age and body weight between elbow OA and normal cats. The age difference between the OA and normal cats is significant. There is no significant difference in BW of cats with and without OA. Data presented as median (Mann Whitney *U* test, * represents P<0.05; ns: not significant P>0.05).**

	Radiographic OA Global Score			
	Score 0	**Score 1**	**Score 2**	**Score 3**
Left elbow	31	13	0	2
Right elbow	30	38	0	1
Total	61	51	0	3
Percentage (%)	53	44.3	0	2.7

Table 4.2: Number of joints with different radiographic OA Global Scores.

Age group	**Total number of OA**
Adult (>1 y/o)	17
Mature - middle age (7-10y/o)	16
Senior (>11 y/o)	16
Geriatric (>15 y/o)	3

Table 4.3: Age distribution among elbow OA group.

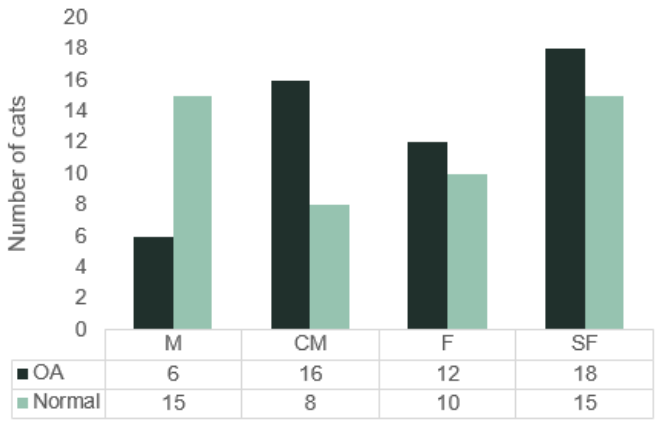

Figure 4.2: Sex distribution among elbow OA and normal cats.

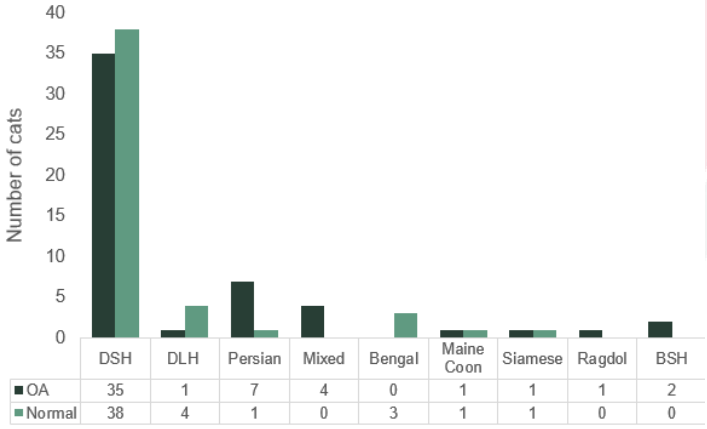

Figure 4.3: Breed distribution among elbow OA and normal cats.

Figure 4.4: Large and severe osteophyte formation at the caudal aspect of the distal humeral condyle. (B) Small osteophyte at the radial head and caudal aspect of the distal humeral condyle (yellow arrows).

Figure 4.5: (A) Present of supinator sesamoid bone <3mm. (B) Present supinator sesamoid bones with additional areas of mineralisation in the region of the sesamoid bone (white arrow).

Figure 4.6: Increase in radio-opacity beneath ulnar notch (yellow arrowhead).

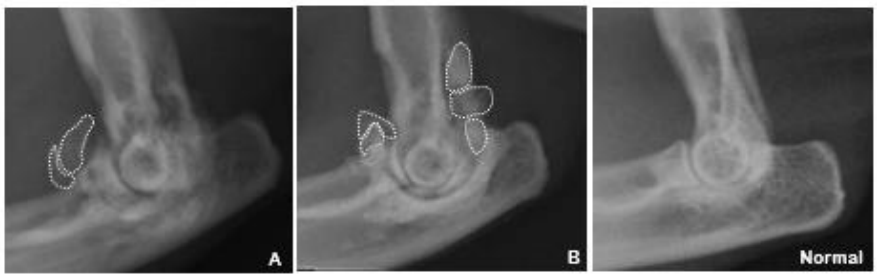

Figure 4.7: (A) & (B) The border of the abnormal mineralization areas highlighted by white dotted line. Delineated border describe as discrete area that separated from the bones which the border 80% could be seen and least partly superimposed on the bones of the joint.

