



UNIVERSITI PUTRA MALAYSIA

**RETROSPECTIVE STUDY OF CANINE HIP DYSPLASIA TREATMENT
IN UVH-UPM FROM YEAR 2019 TO 2021**

GONG LIQUAN

**Ip
FPV 2022 78**

**RETROSPECTIVE STUDY OF CANINE HIP DYSPLASIA
TREATMENT**

IN UVH-UPM FROM YEAR 2019 TO 2021

GONG LIQUAN

A project paper submitted to the
Faculty of Veterinary Medicine, Universiti Putra Malaysia

In partial fulfillment of the requirement for the
DEGREE OF DOCTOR OF VETERINARY MEDICINE

Universiti Putra Malaysia
Serdang, Selangor Darul Ehsan.

October 2022

It is hereby certified that I have read this project paper entitled “Retrospective study of Canine Hip Dysplasia Treatment in UVH-UPM from year 2019 to 2021”, by Gong LiQuan and in my opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the course VPD 4901 - Project.

The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a red and white color scheme. At the top left, the letters 'UPM' are displayed in white on a red background. The central part of the shield contains a stylized white bird or wing design. To the right of the bird is an open book. The bottom of the shield has a series of vertical white lines. A large, semi-transparent watermark reading '@COPYRIGHT UPM' is overlaid diagonally across the entire page, including the logo.

ASSOCIATE PROF. DR. LOQMAN BIN HAJI MOHAMAD YUSOF

Lecturer,
Faculty of Veterinary Medicine
Universiti Putra Malaysia
(Supervisor)

DEDICATION

This thesis is especially dedicated to:

My parents, who has done everything to support me

Gong ShuiShan, Li ShuYin

My supportive supervisors, who guided me in my research

Dr. Loqman Bin Haji Mohamad Yusof

and

All my fellow DVM friends.

ACKNOWLEDGEMENTS

First I would like to express my deepest appreciation to my dear supervisor, Dr. Loqman Bin Haji Mohamad Yusof, for his invaluable patience and guidance helped me complete the research.

I am truly thankful to my fellow classmates and friends, who generously shared knowledge and experience to support my study. I am also grateful for my parents with their unintentional love, trust and guidance. I could not be in my position now without them.

I need to also express my thanks to my faculty staff for their patience and care when gathering case files and providing information for the research.

Lastly I would like to express my thanks to my university, University Putra Malaysia, for giving me the opportunity to conduct this research and complete this project successfully.

CONTENTS

TITLE	I
CERTIFICATION	II
DEDICATION	III
ACKNOWLEDGEMENTS	IV
CONTENTS.....	V
LIST OF TABLES	VII
LIST OF FIGURES	VIII
LIST OF GRAPHS	IX
ABSTRACT.....	X
ABSTRAK.....	XII
1.0 INTRODUCTION:	13
2.0 LITERATURE REVIEW	4
2.1 Aetiology and pathophysiology of CHD	4
2.2 Diagnosis of CHD	5
2.3 Grading and screening system.....	8
2.4 Conservative Treatment of CHD.....	10
2.5 Surgical treatment of CHD	12
3.0 MATERIALS AND METHODS:.....	14
3.1 CHD case identification.....	14
3.2 Severity grading using OFA method	15
3.3 Evaluation on the age, sex, body weight and breed.....	15
3.4 Spearman's rank correlation.....	16
3.5 Statistical Analysis	16
3.5.1 Comparison of the severity of CHD between large, medium and small breed dogs	17
3.5.2 Comparison of body weights of dogs with mild, moderate and severe CHD	17
3.5.3 Comparison of ages of large, medium and small breed dogs with CHD	18

4.0 RESULTS	19
4.1 General evaluation of different parameters to CHD and the severity	19
4.1.1 Relation of breed with CHD and severity	19
4.1.2 Relation of age with CHD and severity	20
4.1.3 Relation of gender with CHD and severity	22
4.1.4 Comparison of breeds to CHD cases.....	22
4.2 Body weight and gender correlation to hip dysplasia severity	24
4.3 Hypothesis testing result using statistical analysis	25
4.3.1 Severity of CHD between large, medium and small breed dogs	25
4.3.2 Body weights of dogs with mild, moderate and severe hip dysplasia..	26
4.3.3 Age of large, medium and small breed dogs.....	27
4.4 Medication choices and conservative management of hip dysplasia at UVH 30	
4.5 Surgery treatment outcomes	32
5.0 DISCUSSION	38
6.0 CONCLUSION.....	40
7.0 RECOMMENDATION	41
REFERENCES	43

LIST OF TABLES

	Page
Table 1 : Total cases of mild, moderate and severe hip dysplasia based on OFA grading	19
Table 2 : Age group of Juvenile, adult and senior cases.....	20
Table 3 : Severity comparison between juvenile and adult CHD	21
Table 4 : Breed comparison of average body weight and age	23
Table 5 : Average age for large, medium and small breed dogs.....	28
Table 6 : common choice of medication and cases used in UVH for hip dysplasia....	32
Table 7 : Surgery cases with recovery time, surgical outcomes and concurrent diseases	33

LIST OF FIGURES

	Page
Figure 1 : Ortolani test illustration.....	7
Figure 2 : landmarks in evaluating the severity of canine hip dysplasia	9
Figure 3 : Case severity grading based on OFA method	15
Figure 4 : Spearman’s rank correlation of different parameters	25
Figure 5 : Kruskal Wallis test compares median OFA grading for different breeds ...	26
Figure 6 : the Kruskal Wallis test compares body weight of mild, moderate & severe OFA.....	27
Figure 7 : the Kruskal Wallis test compares the age of large, medium and small breed dogs.....	28
Figure 8 : the Mann-Whitney Test compares age between large and medium breed dogs.....	29
Figure 9 : Radiograph of progression of CHD for a 11-year-old Rottweiler post left hind limb EA.....	34
Figure 10 : Radiograph of surgery case 3 & 4	36

LIST OF GRAPHS

	Page
Graph 1 : The percentage of large, medium and small sized dogs diagnosed with CHD presented at UVH.....	19
Graph 2 : Bar chart of age distribution for 54 CHD cases.....	21
Graph 3 : Gender difference between large, medium and small sized dogs with CHD	22
Graph 4 : Occurrence of CHD identified based on breeds	23
Graph 5 : Line graph of the mean of OFA for large, medium and small breed dogs. .	26
Graph 6 : Line graph of the mean body weight for mild, moderate and severe CHD. .	27
Graph 7 : Box plot of average age for large, medium and small breed dogs.....	30

ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfillment of the course VPD 4901- Project.

RETROSPECTIVE STUDY OF CANINE HIP DYSPLASIA

TREATMENT

IN UVH-UPM FROM YEAR 2019 TO 2021

By

GONG LIQUAN

2022

Supervisor: Assoc. Prof. Dr. LOQMAN BIN HAJI MOHAMAD YUSOF

Canine Hip Dysplasia (CHD) is a chronic orthopaedic disease affecting all breeds and age groups of dogs. It is critical to diagnose and control the disease early in order to improve the patient's quality of life and delay the development of osteoarthritis. Since CHD is hereditary, it is imperative to identify CHD patients and avoid breeding them. In this retrospective study, cases of CHD at Universiti Veterinary Hospital (UVH)-Universiti Putra Malaysia (UPM) in 2019 and 2021 were analysed in relation to some body parameters including body weight, age, breed, and gender. In this study, the therapeutic management of CHD was also evaluated. A total of 54 cases of CHD were identified based on the history, physical examination and radiography results. The severity of 35 cases was evaluated radiologically using the Orthopaedic Foundation for Animals (OFA) scale. The correlation of variables was determined by Spearman's

correlation, and a positive correlation was identified between body weight and severity of CHD in large breed dogs [$r(18) = 0.518, p = 0.028$], and between age and CHD severity in medium breed dogs [$r(12) = 0.541, p = 0.035$]. The Kurskal-Wallis test shows significant differences between age of different breed of dogs visited UVH due to CHD ($H(2) = 9.342, p = 0.009$). For medical management, the combination of NSAIDs, joint supplements, and pain management was used, in addition to weight control, dietary changes and physiotherapy. For surgical treatment, only excisional arthroplasty was performed at UVH, and the surgical outcomes were generally good with improved pain and limb performance.

Keywords: Canine Hip Dysplasia, severity, therapeutic, OFA, excisional arthroplasty

ABSTRAK

Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4901 -Projek.

KAJIAN RETROSPEKTIF RAWATAN DISPLASIA PINGGUL KANIN DI UVH-UPM DARI TAHUN 2019 HINGGA 2021

Oleh

GONG LIQUAN

2022

Penyelia: Prof. Madya Dr. LOQMAN BIN HAJI MOHAMAD YUSOF

Displasia pinggul kanin (CHD) ialah penyakit ortopedik kronik yang melibatkan semua baka dan kumpulan umur anjing. Adalah penting untuk mendiagnosis dan mengawal penyakit lebih awal untuk meningkatkan kualiti hidup pesakit dan melambatkan perkembangan osteoarthritis. Memandangkan CHD boleh diwarisi, adalah penting untuk mengenal pasti pesakit CHD dan mengelakkan pembiakan melibatkan anjing ini. Dalam kajian retrospektif ini, kes CHD di Hospital Veterinar Universiti (UVH)-Universiti Putra Malaysia (UPM) pada tahun 2019 dan 2021, dan hubungannya dengan beberapa parameter badan termasuk berat badan, umur, baka dan jantina dianalisa. Dalam kajian ini, pengurusan terapeutik CHD juga dinilai. Sebanyak 54 kes CHD dikenal pasti berdasarkan sejarah, pemeriksaan fizikal dan keputusan radiografi. Keterukan 35 kes dinilai secara radiologi menggunakan skala, *Orthopaedic Foundation for Animals* (OFA). Korelasi pembolehubah ditentukan oleh korelasi Spearman, dan korelasi positif telah dikenalpasti antara berat badan dan keterukan CHD dalam anjing

baka besar [$r(18) = 0.518, p = 0.028$], dan antara umur dan keterukan CHD dalam anjing baka sederhana [$r(12) = 0.541, p = 0.035$]. Ujian Kruskal-Wallis menunjukkan perbezaan yang ketara antara umur pelbagai baka anjing yang dilawati UVH disebabkan oleh CHD ($H(2) = 9.342, p = 0.009$). Untuk rawatan perubatan, gabungan NSAIDS, makanan tambahan untuk sendi, dan pengendalian sakit digunakan, sebagai tambahan kepada kawalan berat badan, perubahan diet dan fisioterapi. Untuk rawatan pembedahan, hanya artroplasti eksisi dilakukan di UVH, dan hasil pembedahan secara amnya baik dengan kesakitan yang bertambah baik dan peningkatan prestasi anggota badan.

Kata kunci: Displasia pinggul kanin, keterukan, terapeutik, OFA, artroplasty eksisi

1.0 INTRODUCTION:

Canine Hip Dysplasia (CHD) is an inherited, developmental orthopaedic disease (Lust, 1997) which involves mainly large breed dogs, sometimes also seen in small breed dogs. The disease involves the luxation or subluxation of femoral head from the hip socket and irregular or delayed endochondral ossification (Schachner & Lopez, 2015), which in a long term lead to degenerative joint disease (DJD) if not diagnosed early and given proper treatment. In genetically predisposed individuals, there are various environmental factors that lead to the development and worsening of CHD, including overfeeding leading to rapid increase of body weight, and excessive calcium and vitamin D consumptions (Fries, & Remedios, 1995). The common signs of CHD

in old dogs is hindlimb lameness associated with secondary DJD, while in younger dogs usually show pain associated with joint laxity (Burns et al., 1987; Morgan, 1987).

Early diagnosis is critical to prolong the usage of the hip joints. The confirmation of a CHD case involves the combination of various diagnostic methods, including combination of patient history, breed predisposition, physical and neurologic examination, palpation techniques and radiographs as the gold standard for diagnostic image. Other techniques including arthroscopy, computerised tomography (CT), and magnetic resonance imaging (MRI) also can be used in some situations limited by the technique, funds and equipment (Morgan, 1987; Schachner & Lopez, 2015). It is important to rule out other diseases that could cause hindlimb lameness before confirming CHD.

Conservative medical treatments usually involve five management methods, including the management of body weight, the use of nonsteroidal anti-inflammatory drugs (NSAIDs), other joint supplements, exercise restriction and physiotherapy (Bojrab, 2014).

The choice of surgical treatment mainly depends on the patient's age and the severity of disease. For puppies aged five month and below, juvenile pubid symphysiodesis (JPS) can be done to moderate the growth of pelvic ossification to facilitate better femoral head coverage. Triple or double pelvic osteotomy (TPO/DPO) can be done in young dogs for the same purpose as JPS by rotating the acetabulum socket in small angles. Total femoral head replacement (THR), including cemented and cementless designs, is consider a salvage procedure mainly used on older dogs when the joint is no longer functioning and the life quality of the patient is severely affected (Bojrab, 2014; Schachner & Lopez, 2015).

This study is a retrospective study involving cases of CHD in dogs presented at UVH between 2019 and 2021. The objective of this study is to investigate 1) the relation between CHD and its severity with patient parameters including age, breed, body weight and gender; 2) the choice of CHD medical treatment and duration; and 3) the surgical treatments and outcomes.

The null hypothesis of this study including 1) the severity of CHD is similar between large, medium and small breed dogs; 2) the body weight of mild, moderate and severe hip dysplasia are similar; and 3) the age of large, medium and small breed dogs diagnosed with CHD are similar. The alternative hypothesis including 1) the severity of CHD is different between large, medium and small breed dogs; 2) the body weight of mild, moderate and severe hip dysplasia are different; and 3) the age of large, medium and small breed dogs diagnosed with CHD are different.

2.0 LITERATURE REVIEW

2.1 Aetiology and pathophysiology of CHD

Canine hip dysplasia is a common chronic orthopaedic disease mainly involving large and giant breeds, although it can be seen also in small breed dogs (Lust, 1997). It can be caused by both genetic and environmental factors. Study shows that there is a strong correlation between genetic predisposition to the development of hip dysplasia. When both parents have CHD, the percentage for offspring having CHD is 85%. If one parent has CHD, 52% offspring will have CHD as well (Fries & Remedios, 1995). Current literature shows that there are three genetic mutations that are related with the development of CHD, which are Carbohydrate sulfotransferase 3, fibronectin 1 and fibrillin 2 (Peterson, 2017). The genetic mutations lead to joint cartilage malformation, deposition of glycoprotein in the cartilage, and modified the joint connective tissue, which eventually led to hip dysplasia and the development of osteoarthritis (Wurster & Lust 1982; Zhu et al. 2012). The breed predisposed to hip dysplasia including Bearded Collie, Border Collie, Bulldog, Chow Chow, English Springer Spaniel, German Shepherd, Giant Schnauzer, Golden Retriever, Great Dane, Labrador Retriever, Rottweiler, Samoyed, etc. (Breur, 2001).

Despite its hereditary nature, other factors include rapid weight gain in young age, and excessive calcium and vitamin D consumptions also leads to hip dysplasia (Fries, & Remedios, 1995). One study shows that on Labrador Retrievers fed with limited amounts, only 4 out of 24 (around 29.2%) CHD were diagnosed, compared to 16 out of 24 dogs (around 66.7%) CHD cases in dogs feeding ad libitum (Kealy et al, 1992). The increase in body weight promotes excessive pressure on the hip joint, leads to irregular development of the femoral soft tissue and subluxation of femoral head, which

further lead to wear of femoral cartilage in juvenile dogs (Bojrab, 2014). The worn femoral cartilage exposes the underlying pain fibre leading to pain and lameness in young patients. In older dogs with the development of degenerative joint disease, the deformed femoral head and acetabulum apply irregular pressure on the joint surface, which leads to microfracture of the trabecular bone causing severe pain and thickening of trabecular bone (Bojrab, 2014). Another possible causation of CHD is small but repeated trauma leading to synovitis and further leads to joint subluxation and cartilage change (Bojrab, 2014).

2.2 Diagnosis of CHD

It is encouraged to examine Canine hip dysplasia using a combination of diagnostic methods, including patient history, breed predisposition, visual and palpation examination, and the viewing of radiographs or arthroscopy. The suspect patients with CHD usually will show a history of intermittent or long term lameness, exercise intolerance, and pain involving hip movement (Bojrab, 2014). During first observation, weight bearing or non-weight bearing lameness, abnormal tip-toe or bunny hopping gait can be seen during short tort of the animal. Upon physical examination, dogs with hip dysplasia will usually show pain upon manipulation, limited range of motion and muscle atrophy of the hindlimb (Bojrab, 2014). It is important to rule out other possible causes of lameness including osteochondrosis, neurotic injury, patella luxation, cruciate ligament rupture, bone neoplasia etcetera.

Common palpation techniques used can be categorised into standing palpation and recumbent palpation. While the standing palpation mainly identifies the pelvis and hind limbs anatomical location and the presence of any muscle atrophy. The recumbent

palpation technique to examine joint laxity usually involves the Barden and Ortolani tests (Bojrab, 2014). During the Ortolani test, the dog is placed in dorsal or lateral recumbency with the examiner applying force along the femoral bone to sublux the femoral head and then abduct the leg to feel a “pop” sound, which means there is positive joint laxity. (Schachner, 2015; **Figure 1**) A closed cohort study conducted with Rottweilers shows that the mean of the reduction angle and the Ortolani manoeuvre can be used to diagnose hip joint laxity and predict FCI scores in Rottweilers as early as 35 ± 2 weeks of age, and the Ortolani test performed in dorsal recumbency provide a more reliable result (Vidoni, 2021).

The Barden’s test involves the dog being in lateral recumbency, elevating the femur laterally and applying force on the greater trochanter to feel for any displacement. Displacement more than 2 mm is a positive Barden test (Schachner, 2015). However the Barden and Ortolani test alone is not sufficient to diagnose CHD as the test can be interfered with by the proliferative fibroplasia of the joint (Schachner, 2015).

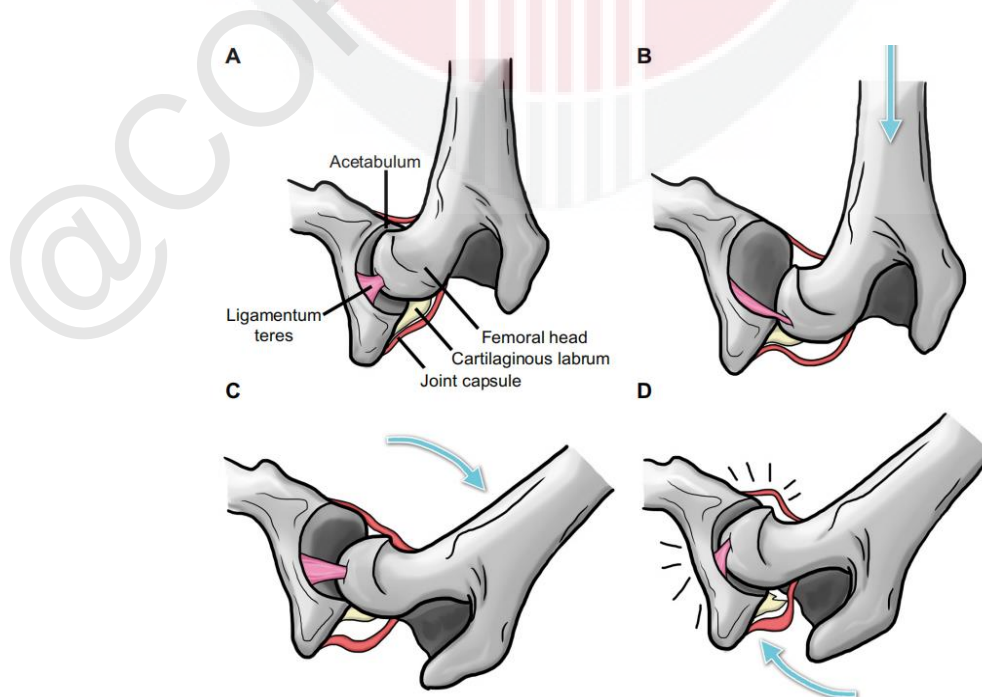


Figure 1: Ortolani test illustration. A) position of the femoral head before subduction. B) applying force along the femoral bone to sublux the femoral head. C) abduct the leg. D) feel a “pop” sound when the joint goes back to space. (adapted from Chalman and Butler, 1985)

For radiography taking, usually the dog is placed in dorsal recumbency with both hindlegs extended and medially rotated to position the patella in the middle of trochlear grooves, and the hip extended view can be taken. There are also other radiological views that can be taken based on different scoring systems' requirements, including stress radiograph and distraction view for PennHip screening test which will be further discussed below. During the radiograph taking, the animal should be heavily sedated or anaesthetized in order to get a good radiograph view (Bojrab, 2014).

Although radiographs still remain the gold standard in diagnosing hip dysplasia, there is an increased popularity of using computer tomography (CT) scan (Schachner, 2015). Two dimensional CT image is useful to measure the similar landmarks of the coxofemoral joint as a radiograph. More importantly, the building of three dimensional CT models can help to predict the change in acetabulum and femoral head coverage in dogs with joint laxity (Andronescu A A, 2015). In conclusion, combining the measure of distraction index and center edge angle at week 16, or dorsal acetabular sector angle and Norberg angle at week 32 is useful for the prediction of developing osteoarthritis (Schachner, 2015).

2.3 Grading and screening system

According to Hip International Ratings Matrix, there are four rating systems to measure the severity of the disease, including The Orthopaedic Foundation for Animals (OFA), the Modified Fédération Cynologique Internationale (FCI), The British Veterinary Association (BVA) and The Kennel Club (KC), and Verein für deutsche Schäferhunde (SV). The OFA method evaluates nine anatomical parameters (**Figure 2A**) of the femoral joint by three qualified veterinarians, and the result in seven categories. Normal dogs with no hip dysplasia graded as excellent, good, fair, or borderline. The CHD positive cases are graded as mild, moderate or severe. As the information from the OFA Canine Health Information Centre states, mild hip dysplasia indicates there is significant subluxation of the coxofemoral joint, increase in joint space, shallow acetabulum but with no arthritic changes observed. In moderate hip dysplasia, there is remodelling of the femoral head and neck as well as the acetabular rim, and sclerosis or osteophytes can be observed. In severe hip dysplasia, there is more prominent arthritic bone change and the femoral head is partially or completely out of the acetabulum socket (Schachner, 2015). The OFA result is only valid for dogs more than twenty-four months of age.