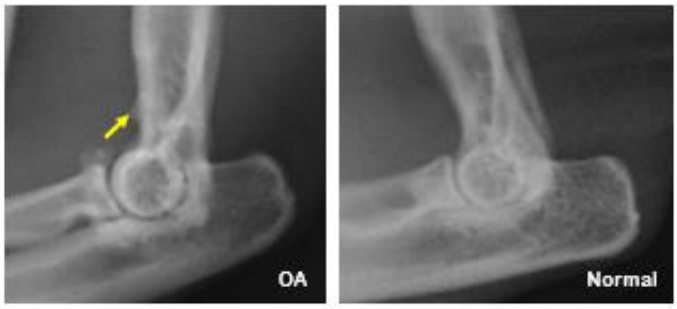

Figure 4.8: An extra-articular enthesiophyte was identified at the extensor carpi radialis muscle attachments (yellow arrow).

Figure 4.9: Change of joint space of elbow joint (black arrowheads).

Figure 4.10: Joint remodeling characterized by changes in the anatomical shape of distal humeral condyle.

CHAPTER 5

DISCUSSION

5. 1 Elbow OA population

The prevalence of cats attended to UVH was measured to be 52 percent (52 of 100 cats) of elbow OA radiographic changes. This was slightly higher compared to the previous Pacchiana et al. (2004) study, which estimated that 21% of cats had elbow OA. Clarke et al. (2005) and Godfrey (2005) both stated that the elbow OA cats were 26.5% and 22% respectively. Retrospective study conducted in Japan by Kimura et al. (2020) showed that 19.5% of the cats had radiographic changes in the elbow OA. In these studies, the emphasis was on the evaluation of osteophyte formation, increased radioactivity, abnormal mineralization and enthesiophyte formation. More recent studies have included more features that are significant and linked to OA. The study carried out by Ariffin (2015) measured eight radiographic features of 86.2% of cats with radiographic changes in elbow OA. This may have affected the prevalence of the study, as in this study the prevalence was high possibly because seven radiographic characteristics were measured, including the combination of osteophytes, increased radio opacity below the ulnar semi-lunar notch, the presence of supinator sesame bone, the presence of extra-articular enthesiophytes, irregular soft tissue mineralization, synovial effusion, joint volume, and

other than that, a large number of older cats in the overall sample size may have an effect on prevalence as older cats appear to grow OA.

From this study, out of 155 joints evaluated (46 on the left and 69 on the right), the right elbow have higher radiographic changes with 56 per cent compare to left elbow that only 32.6 percent. This was because number right elbow visible on radiograph compare the right elbow. As mention the limitation of this retrospective study was the variable cannot be adjusted and only depends on the existing data that collected in the Castream Vue Motion software system. Due to this limitation also, this study was only able to identify one cats had bilateral involvement; three cats had unilateral involvement with the rest only can be evaluated on one side of the elbow only.

Majority of the cats had mild elbow OA. This probably due to the scoring method used in this study. Cats consider having OA even its have only slightly changes in the periarticular and soft tissue changes. This could be some error as this study was assessed subjectively and the quality of the radiograph itself can influence the interpretation of radiographic changes. From study done before, the cats consider having OA only when the cats have osteophyte formation even though it had changes in others periarticular and soft tissue changes.

High number of spayed female (35%, N=18) in OA population. This aligned with the study done by Godfrey (2007) and Kimura et al. (2020) that stated female are more likely to develop OA. This statement supported with the statement postmenopausal women are predisposed to OA due to estrogen deficiency which can influence the

molecular activity of joint tissues by Roman-Blas et al. (2009) that could be apply same principle in animal.

Most cats with OA in this study were domestic shorthaired (67%, N=35), which reflects the majority of cats in the general population. Persian and Maine Coon breed population among OA were (88%, 7 out of 8) and (50%, 1 out of 1) respectively. Maine Coon & Persian most likely to developed OA because of their larger body type reported by Perry (2016).

5.2 Comparative analyses of signalment, body weight and body condition score between elbow OA and normal cats

Cats with OA are much older than cats without OA. These findings are predicted in a chronic age-related disorder and were previously recorded in cats (Godfrey, 2005; Clarke et al., 2005; Clarke and Bennett, 2006; Lascelles et al., 2010, Slingerland et al., 2011). This also supported with statement Sacitharan and Vincent (2016) stated aging is associated with alteration in the cartilage matrix such as proteoglycan content and glycosaminoglycan composition.