The BVA method used nine standards (**Figure 2B**) to evaluate the CHD from 0-5 or 0-6 and a total of 106 points, the lower the score, the better the hip condition. The nine standards including the Norberg angle (**Figure 2C**), acetabular fossa (AF), acetabular notch (An), caudal acetabular edge (CaAE), cranial acetabular edge (CrAE), cranial effective acetabular rim (CrEAR), dorsal acetabular edge (DAE), femoral head (Fh) and foveal defect (Fv) (Schachner, 2015). The method only can be used on canines more than 1 years old and the hip extended radiograph used to be evaluated by two

registered veterinarians. The FCI is performed on dogs 18-24 month old using extended hip and abducted hindlimb view. It has five gradings ranging from A to E with only A (1 / 2) as graded normal hips.

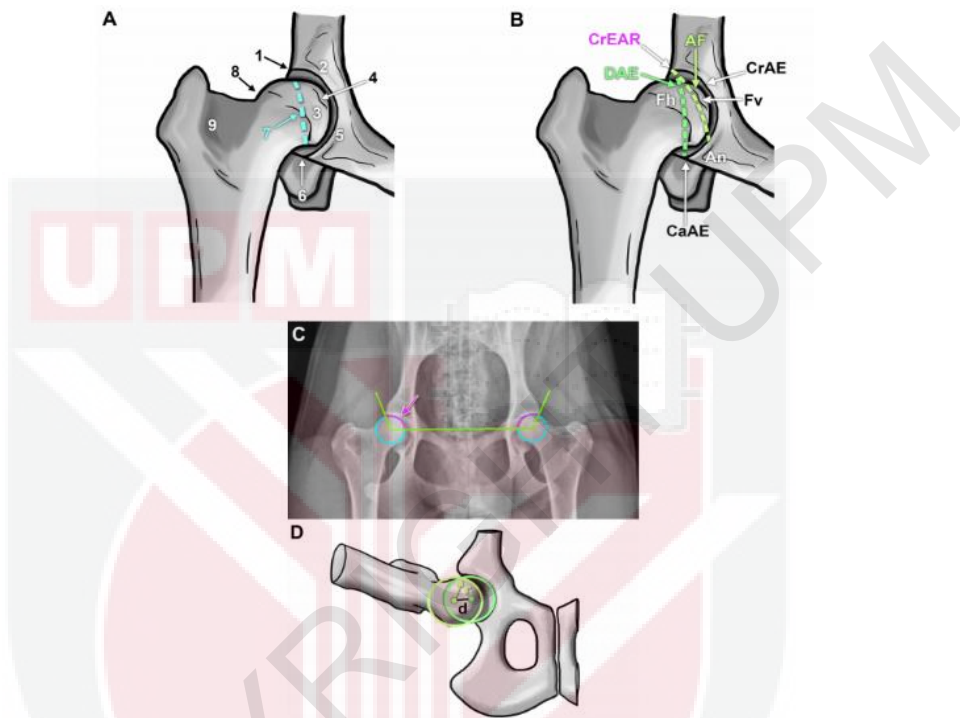


Figure 2: landmarks in evaluating the severity of canine hip dysplasia. A) OFA grading method's nine anatomical parameters: 1) craniolateral acetabular rim, 2) cranial acetabular margin, 3) femoral head, 4) fovea capitis, 5) acetabular notch, 6) caudal acetabular margin, 7) dorsal acetabular margin, 8) junction of femoral head and neck, 9) trochanteric fossa. B) BVA grading parameters. C) Norberg angle. D) Pennhip method. (adapted from Schachner & Lopez, 2015)

As canine hip dysplasia is a hereditary disease, early screening methods are important to promote better breeding selection and for early diagnosis and treatment to delay the progression of degenerative joint disease. The University of Pennsylvania Hip Improvement Program (PennHip) is used to screen the hip laxity as early as 16 weeks

old. (AIS PennHIP) This method evaluates based on three radiological views including the hip extension view, stress view and distraction view. The hip extension view is to evaluate the presence of any current arthritic change, and the stress view is to evaluate the fitness of the femoral head into the acetabulum sockets. The hip extension view is taken using special equipment to pull the femoral head slightly off the acetabulum rim to measure the degree of loss of joint (Bojrab, 2014). The distraction index (DI) is calculated by measuring the distance between the centre of femoral head and acetabulum (d), and divided by the radius of femoral head (r) (**Figure 3D**). The score is from 0 to 1, with numbers closer to 1, the looser the joint is, and DI greater than 0.3 is considered a loose hip (Schachner, 2015; Kapatkin, 2002). As only DI less than the medium score of the total breed population can be selected based on the PennHip program, the offspring will have tighter and tighter hip joints (Gail, 2005). A recent study using OFA and Pennhip for breeding selection showed that with only OFA scoring, there is no change in hip joint scores. Whereas when using the combination of OFA and Pennhip method, there is significant improvement in the offspring joint quality (Haney, 2020). As studies have shown that 53% of dogs with OFA scoring excellent have DI more than 0.3, and the percentage for OFA scoring good and fair are 77% and 93% respectively, which means the OFA method is not a good screening method in breeding programmes (Fordyce, 2000).

2.4 Conservative Treatment of CHD

Dogs with hip dysplasia can be managed with long term conservative treatment. In a study of observation of 68 dogs with CHD and managed conservatively, 76% were evaluated 10 years later, among those, 63% to 79% show normal range of motion and

exercise tolerance (Barr et al. 1987). There are five main principles in conservative management of the hip condition (Bojrab, 2014). First and most important is body weight control. Excessive weight on the body mass increases the joint load, increases the degree of laxity and speeds up the process of joint degeneration (Kirkby, 2012). Ideal body condition score (BCS) is 4.5 to 5 out of 9. Proper weight control can be achieved by feeding 80-100% resting energy requirement (RER) calculated by formula seventy times body weight times 0.75 calories, in order to achieve 1-2% loose in body weight per week. (Bojrab, 2014) Feeding a prescription diet low in fat and protein is recommended.

Second is to manage the joint inflammation through the use of non-steroidal anti-inflammatory drugs (NSAIDs). Most veterinary NSAIDs preferred in inhibiting cyclooxygenase (COX)-2 pathways in order to reduce the side effect of gastric ulcerations. The most common drugs used include carprofen (mild to moderate pain), amantadine (for chronic neuropathic pain), deracoxib (for acute postoperative pain) and many more depending on availability and veterinary preference (Bojrab, 2014).

The third principle is to provide additional supplements for nutritional and anti-inflammatory effects, including omega-3 fatty acids, as well as joint cartilage supplements including glucosamine and chondroitin sulphate (Bojrab, 2014; Fritsch DA, 2010). It can help in prevention and treatment of osteoarthritis as well as reduce the use of NSAIDs in order to limit the side effects on gastrointestinal tract (Kirkby KA, 2012).

Fourth principle is related to proper exercise control depending on the stage of the disease. Cage rest is recommended for dogs with severe joint inflammation and hip luxation as well as post surgically. And the last fifth point is to promote recovery of the

limb function through physical therapy. The purpose is to increase the limb range of motions, prevent muscle atrophy, and slow down the progress of degenerative joint disease (Bojrab, 2014). Range of motion (ROM) and limb extension can be done when there is no pain involved. If pain is observed, a combination of pain management through medication and laser therapy can be done (Edge-Hughes, 2007). Additional treatment options including acupuncture, gold bead implantation and aquatic therapy with some evidence of improvement or non-significant effects (Schachner, 2015).

2.5 Surgical treatment of CHD

Multiple surgical options can be chosen based on the patient's age, disease severity and the viability of the joint. Juvenile pubic symphysiodesis (JPS) can be performed on puppies less than five month old. Through the closure of pubic symphysis, ventrolateral rotation of the acetabulum can be achieved to facilitate better femoral head coverage (Schachner, 2015). The candidates are selected based on a hip screening programme with joint subluxation or high distraction index (Bojrab, 2014). Triple or double pelvic osteotomy (TPO/DPO) can be performed on younger dogs with hip subluxation but minimal arthritic changes upon radiographic examination (Bojrab, 2014). The purpose of this surgery is to rotate the acetabulum socket ventrolateral for better femoral head coverage by cutting the ilium, pubis and ischium and stabilise with bone plates on the iliac osteotomy to facilitate the rotation (Schachner, 2015).

Another salvage procedure that can be done on cases with severe DJD is called total hip replacement (THR), which is done on older dogs. The implant designs are identified as cemented and cementless. The cemented THRs include a femoral stem, femoral head and acetabular cup. This technique is mainly used on old patients with

limited exercise requirements and short life expectancy (Bojrab, 2014). Compared to the cemented design, the cementless THRs allow bone to grow into the cup shell allowing long term fixation of the implant. It is more often done on younger patients with faster bone growth rate, higher level of exercise requirements and longer life expectancy (Bojrab, 2014). The postoperative complication of implantation including the loss of cement, inflammatory response with improper handling and asepsis (Schachner, 2015). A successful hybrid design of cementless acetabular cup with cemented femoral implant was achieved on dogs (Gemmill, 2010) .

Femoral head and neck excisional arthroplasty (EA) is performed to reduce the joint contact and lead to the formation of a fibrous false joint. Although it is considered a salvage procedure by many veterinarians due to unpredictable fibrous pseudoarthrosis joints, many patients have reduced lameness and better limb function after the surgery (Bojrab, 2014).

Another orthopaedic surgery called intertrochanteric varus osteotomy (IVO) has the similar principles as JPS and DPO to achieve better femoral head coverage on patients with minimal osteoarthritis. It is achieved by a femoral wedge osteotomy proximal to the lesser trochanter, reducing the femur and fixation with a double hook plate (Remedios, 1995). A study on dogs post IVO shows significant improvement of both Norberg angle and femoral head coverage percentage, from pre-surgically 78.9 ± 7.5 degree and $36.9 \pm 5.2\%$ to post-surgically 92.2 ± 6.7 degree and $50.6 \pm 8.3\%$ respectively (Pinna, 2013).

3.0 MATERIALS AND METHODS:

3.1 CHD case identification

A total of 126 cases were identified from the UVH log book from year 2019 to year 2021, based on the information related to signs of hindlimb lameness, revisit cases of canine hip dysplasia, and cases involving osteoarthritis. Further based on the patient case file history, medical treatment and radiograph image, 54 cases of CHD were identified. Among the 54 patients, 38 cases were able to access the radiograph image, and 4 surgery cases were noted down.

During physical examination, information relates to CHD cases on the case file including weight bearing or non-weight bearing lameness, stiff gait, tip-toe gait and muscle atrophy. The neurological tests were done for most cases to rule out other possible causes of lameness, including anal and tail tone, patella and sciatic reflex, and withdrawal reflex on hindlimbs.

For cases with no final diagnosis, identification for CHD was achieved through radiographic examination. Individuals with shallow acetabulum, thickened femoral neck, increased joint space, irregular acetabulum, and sclerosis or osteophytes were noted down as CHD. The other false identification of joint luxation due to trauma was ruled out by the combination of history (usually hit by car or fall) and the radiograph image with normal acetabulum depth and femoral head shape. For cases without viable radiograph images, identification based on radiographic description on case files and history of lameness were used to identify the case. Referred and revisited CHD cases were also noted down.

3.2 Severity grading using OFA method

According to the OFA grading system (Orthopedic Foundation for Animals, 2022), hip dysplasia is categorised into mild, moderate and severe based on nine parameters including craniolateral acetabular rim, cranial acetabular margin, femoral head, fovea capitis, acetabular notch, caudal acetabular margin, dorsal acetabular margin, junction of femoral head and neck, and trochanteric fossa (Schachner, 2015). The main difference between mild and moderate hip dysplasia is the absence of arthritic change on femoral head and acetabulum, and the difference between moderate and severe is related to the severity of sclerosis and remodelling. (Figure 3)

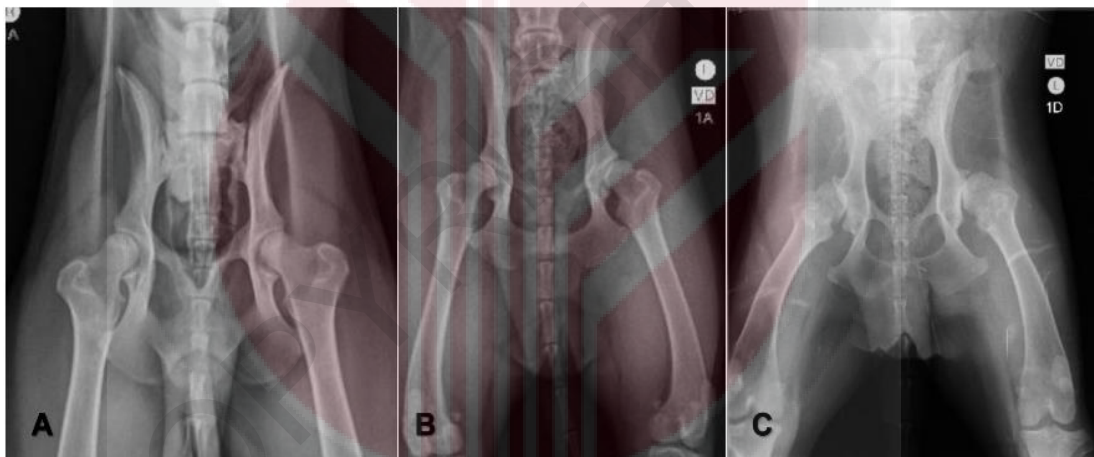


Figure 3: Case severity grading based on OFA method A) German Shepherd (9 year old, 32 kg, 094292) with mild hip dysplasia. B) Rottweiler (1 year old, 33 kg, 094795) with moderate hip dysplasia. C) German Shepherd (1 year old, 41 kg, 098755) with severe hip dysplasia.

3.3 Evaluation on the age, sex, body weight and breed

Fifty four CHD cases were identified and the parameters including age, gender, breed, body weight, treatment choice was noted down and tabulated into Excel sheets. For general evaluations on the parameters, various tables, pie chart and box graphs were

used for visualisation of various data information. In order to do statistical analysis of the correlation between breed and body weight with other parameters, the 54 cases were classified into large (≥ 25 kg), medium (>10 kg, ≤ 25 kg) and small (≤ 10 kg) breed and sized dogs, and the percentage of each size breed was compared using pie charts. To compare the age parameters, the cases were identified based on age group including juvenile (≤ 2 year old), adult (3-9), and seniors (≥ 10 year old) and further classified based on breed size. Evaluation of gender influence on CHD was done based on calculation of case presence for large, medium and small breed dogs. Then the CHD cases were further classified based on the occurrence of different breeds, and the most common breeds visited were used to compare the case numbers, average body weight and average age when diagnosed with CHD.

3.4 Spearman's rank correlation

Spearman's rank correlation test was done on individual breeds including Golden Retrievers, GSD and Rottweilers to identify the correlation between body weight, age and gender with the severity of hip dysplasia based on OFA scoring.

As well for the 35 cases with OFA scoring, Spearman's rank correlation was computed to assess the relationship between body weight, age, gender and the OFA scoring. The 35 cases were identified based on breed sizes including large, medium and small breed dogs, and the correlations of the parameters within different sized breed were tested using the spearman's correlation as well.

3.5 Statistical Analysis

The data from Fifty four CHD cases were presented in Microsoft Excel sheets and analysed using IBM SPSS Statistics version 26. The test used for hypothesis testing

was the Kruskal Wallis test as it is a non-parametric test to compare between two or more groups based on a dependent variable (McKight, 2010). The test will show a significant difference between groups if the P value is less than 0.5 ($P < 0.5$), then a series of Mann-Whitney U tests could be done to determine the difference between each group of animals. The test will be non-significant if the P value is more than 0.5 ($P > 0.5$), which indicates that there were non-significant differences among the groups of animals related to the dependent variable. The specific hypothesis, test groups and related dependent variables were stated as follow:

3.5.1 Comparison of the severity of CHD between large, medium and small breed dogs

Thirty five cases with OFA grading based on radiograph were used to compare the median severity of CHD between large, medium and small breeds using the Kruskal Wallis test. Null hypothesis was that the median of severity of CHD were equal for large, medium and small breed dogs. The alternative hypothesis was that the median of severity of CHD were equal for large, medium and small breed dogs. The dependent variable is the severity of CHD based on OFA grading, independent variable was the 3 breed groups (Large, medium, and small). The descriptive statistics and the result was note down in the result section.

3.5.2 Comparison of body weights of dogs with mild, moderate and severe CHD

Thirty five cases were tested using the Kruskal Wallis test, to compare the ranked median body weight between mild, moderate and severe hip dysplasia based on OFA grading. Null hypothesis was that the median body weight was equal for mild, moderate and severe CHD. The alternative hypothesis was that the median body weight was not

equal for mild, moderate and severe CHD. The dependent variable was the body weight of 35 dogs, independent variable was the three groups of CHD severity (mild, moderate, and severe). The descriptive statistics and the result was note down in the result section.

3.5.3 Comparison of ages of large, medium and small breed dogs with CHD

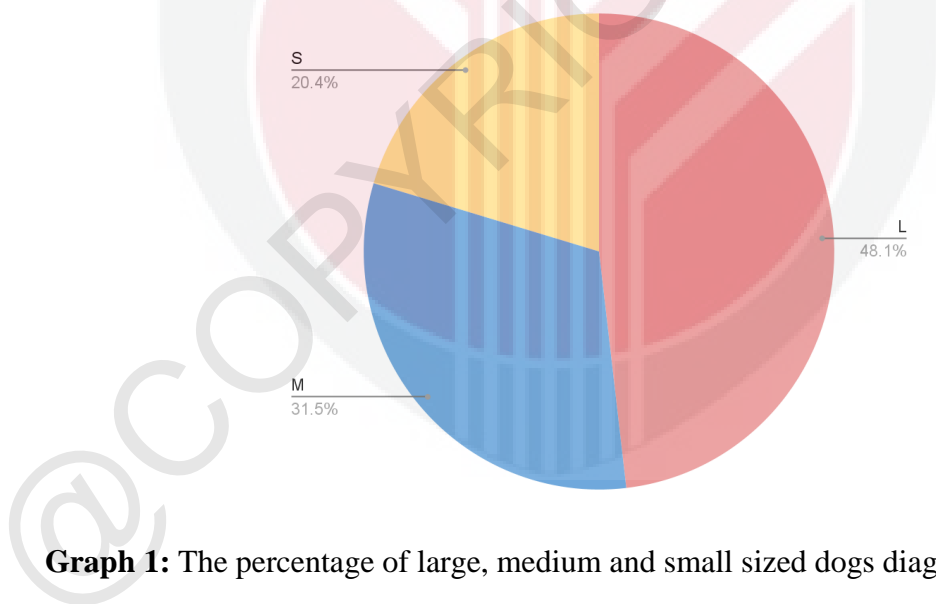
The total 54 cases were used to compare the mean rank of age for large, medium and small breed dogs presented to UVH due to CHD. Null hypothesis was that the mean rank of age for large, medium, and small breed dogs diagnosed with CHD were the same. The alternative hypothesis was that the mean rank for large, medium and small breed dogs were not the same. The dependent variable was the age of 54 dogs, the grouping variable was the 3 breed sizes of dogs (large, medium and small). A series of Mann-Whitney U tests will be done if the Kruskal Wallis test show significant result, which means there is significant age difference between the three breed of dogs, in order to compare between two separate groups with the dependent variable of age.

4.0 RESULTS

4.1 General evaluation of different parameters to CHD and the severity

4.1.1 Relation of breed with CHD and severity

Among the 54 cases, the number of large breed dogs was 26 (48.1%), medium breed dogs was 17 (31.5%), and small breed dogs was 11 (20.4%) (**Graph 1**). The 35 numbers of OFA graded hip dysplasia cases were identified based on the breed size are tabulated into a table (**Table 1**). Conclusion can be made that there were more large breed dogs visiting UVH due to CHD compared to medium and small breed dogs, which could indicate that CHD affects more large breed dogs compared to medium and small breed dogs.



Graph 1: The percentage of large, medium and small sized dogs diagnosed with CHD presented at UVH

Table 1: Total cases of mild, moderate and severe hip dysplasia based on OFA grading

OFA grading	case no	Large breed	Medium Breed	Small breed
Mild	10	5	4	1

Moderate	13	7	5	1
Severe	12	6	3	3
Total	35	18	12	5

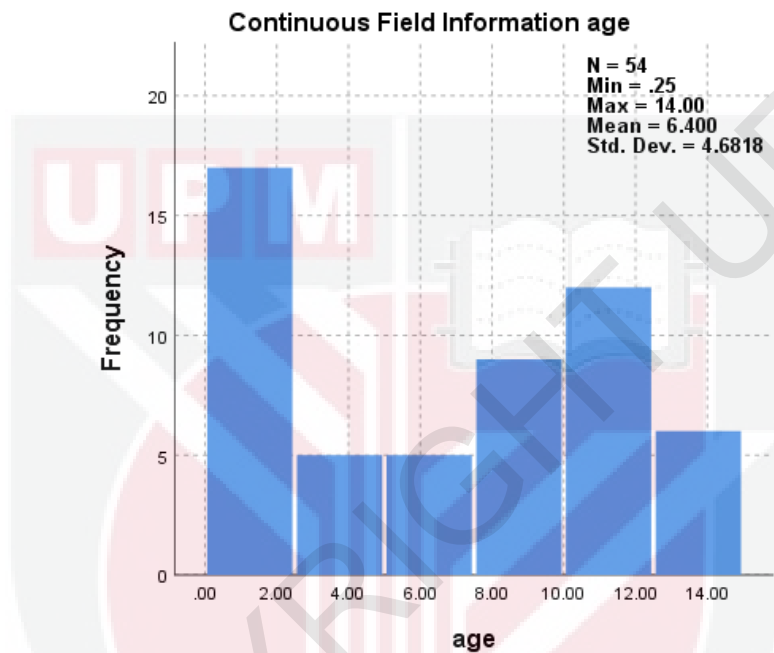
4.1.2 Relation of age with CHD and severity