In this study, 73 percent (19 out of 52) had radiographic elbow OA were aged more than 11 years old. This finding was aligned with Hardie et al. (2002) that reported up to 90% of cats aged over 12 years had signs of osteoarthritis. As cats age, the articular cartilage deteriorate and degenerate stated by Ariffin (2015). It was also supported by a

finding by Godfrey (2005) stated that cats with radiographic evidence of OA were from the older population.

The difference between elbow OA and normal cats for BW was not significant (P=0.75) that related to the outcomes of other studies done by Lascelles et al. (2011) and Kimura et al. (2020). Body weight and condition score are correlated with the development of OA in the canine (Kealy, 2002) and even the same could be true for cats (John, 2013). In study done by Clarke et al. (2012), he stated that obesity can exacerbate the condition especially if the cats are old. The obesity of the older cat definitely exacerbates the clinical crisis, allowing the diseased joint to 'mechanically overload.' However, obesity is gradually becoming more specifically involved in human OA pathogenesis by leading to synovial inflammation and chondrocyte injury. Adipose tissue is now thought to be an essential secretive and endocrine gland that secretes many of the cytokines associated with cartilage degeneration (TNF-alpha, IL-1, and IL-6) as well as fat-specific hormones such as leptin and adiponectin that can facilitate cartilage degeneration.

5.3 Distribution of radiographic features among OA population

The most common radiographic feature in this study was osteophyte with 87 percent (47 out of 115 joints) assessed. This followed by radiological features of presence of supinator sesamoid bone and increased radio-opacity beneath the ulnar semilunar notch with 46.3 percent and 48.1 percent respectively. Extra-articular enthesophytes and joint remodeling, however, is rare.

Osteophyte feature was the most common finding in this study as expected because osteophyte was known to be a key of radiographic feature of OA (Bennet et al., 2012).

Abnormal mineralization was describe as discrete area that appeared separated from bone which the border 80% could be seen and least partly superimposed on the bones of the joints. Other study done by Clarke et al. (2005) and Godfrey (2007) found this feature predominantly in elbow joint but unfortunately only 6 joints out of 115 joints assessed have this feature in this study.

Increased radio-opacity beneath the ulnar semilunar notch could be seen due to superimposed of osteophyte development around the articular margin (Jewell et al., 1998) or soft tissue mineralization inside the joint capsule and/or intra articular mineralized bodies that known as osteochondromas (Ariffin, 2015) with the ulnar. It normally happens in stress-prone areas of the joint (Marshall, 1969) which elbow is one of the joints. However in order to confirm these features, gross pathology examination should be done.

SSB developed due to painful OA that leading to altered gait or conformation then will increase the mechanical pressure on the supinator tendon, which encourages SSB development (Ariffin, 2015). The SSB will become the subject of new bone deposition in arthritic joints, making it more apparent on the radiograph (Ariffin, 2015).

Changes in joint space are very subjective to assess as for this feature the distance between joint spaces was note measured in this study. Articular cartilage losses are usually known to reduce the joint region between the opposite surfaces of the bone (Owens, 1982). Joint remodelling was observed as a change in anatomical shape of normal anatomy elbow joint.

5.4 Primary and Secondary OA

In this study, 88.5 percent (46 out of 52 cats) of OA cats were considered to be accidental, since the cause for the visit is not linked at all to the clinical symptom of OA without a musculoskeletal complaint. These cases were listed as primary OA because there was no apparent underlying disorder and it often emerged as a late-onset illness without a clear predisposing factor.

In 11.5 percent (6 of 52 OA cats) secondary OA was found. 6 cats have traumatic cases history and one cat has elbow luxation history. This occurrence contributes to joint incongruity that causes unequal joint pressure causing the formation of the osteophyte.

CHAPTER 6

CONCLUSION AND FUTURE RECOMMENDATIONS

Prevalence of elbow OA at UVH-UPM is 52% with age associated with the elbow OA. This study provides information on feline OA in a hospital population of cats. It is recommended that owners of cats over 6 years of age are asked to do senior wellness examinations twice a year. Prospective and behavioral studies in cats with OA can also be done in future.

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