Juvenile canine hip dysplasia happens on dogs less than 2 years of age, which in this study include 17 cases. Most of the cases are from medium breed dogs (70.59%). Adult canine hip dysplasia calculated for dogs aged between 3 to 9, which contain 19 cases. For senior dogs age older than 10 years old, there were 18 cases (**Table 2**). The frequency of age for CHD cases was graphed on a bar chart with minimum of 0.25 (3 month) and maximum 14 year old, and the mine age is 6.4 with standard deviation of 4.68. (**Graph 2**) According to the comparison of severity percentage of juvenile hip dysplasia to adult hip dysplasia, there was increased percentage of severe scoring (42%) in adult dogs, compare to juveniles with mostly mild and moderate hip dysplasia (44%). (**Table 3**)

Table 2: Age group of Juvenile, adult and senior cases

Age (year)	Case No	Breed	Breed No	Percentage
≤2	17	L	2	11.76%
		M	12	70.59%
		S	3	17.75%
3-9	19	L	8	42.11%
		M	7	36.84%
		S	4	21.05%

≥10	18	L	10	55.56%
		M	4	22.22%
		S	4	22.22%



Graph 2: Bar chart of age distribution for 54 CHD cases

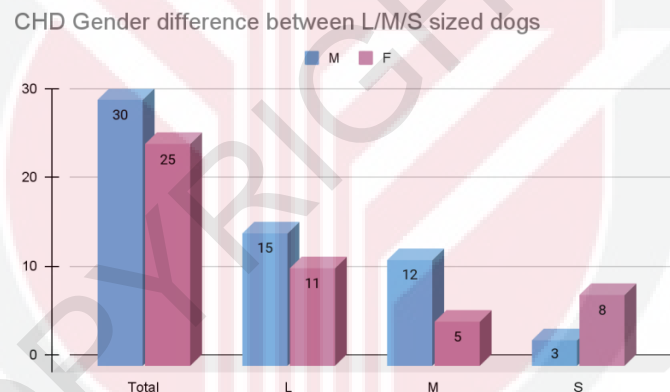
Type	Case No	OFA grading		Percentage
Juvenile CHD	9	Mild	4	44%
		Moderate	4	44%
		Severe	1	11%
Adult CHD	26	Mild	6	23%
		Moderate	9	34%
		Severe	11	42%

Table 3: Severity comparison between juvenile and adult CHD

4.1.3 Relation of gender with CHD and severity

General evaluation of gender influence on CHD was done based on calculation of case presence for large, medium and small breed dogs. Among the 26 large breed dogs with CHD, there were 15 males (57.7%) and 11 females (42.3%). Among the 17 medium breed CHD dogs, there were 12 males (42.3%) and 5 females (42.3%), and for the small breed dogs, there were 3 males (27.2%) and 8 females (72.8%). In total out of 54 total CHD cases, there were 30 (55.6%) male dogs and 25 (44.4%) female dogs.

(Graph 3) There were more male dogs visiting UVH due to CHD compared to female dogs, however the difference was not significant.

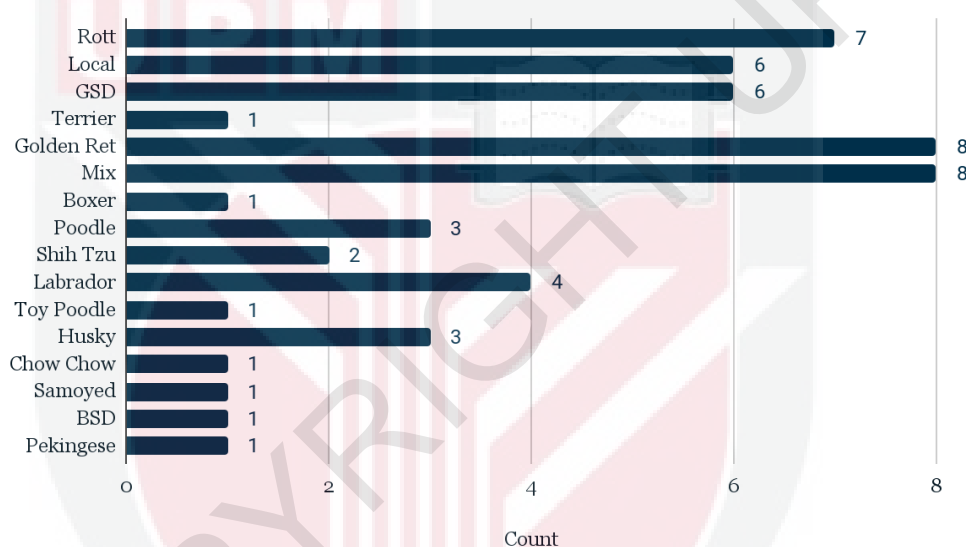


Graph 3: Gender difference between large, medium and small sized dogs with CHD

4.1.4 Comparison of breeds to CHD cases

Based on the CHD cases occurrence in different breeds (**Graph 4**), there were 8 cases of Golden Retriever (15.1%), 8 mix breed dogs (15.1%), 7 Rottweilers (13.2%), 6 German Shepherd (11.3%), 6 local breeds (11.3%), 4 Labrador (7.5%), 3 Poodle (5.7%), 3 Husky (5.7%), 2 Shih Tzu (3.8%) and other breeds including Boxer, Terrier, Toy Poodle, Chow Chow, Samoyed, Pekingese all 1 cases (1.9%). The most common breed predisposed to hip dysplasia was Golden Retrievers, followed by Rottweilers,

and German Shepherds. The average age for Golden Retrievers to be identified with CHD clinic signs was 2.6 years old, and 5 out of the 8 cases (62.5%) were identified at dogs below 12 month old. (Table 4) Compared to the average age of CHD for Rottweilers and German Shepherds are 8.1 and 6 years old respectively, Golden Retrievers had more common juvenile hip dysplasia which might be due to genetic predisposition of loose hip.



Graph 4: Occurrence of CHD identified based on breeds

Breed	Case no	Mean BW (kg) \pm SD	Mean age(Year) \pm SD
Golden Retriever	8	24.90 \pm 4.56	2.6 \pm 4.4
Rottweiler	7	38.71 \pm 7.02	8.1 \pm 3.9
German Shepherd	6	34.77 \pm 9.52	6.0 \pm 4.0

Table 4: Breed comparison of average body weight and age

4.2 Body weight and gender correlation to hip dysplasia severity

The Spearman's rank correlation result within individual breeds (including Golden Retrievers, GSD and Rottweilers) shows that there was a significant positive correlation between body weight and OFA severity grading for GSD, $r(5) = [0.949]$, $p = [0.007]$. For the other two breeds, no significant correlation was tested which might be due to insufficient case number and OFA scoring, and the diversity of individual animals.

For the 35 cases with OFA scoring, there were 18 large breed dogs, 12 medium breed dogs, and 5 small breed dogs. For large breed dogs, the Spearman's rank correlation show there was a positive correlation between the body weight and the severity of CHD [$r(18) = 0.518$, $p = 0.028$]. **(Figure 4A)** The result indicates that increase of body weight leads to more severe CHD in large sized dogs. However there was no significant correlation between age and gender to the OFA graded CHD severity. Between 12 medium sized dogs, there was a positive correlation between age and OFA scoring [$r(12) = 0.541$, $p = 0.035$] which means that the severity of CHD increases with age in medium sized dogs. **(Figure 4B)** There was no significant correlation between body weight and gender to the OFA scoring in medium sized dogs. Between small sized dogs, there was no significant correlation between age, body weight and gender to the severity of CHD being tested though spearman's correlation. This might be due to insufficient case numbers.

A

Correlations

			Body weight	OFA scoring
Spearman's rho	Body weight	Correlation Coefficient	1.000	.518*
		Sig. (2-tailed)	.	.028
		N	18	18
	OFA scoring	Correlation Coefficient	.518*	1.000
		Sig. (2-tailed)	.028	.
		N	18	18

*. Correlation is significant at the 0.05 level (2-tailed).

B

Correlations

			OFA	Age
Spearman's rho	OFA	Correlation Coefficient	1.000	.541*
		Sig. (1-tailed)	.	.035
		N	12	12
	Age	Correlation Coefficient	.541*	1.000
		Sig. (1-tailed)	.035	.
		N	12	12

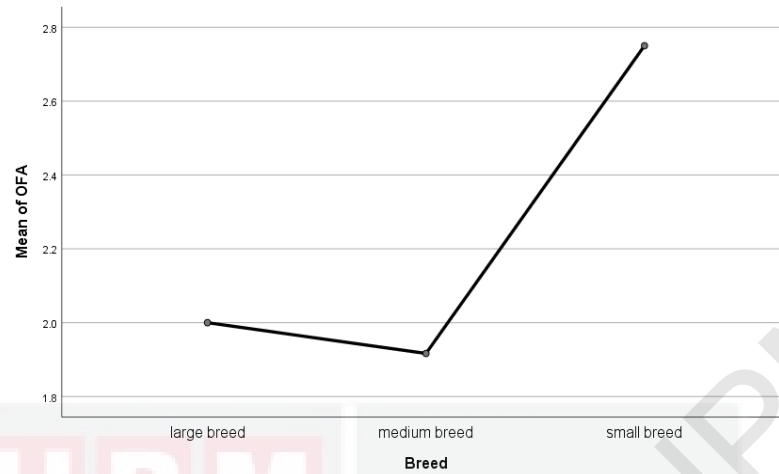
*. Correlation is significant at the 0.05 level (1-tailed).

Figure 4: Spearman's rank correlation of different parameters

4.3 Hypothesis testing result using statistical analysis

4.3.1 Severity of CHD between large, medium and small breed dogs

According to the descriptive statistics, the mean value for OFA grading for Large breed dogs was moderate (2 ± 0.82), for medium breed dogs was mild to moderate (1.92 ± 0.79), for small breed dogs was moderate to severe (2.75 ± 0.5) (**Graph 5**). As **Figure 5** shows, the mean rank for large breed dogs ($n=18$) was 17.97, medium breed dogs ($n=12$) was 16.29 and small breed dogs ($n=5$) was 22.2. However the Kruskal-Wallis Test show no significant difference [$H(2) = 1.325, p = .516$] among the three categories of mild, moderate and severe OFA scoring. This result means that the severity of hip dysplasia, scored based on the OFA method, showed no significant difference between large, medium and small breed dogs.



Graph 5: Line graph of the mean of OFA for large, medium and small breed dogs.

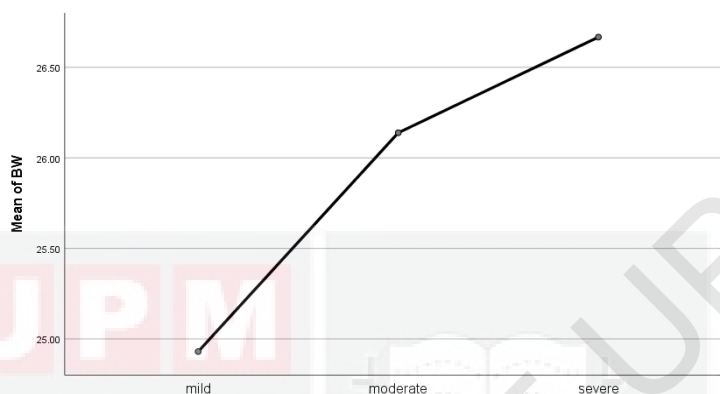
Ranks				Test Statistics ^{a,b}	
	breed	N	Mean Rank		OFA
OFA	Large Breed	18	17.97	Kruskal-Wallis H	1.325
	Medium Breed	12	16.29	df	2
	Small Breed	5	22.20	Asymp. Sig.	.516
	Total	35		a. Kruskal Wallis Test	
				b. Grouping Variable: breed	

Figure 5: Kruskal Wallis test compares median OFA grading for different breeds

4.3.2 Body weights of dogs with mild, moderate and severe hip dysplasia

Statistical descriptive shows that, the mean value for body weight for mild CHD cases was 24.93 (± 13.18), for moderate CHD cases was 26.14 (± 0.79), for severe CHD cases was 26.67 (± 15.96), and the total mean body weight for all 35 cases was 25.97 (± 13.56) kg. According to the line graph (**Graph 6**), the mean of body weight increases slightly with the severity of CHD based on OFA grading. However there were no statistically significant differences between group median as determined by Kruskal-

Wallis H test ($H(2) = 0.193, P = .908$) with a mean rank of 16.95 for mild OFA grading, 18 for moderate OFA grading, and 18.88 for severe OFA grading. (**Figure 6**)



Graph 6: Line graph of the mean body weight for mild, moderate and severe CHD

Ranks			Test Statistics ^{a,b}	
OFA	N	Mean Rank	bodyweight	
Mild	10	16.95	Kruskal-Wallis H	.193
Moderate	13	18.00	df	2
severe	12	18.88	Asymp. Sig.	.908
Total	35		a. Kruskal Wallis Test	
			b. Grouping Variable: OFA	

Figure 6: the Kruskal Wallis test compares body weight of mild, moderate & severe OFA

4.3.3 Age of large, medium and small breed dogs

The descriptive statistic shows that the mean age for large, medium and small breed dogs showing CHD were 8.55 (± 3.7), 4.36 (± 4.4), and 6.75 (± 5.0) respectively. The total average of dog age showing CHD was 6.4 (± 4.7). (**Table 5**) The Kruskal Wallis test (**Figure 7**) showed significant age difference between large, medium and small breed dogs ($H(2) = 9.342, p = 0.009$), with a mean rank of 34.95 for large breed

dogs (n = 20), 20.37 for medium breed dogs (n = 23), and 28.86 for small breed dogs (n = 11).

Table 5: Average age for large, medium and small breed dogs

	N	Mean	Std. D	Minimum	Maximum
Large breed	20	8.55	±3.7	1	13
Medium breed	23	4.36	±4.4	0.3	13
Small breed	11	6.75	±5.0	0.25	14
Total	54	6.4	±4.7	0.25	14

Ranks				Test Statistics ^{a,b}		
		Breed (L/M/S)	N	Mean Rank	Age (year)	
Age (year)	Large Breed		20	34.95	Kruskal-Wallis H	9.342
	Medium Breed		23	20.37	df	2
	Small Breed		11	28.86	Asymp. Sig.	.009
	Total		54		a. Kruskal Wallis Test	
					b. Grouping Variable: Breed (L/M/S)	

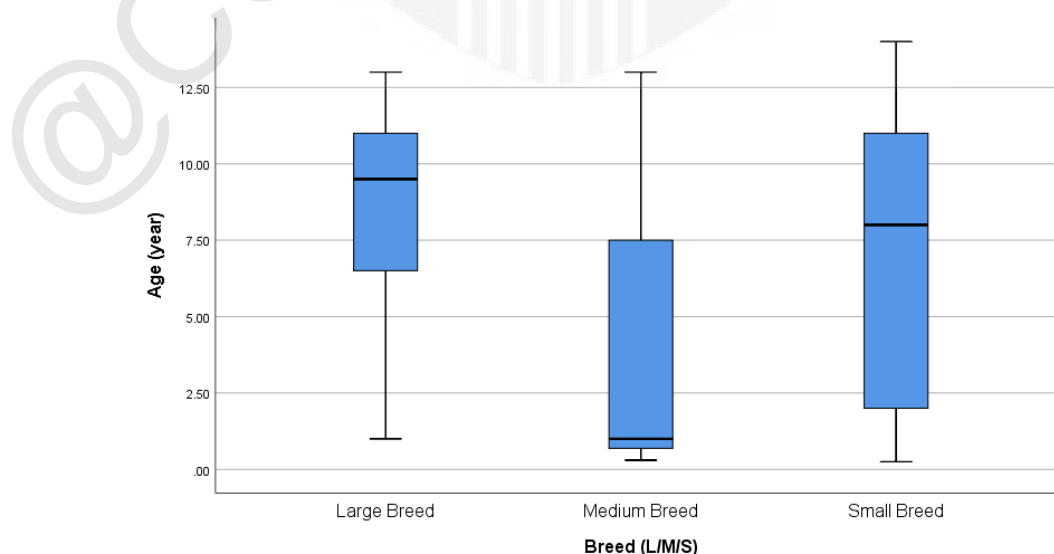
Figure 7: the Kruskal Wallis test compares the age of large, medium and small breed dogs

A series of Mann-Whitney U tests was done to compare between two separate groups with the dependent variable of age. As **Figure 8** shows, the age for medium breed dogs (Mdn = 16.59) was significantly lower than large breed dogs (Mdn = 28.23; U = 105.5, P = 0.002). However there was no significant difference of median age between large (Mdn = 17.23) and small (Mdn = 13.77) breed dogs (U = 85.5, p = .309).

In addition, there was also no significant difference of median age between medium (Mdn = 15.78) and small (Mdn = 21.09) breed dogs ($U = 87, p = .145$). Overall, the medium breed dogs tend to show CHD in younger age compared to large and small breed dogs from the year 2019 to 2021 in UVH-UPM. (**Graph 7**) However there was no significant age difference between large and small breed dogs, as well for medium and small breed dogs when showing CHD conditions according to Mann-Whitney U tests.

Ranks				Test Statistics ^a		
				Age (year)		
	Breed (L/M/S)	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W
Age (year)	Large Breed	20	28.23	564.50	Z	-3.039
	Medium Breed	23	16.59	381.50	Asymp. Sig. (2-tailed)	.002
	Total	43			a. Grouping Variable: Breed (L/M/S)	

Figure 8: the Mann-Whitney Test compares age between large and medium breed dogs



Graph 7: Box plot of average age for large, medium and small breed dogs

4.4 Medication choices and conservative management of hip dysplasia at UVH

As the **table 6** shows, the most common choice of medication used in managing CHD cases in UVH was Synoquin which was used in 31 cases (56.36%). Information from Vetplus (VetPlus 2021) stated that they provide two types of chondroprotective including Synoquin® Growth for puppies and young adults of 18 to 24 months old to strengthen the cartilage with rapid growth, and the other type Synoquin® is a chewable tablets for large, medium and small breed adult dogs to maintain cartilage health, mobility of the joint and manage hip dysplasia. The main ingredients include Chondroitin sulphate and Glucosamine hydrochloride (for cartilage and joint fluid health), Dexahan (rich in omega-3 fatty acids), Zinc (for cartilage metabolism) and Vitamin C (antioxidative vitamin). It can be used for short term or long term joint disease management with a initial loading rate of 6 weeks (Hart, 2022). At UVH, average prescription time for Synoquin® was 48 days and additional 7 out of 31 cases (22.6%) choose long term management of initially three capsules a day for 6 weeks followed by one capsule a day. The duration of prescription for other cases range from 1 week to 6 weeks with dosage of two capsules per day.

The second most commonly used medication was tramadol, as a synthetic opioid to treat chronic and acute pain with conditions like osteoarthritis As this medication does not treat the underlying cause of pain, conjunction use with NSAIDs like carprofen (Rimadyl) was often applied. The side effects of tramadol include vomiting, nausea, anorexia, constipation, etc, and it is not suitable for dogs with liver or kidney disease (Burke, 2018). Thus it is only used when necessary with a dosage of 3 mg/kg, 50 mg

per capsule, two or three times a day depending on patient body weight and situation of pain. The dosage for carprofen was 4.4mg/kg, 25mg or 75mg or 100 mg per tablets, two times per day for 3-7 days, or 1 time per day for 14-21 days depends on the tablet concentration and patients' body weight.

Beazyme tablets are used together with physical therapy or other chemotherapy for the treatment or prevention of swelling and inflammation (NPRA, 2018). The active ingredient is proteolytic enzyme from carica papaya which is an anti-inflammatory enzyme. The prescription dosage from UVH was 1-2 tablets, two times a day for 1-2 weeks depending on the severity of condition.

Danzen tablets contain dexamethasone which works as an anti-inflammatory, immunosuppressive drug, used on 8 cases (14.55%) with prescription dosage of 1 tablet, two times a day for 1 to 3 weeks. It can be used together with Synoquin® and tramadol in managing CHD. The side effects of Danzen for long term usage include anorexia, increased thirst and urination, lethargy, hyperglycemia, etc, thus it is contraindicated in some situations such as cushing's disease, heart and kidney disease and diabetes (Clark, 2020).

Another choice of NSAIDs in UVH was Cimicoxib (Cimalgex®) It is a COX-2 inhibitor used to manage pain and inflammation associated with osteoarthritis (European Medicines Agency medicine appendix), and was used by 8 cases (14.55%) in a dosage of 2 mg/kg, one tablet a day for 1-3 weeks. It can be used alone or together with Synoquin® for management of CHD. Meloxicam was another commonly used NSAIDs used for treating pain relating to osteoarthritis, with a dosage of 0.1 mg/kg, 1.5 mg/ml, one time a day depends on patients' body weight, and given through oral or subcutaneous injection.

Medication	Active ingredient	Function	Case used	Percentage
Synoquin	chondroitin sulphate, Dexahan	advanced joint supplement	31	56.36%
Tramadol	Tramadol hydrochloride	pain management	20	36.36%
Rimadyl	carprofen	NSAIDs	18	32.73%
Beazyme	Carica papaya proteolytic enzymes	reduce pain or inflammation	10	18.18%
Danzen	Dexamethasone	anti-inflammatory, immunosuppressive	8	14.55%
Cimalgex	Cimicoxib	manage pain and inflammation associated with osteoarthritis	8	14.55%

Table 6: common choice of medication and cases used in UVH for hip dysplasia

Other management suggestions for the owner include physiotherapy to reduce muscle atrophy, stiffness and fasten recovery of viability of the hindlimb. Other suggestion including change to prescription diet to facilitate fast growth (eg. Healthy Mobility diets for large breed dogs from Hills/Royal Canin) and weight control though restricted feeding, instead of feeding ad libitum. Cage rest for at least a month was also suggested to fasten recovery of joint inflammation and fasten recovery postoperatively.

4.5 Surgery treatment outcomes

Out of the fifty four CHD cases, four chose to treat CHD surgically at UVH, and three out of the four cases revisited with optimum improvement of the disease condition. One case was euthanized due to disease complications (**Table 7**).

no	Body weight (kg)	OFA	Warded post-op	Outcomes	Post-op complication	Concurrent diseases
1	40.4	Moderate	1 day	Marked muscle wasting, occasional limping	None	Lump, atopic dermatitis
2	14	Moderate	none	Euthanized 1 day after surgery	Unstable BP, hypothermia, tachycardia	Multiple lump, early stage degenerative mitral valve disease
3	3	Mild	5 days	Less painful HLs, stiffness muscle, abnormal gait	None	Upper respiratory disease, sensitive skin
4	3.8	Moderate	2 days	Less painful, muscle atrophy, abnormal gait	None	Pelvic fracture history

Table 7: Surgery cases with recovery time, surgical outcomes and concurrent diseases

As shown in **Table 7**, case 1 was a 11 year old male Rottweiler with body weight 40.4 kg, and a history of pain and difficulty walking. Left hip excisional arthroplasty was done together with lumpectomy in 2017. The dog was awarded for 2 days post surgery and could sit, stand and walk with non-weight bearing lameness of left hindlimb. Medication prescribed in hospital was Tramadol (3 mg/kg, 50mg/ml, 2.4ml SQ TID), Baytril (5 mg/kg, 4.1 ml IV SID), Beazyme (2 tab PO BID), Meloxicam (0.1mg/kg 0.8ml SQ SID). Baytril is an antibiotic to prevent negative bacteria with a dosage of 5-20 mg/kg. (Bojrab, 2014) Upon suture removal, the dog was able to use the left hindlimb with weight-bearing lameness and obvious limping gait, however, marked

muscle wasting was noticed. **(Figure 9A)** The owner was suggested to do physiotherapy at home. During the revisit for 6 weeks later, the dog was able to use the left hindlimb well with occasional limping, and was very active. 8 month later the owner revisited with complaints of easily slipped off of the left hindlimb **(Figure 9B)**. The dog was prescribed with Danzen (1 tab BID 7d 14 tab), Tramadol (2 tab BID 7d), and Synoquin Large breed (1tab BID) as daily supplements. In 2020, the dog was revisited for pain and limping. Physical examination showed no lameness and inflammation, and crepitus felt upon flexion of left hindlimb, prescribed with pain killer, Beazyme and Synoquin. **(Figure 9C)**

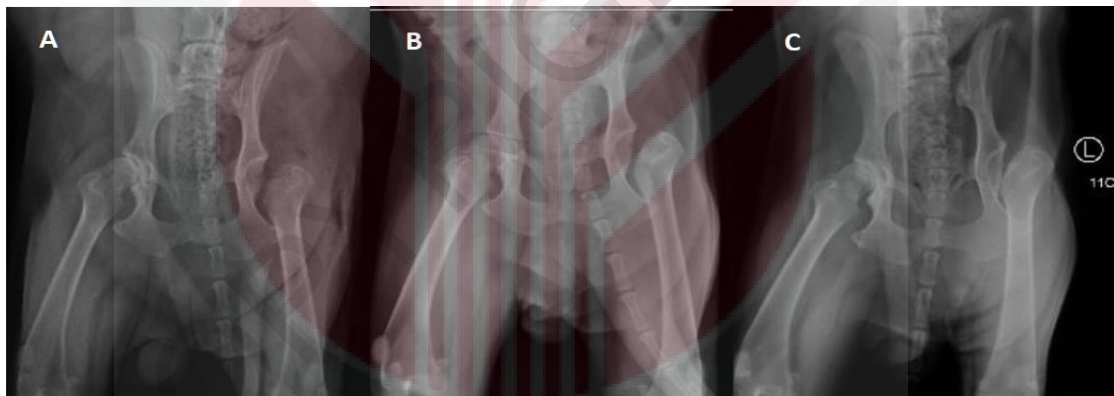


Figure 9: Radiograph of progression of CHD for a 11-year-old Rottweiler post left hind limb EA. **A)** Post EA in 2017 with absence of left femoral head and neck, and mild hip dysplasia of right coxofemoral joint. **B)** Radiograph taken in 2018 showed no obvious change on L joint and progression of moderate hip dysplasia of right coxofemoral joint. **C)** Radiograph taken in 2020 showed severe hip dysplasia of the right coxofemoral joint.

For case 2, although EA was done, the dog was euthanized one day post surgery due to unstable condition and concurrent diseases including multiple lumps growth, and early stage Degenerative Mitral Valve disease (DMVD).

Case number 3 was a referred case from a private clinic with left coxofemoral luxation. The dog was a 5-year old female toy Poodle with a body weight of 3 kg, and a history of limping, unable to stand, and pain of both hindlimbs. **(Figure 10A)** Left hindlimb coxofemoral EA was done in March 2019 and the recovery period was 5 days with no complications. During the 5 days of hospitalisation, the dog's gait was improved from non-weight bearing to weight bearing lameness. Medication prescribed including Clavamox (12.5 mg/kg 1tab 62.5 mg PO BID), Tramadol (3mg/kg 0.2ml slow IV TID to ¼ tab 50 mg PO TID), Meloxicam (0.1 mg/kg 0.06ml SQ SID), and Beazyme (1 tab PO BID). Upon suture removal, the dog was showing less pain and able to use the left hindlimb. Upon physical examination, the left quadriceps muscle was stiff and the dog had a tip-toe gait. The owner was suggested to do physiotherapy at home.

The fourth case was a 1 year 6 month toy poodle with a body weight of 3.8 kg. She was diagnosed with right femoral head total luxation and referred from a private clinic, with a history of non-weight bearing lameness. Upon physical examination, minimum pain was observed and slight stiff gait and mild weight bearing of right hindlimb. Surgery of right coxofemoral joint EA was done in July 2021 and the recovery period was 2 days. There was gait improvement observed from occasional weight bearing to weight bearing lameness. Medication prescribed included Clavamox, Tramadol, Ranitidine (2mg/kg 0.3ml IV BID), Metoclopramide (0.5mg/kg 0.4ml IV BID) and Meloxicam (0.1mg/kg 0.08ml SQ SID). Upon suture removal, there was right hindlimb muscle atrophy with weight bearing lameness, and crepitus was felt at the

right hip joint. After 6 weeks post EA, the dog revisited with a complaint of hesitation to use the right hindlimb after running. Physical examination showed weight bearing lameness, slight crepitus felt and 30% muscle atrophy of right hindlimb. (**Figure 10B**) The owner was suggested to do physiotherapy at home.

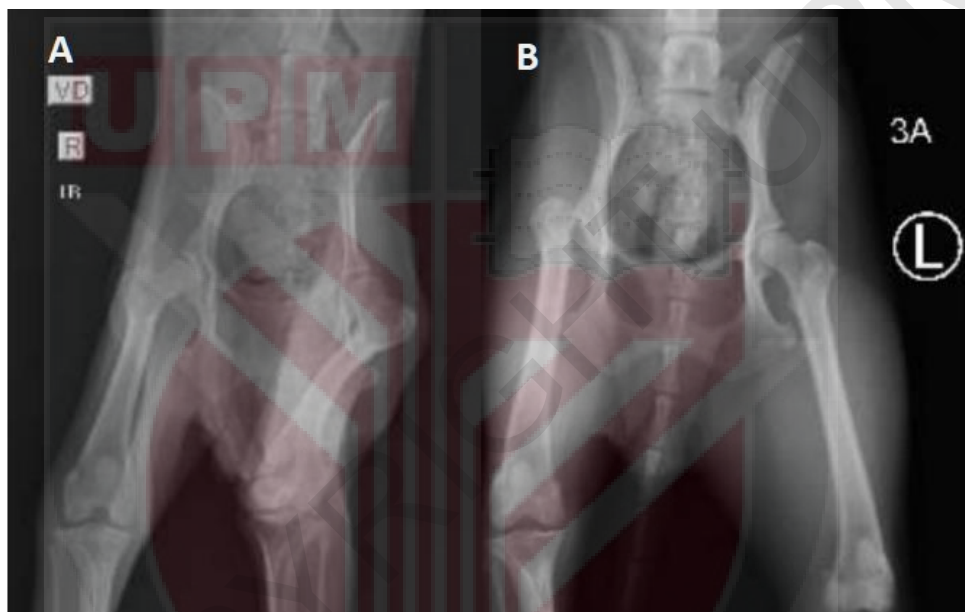


Figure 10: Radiograph of surgery case 3 & 4. **A)** Prior EA, the dog showed moderate hip dysplasia of the left coxofemoral joint. **B)** Post EA with absence of right femoral head and neck. There was contact between lesser trochanter and acetabulum might be the reason for lameness during revisit.

Overall, total of 4 CHD patients (9%) had excisional arthroplasty in UVH. One of them was euthanized due to post-op complications and concurrent diseases. Three of them had smooth recovery after surgery with no complications. As the surgery goal was to reduce pain and osteoarthritis, the three cases were all able to achieve the expectation as the dogs show reduced pain and start using the hind limb post-surgically. The gait of

the dogs with successful EA only show little improvement as they still show limping or weight bearing lameness 2-5 days post surgically, and during revisit evaluation. Case one showed painful or weight bearing lameness of left hind limb during revisit at 10 days, 3 month, 11 month, 14 month and 3 years post-surgically. Case 4 shown weight bearing lameness after exercise 6 weeks post-surgically. All the 3 dogs showed stiffness or wasted muscles on the surgical hind limbs. In this situation physiotherapy was suggested to be performed at home and the result was good. For active outdoor dogs like Rottweilers, long term joint supplement (Synoquin) is recommended to manage the occasional lameness, along with the use of painkillers (Tramadol). But overall the surgical outcomes were good.

5.0 DISCUSSION

There have been problems starting with case identification, such as missing cases due to abbreviated notes or logbook errors. All cases of weight-bearing or non-weight-bearing lameness, osteoarthritis, joint luxation, and hip dysplasia were recorded. Additionally, during the case files study, the problems encountered were missing case files, cases with no confirmed diagnosis, and mis-identification due to confusion of cause of joint luxation. As joint luxation could be caused by traumatic injury or hip dysplasia, further identification based on radiographic joint arthritic change is needed. Some cases with no traceable radiograph images were diagnosed based on radiograph description written on the case file, including shallow acetabulum, irregular femoral head, and sclerosis. And in some cases, suspected CHD have been removed from the study due to non-readable radiograph images.

During the radiograph diagnosis, OFA scale method was used to determine the severity of the hip dysplasia. However as this method is subjective, and required three veterinarians to make a precise determination, errors of mis-identification of the severity could occur because of limited trained veterinarians and poor radiograph quality. As this method also required a hip extended view with medial rotation of the hindlimbs, most of the images did not provide a perfect view due to improper position and restraining. In order to achieve a perfect positioning of the hip, heavy sedation or light anaesthesia will be needed due to the pain during manipulation.

According to general evaluation result, the CHD mostly diagnosed in large breed dogs (48%) which correlated with literature statement that the disease mainly involving large breeds (Lust, 1997). The main breeds diagnosed with CHD in UVH were Golden Retrievers, Rottweilers, and German shepherds, and these breeds were all listed in

literature as genetic predisposed breeds (Breur, 2001). The statistical analysis result shown positive correlation between body weight with the severity of CHD in large breed dogs and in German Shepherds, which is similar with the result from literatures stated that increased body weight lead to more severe osteoarthritis, and German Shepherds are more predisposed to DJD (Bojrab, 2014; Smith, 2001). However, the hypothesis testing of body weight and breed size relating to CHD severity show insignificant result, which could be due to insufficient case numbers and time restrains to follow up.

Observation of age distribution from bar chart shows that there was a cluster of cases between 0-2 years old, which indicate the happening of juvenile hip dysplasia in young dogs. In addition there was near even distribution of cases from age 3 to 14 which means CHD can affect all age group of dogs. The comparison of case number for juvenile hip dysplasia with adult hip dysplasia based on OFA scoring showed that, there was increased percentage of severe cases for adult hip dysplasia, which indicate more severe bone change and osteoarthritis in adults. In opposite, juvenile hip dysplasia shown mainly mild and moderate hip dysplasia. The result aligns with Morgan's finding in 1987, shows that hip dysplasia in young dogs usually involving luxation or sub-luxation, various in adult dogs mainly involving osteoarthritis. The statistical significant difference between the age of different breed size shown CHD, with the medium breed dogs shown CHD in younger age compare to large and small breed dogs.

6.0 CONCLUSION

Hip dysplasia affects a greater number of large breed dogs compared to medium and small breed dogs as 48.1% cases identified are large breeds. The common breeds of dogs with CHD were Golden Retrievers (8 cases, 15.1%), Rottweilers (7 cases, 13.2%), and German Shepherds (6 cases, 11.3%). There was a significant positive correlation between body weight and CHD severity in large breed dogs, and a positive correlation between age and CHD severity in medium breed dogs. There was not enough evidence to reject the null hypothesis that the OFA scoring was similar for different breed sized dogs, and body weight were the similar for mild, moderate and severe hip dysplasia. However, the null hypothesis where the age for large, medium, and small breed dogs visiting hospitals due to CHD were the same, was rejected as there was significant difference. The results show that the medium breed dogs generally show CHD in younger age compared to large and small breed dogs.

The common medical treatment methods for CHD used at UVH were a combination of joint supplement (Synoquin), pain killer (Tramadol) and NSAIDs (including carprofen, dexamethasone, cimicoxib or meloxicam). Only excisional arthroplasty was performed in UVH, and the surgical outcomes were generally good with improved pain and limb performance.

7.0 RECOMMENDATION

During diagnosis, the Barden or Ortolani tests could be done to detect the degree of hip laxity, as it is an easy palpation test that usually requires no sedation. Proper sedation or anaesthetics is recommended during radiograph taking for CHD to achieve a perfect image for scoring and to reduce the pain during manipulation. In addition, the PennHip test could be recommended for owners with young patients who have the intention to breed, as a loose hip could be determined by the screening test at 16 weeks of age.

Better medical record keeping for patients is suggested for UVH as loss of case files and missing of viable radiographs were noticed during case finding. For better future reference and study, it is important to draw down the confirmed diagnosis, the radiograph description, and the radiographic diagnosis.

Owners with CHD confirmed dogs should be advised about proper weight management, diet change and proper exercise moderation. Strict cage rest is initially recommended to help with recovery of the joint inflammation. Subsequently, slow rehabilitation exercise is recommended to facilitate fast recovery and rehabilitation of the use of hindlimbs. Exercise such as swimming, short walks, or training on flat ground are good approaches to rebuild the muscle mass and prevent muscle atrophy or stiffness. Physiotherapy should also be taught to the owner for use in the domestic setting. These physiotherapies and combined with the use of joint supplementation, will maintain good muscle strength and joint viability, thus improving the patient outcomes.

This study could be improved by extending study times, including members to diagnose radiographs, and following up on current status of the patients. Due to the limitations of retrospective study, we could not follow up with the current status of the patients and recent surgical outcomes. Additionally, some patients had no follow-up treatment at UVH, resulting in incomplete records. The cohort study should be a better study method for CHD as it is a chronic orthopedic disease, as this study method will continue to follow up with patients over an extended period of time, providing a better sample size and duration of observation for statistical analysis.

REFERENCES

Altunatmaz, K., Yucel, R., Devecioglu, Y., Saroglu, M., and Ozsoy, S. (2003). Treatment of canine hip dysplasia using triple pelvic osteotomy. *Veterinari Medicina*, 48(12), 41.

Andronesu, A.A., Kelly, L., Kearney, M.T., and Lopez M.J. (2015). Associations between early radiographic and computed tomographic measures and canine hip joint osteoarthritis at maturity. *76:19–27*.

Barr, A.R.S., Denny, H.R., Gibbs, C. (1987). Clinical hip dysplasia in growing dogs: the long-term results of conservative management. *J. Sm. Anim. Pract.* 28: 243–252.

Bojrab, M. J., Waldron, D. R., and Toombs, J. P. (2014). Current techniques in small animal surgery. CRC Press. P 1018 - 1040

Breur, G. J., Lust, G., and Todhunter, R. J. (2001). Genetics of canine hip dysplasia and other orthopaedic traits. *The Genetics of the Dog* Ruvinsky A and Sampson J, ed CABI Publ, Wallingford, UK, 267-98.

Burke, A. (2018). Tramadol for dogs: Find out why and how it's used. American Kennel Club. Retrieved October 8, 2022, from <https://www.akc.org/expert-advice/health/tramadol-for-dogs>.

Chalman, J.A., and Butler, H.C. (1985). Coxofemoral joint laxity and the Ortolani sign.

21:671–676

Clark, M. (2020). Dexamethasone for Dogs: Uses, dosage, & side effects. DogTime. Retrieved October 8, 2022, from <https://dogtime.com/dog-health/54489-dexamethasone-dogs-uses-dosage-side-effects>

Edge-Hughes, L., and Nicholson, H. (2007). Canine treatment and rehabilitation. Animal physiotherapy, assessment, treatment and rehabilitation of animals. uK: Blackwell Publishing, 216-8.

Fordyce, H.H., Gregor, T.P., and Smith, G.K. (2000). Correlation of OFA hip scoring to passive hip laxity derived from the hip extended and distraction radiographs. Vet Orthop Soc Annu Meet :36.

Fries, C. L., & Remedios, A. M. (1995). The pathogenesis and diagnosis of canine hip dysplasia: a review. 36(8), 494–502.

Fritsch, D.A., Allen, T.A., Dodd, C.E., et al. (2010). A multicenter study of the effect of dietary supplementation with fish oil omega-3 fatty acids on carprofen dosage in dogs with osteoarthritis. 236:535–539.

Gemmill, T.J., Pink, J., Renwick, A., et al. (2010). Hybrid cemented/cementless total hip replacement in dogs: seventy-eight consecutive joint replacements. 40:621–630.

Gollakner, R. (2018). Meloxicam: VCA Animal Hospital. Vca. Retrieved October 9, 2022, from <https://vcahospitals.com/know-your-pet/meloxicam>

Haney, P. S., Lazarowski, L., Wang, X., Wang, X., Hathcock, J., Lofton, R., Wilborn, R., and Waggoner, L. P. (2020). Effectiveness of PennHIP and Orthopedic Foundation for Animals measurements of hip joint quality for breeding selection to reduce hip dysplasia in a population of purpose-bred detection dogs, *Journal of the American Veterinary Medical Association*, 257(3), 299-304.

Hart, A., Hewitson, A., Cark, J., Pearson, C., and Wagstaffe, A. E. (2022). Synoquin Joint Supplement. *VioVet*. Retrieved October 14, 2022, from <https://www.viovet.co.uk/Synoquin-Joint-Supplement/c64/>

Kapatkin, A.S., Fordyce, H.H., Mayhew, P.D. and Smith, G.K. (2002). Canine hip dysplasia: The disease and its diagnosis. *Compendium on Continuing Education for the Practising Veterinarian*. 24. 526-538.

Kealy, R.D., Olsson, S.E., Monti, K.L., Lawler, D..F, Biery, D.N., Helms, R.W., Lust G., and Smith, G.K. (1992). Effects of limited food consumption on the incidence of hip dysplasia in growing dogs. *J Am Vet Med Assoc*. 201(6):857-863

Kirkby, K.A., and Lewis, D.D. (2012). Canine hip dysplasia: reviewing the evidence for nonsurgical management. 41:2–9.

Lewis, T.W., Woolliams, J.A., and Blott, S.C. (2010). Genetic Evaluation of the Nine Component Features of Hip Score in UK Labrador Retrievers. *PLoS ONE* 5(10): e13610.

McKight, P. E., and Najab, J. (2010). Kruskal- wallis test. *The corsini encyclopedia of psychology*, 1-1.

Peterson, C. (2017). Canine hip dysplasia: Pathogenesis, phenotypic scoring, and genetics. *Duluth Journal of Undergraduate Biology*, 4, 19-27.

Pinna, S., Pizzuti, E., and Carli, F. (2013). Effects of intertrochanteric varus osteotomy on Norberg angle and percent coverage of the femoral head in displastic dogs. *Journal of veterinary science*, 14(2), 185–191. <https://doi.org/10.4142/jvs.2013.14.2.185>

Remedios, A. M., and Fries, C. L. (1995). Treatment of canine hip dysplasia: a review. *The Canadian Veterinary Journal*, 36(8), 503.

Schachner, E. R., and Lopez, M. J. (2015). Diagnosis, prevention, and management of canine hip dysplasia: a review. *Veterinary medicine (Auckland, N.Z.)*, 6, 181–192. <https://doi.org/10.2147/VMRR.S53266>

Smith, G. K., Mayhew, P. D., Kapatkin, A. S., McKelvie, P. J., Shofer, F. S., and Gregor, T. P. (2001). Evaluation of risk factors for degenerative joint disease associated with hip dysplasia in German Shepherd Dogs, Golden Retrievers, Labrador Retrievers, and

Rottweilers. *Journal of the American Veterinary Medical Association*, 219(12), 1719-1724.

Smith, G.K. (2005). Strategies to Control Canine Hip Dysplasia: The Need for Veterinarian and Breeder Alliance Tufts' Canine and Feline Breeding and Genetics Conference.

Synoquin®. VetPlus. (n.d.). Retrieved October 14, 2022, from <https://www.vetplus.co.uk/products/synoquin/>

The Canine Health Information Center. OFA. (2022). Retrieved October 14, 2022, from <https://ofa.org/>

Vidoni, B., Bauer, V., Bockstahler, B., Gumpenberger, M., Tichy, A., and Aghapour, M. (2021) Early Diagnosis of Canine Hip Laxity: Correlation between Clinical Orthopedic Examinations and the FCI Scoring Method in a Closed Cohort of Rottweilers. *Animals*. 2021; 11(2):416. <https://doi.org/10.3390/ani11020416>

Wurster, N. B., and Lust, G. (1982). Fibronectin in osteoarthritic canine articular cartilage. *Biochemical and Biophysical Research Communications*, 109(4), 1094-1101.

Zhu, L., Chen, S., Jiang, Z., Zhang, Z., Ku, H.C., Li, X., McCann, M., Harris, S., Lust, G., Jones, P., and Todhunter, R. (2012). Identification of quantitative trait loci for canine hip dysplasia by two sequential multipoint linkage analyses. *J Appl Statistics*.

