A CLINICAL APPRAISAL OF THE ORTHOPAEDIC CONDITIONS OF COXOFEMORAL JOINTS IN DOGS

THESIS

BY

Dr MRIDULA SHARMA

(V-2021-30-034)

Submitted to

CHAUDHARY SARWAN KUMAR

HIMACHAL PRADESH KRISHI VISHVAVIDYALAYA

PALAMPUR-176062, INDIA

In

Partial fulfilment of the requirements for the degree

of

MASTER OF VETERINARY SCIENCE

(DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY)

(VETERINARY SURGERY AND RADIOLOGY)

2024

Dr. S.P. Tyagi
(Professor and Head)

Department of Veterinary Surgery and Radiology
CSK Himachal Pradesh Krishi Vishavavidyalaya
Palampur-176062 (H.P.) India

CERTIFICATE-I

This is to certify that the thesis entitled, "**A CLINICAL APPRAISAL OF THE ORTHOPAEDIC CONDITIONS OF COXOFEMORAL JOINTS IN DOGS**" submitted in partial fulfillment of the requirements for the award of the degree of Masters of Veterinary Science in the discipline of Veterinary Surgery and Radiology of CSK Himachal Pradesh Krishi VIshvavidyalaya, Palampur is a bonafide research work carried out by **Dr. Mridula Sharma (V-2021-030-034)** daughter of Sh. Moti Lal Sharma and Smt. Sunita under my supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of the investigation have been fully acknowledged.

Place: Palampur
Date:

Dr. S.P. Tyagi
Major Advisor

CERTIFICATE-II

This is to certify that the thesis entitled, "**A CLINICAL APPRAISAL OF THE ORTHOPAEDIC CONDITIONS OF COXOFEMORAL JOINTS IN DOGS**" submitted by **Dr. Mridula Sharma (V-2021-030-034)** daughter of Sh. Moti Lal Sharma and Smt. Sunita to the CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in partial fulfillment of the requirements for the degree of Master of Veterinary Science in the discipline of Veterinary Surgery and Radiology has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

Dr. SP Tyagi
Chair Person

Dr. A.C. Varshney
External Examiner

Dr. Adarsh Kumar
Member

Dr. Amit Kumar
Member

Dr. Ajay Katoch
Member

Dr. Sandeep Manuja
Dean PGS's Nominee

Head of the Department

Dean, Post Graduate Studies

ACKNOWLEDGEMENTS

A thesis is attributed to one student upon completion, yet its achievement invariably involves the collaborative efforts of several individuals. This acknowledgement is an emotional expression of gratitude for everyone who made this work a memorable milestone. This acknowledgement recognized the wonderful people surrounding me for giving direct or indirect contributions. I would like to express my heartfelt thanks and recognition to all those who played a part in making this possible.

First and foremost, I am immensely grateful to my advisor and research mentor, Dr. S.P. Tyagi, Professor and Head, Department of Surgery and Radiology, DGCN, COVAS. His unwavering support, encouragement, and guidance were instrumental in guiding me through each step of my thesis completion. His passion for research and commitment to excellence have left a profound impression on me. His words consistently inspired me and elevated my thinking. Without his patient and compassionate instructions, completing my thesis would not have been possible. I couldn't have envisioned a more suitable advisor for my MVSc studies.

I would also like to express my unfailing gratitude to Dr Adarsh Kumar, Professor and Head, VCC and Veterinary Medicine for his insightful remarks and encouragement, which encouraged me to widen my research from various perspectives.

I am deeply obliged to Dr Amit Kumar, Assistant Professor, Department of Veterinary Surgery and Radiology for his valuable support, critical comments and constant encouragement during my study.

I extend my deepest gratitude to my advisory committee Dr Ajay Katoch (Assistant Professor, Department of Veterinary Medicine) and Dr. Sandeep Manuja (Dean PG's nominee). Their invaluable guidance, insightful suggestions, unwavering assistance, and continual encouragement were instrumental throughout my research journey.

I am very much thankful to Dean PG for providing the necessary facilities required for the successful completion of my academic endeavors.

I extend my sincerest appreciation and gratefulness to Dr. Rohit Kumar (Assistant Professor), Dr. Deepti Sharma (Assistant Professor), and Dr. Deepti Bodh (Assistant Professor). Throughout my academic journey, they have consistently provided me with unwavering support, guidance, and mentorship.

I convey my sincere thanks to my seniors Dr. Rajnish, Dr. Ankit, Dr. Aabha Kaushal, Dr Kirti Sharma, Dr. Vasvi and Dr. Pururava for their support and endless help during this research study.

I would also like to thank my senior Dr Sara Kaushal for her unwavering support and her patience with my many queries and doubts.

I wish to thank my seniors and batchmates Dr(s) Shivani, Kapil, Dhruv, Vijay, Akshay, Kalpna, Ashish, Reva, Sankalp, Sidharth, Bikram, Diksha, Ahan, Parveen, Nirmay, Anjali, Sanjay, Sonal and Ankita for their help during my research, constant care and support which stirred me to my best.

My heartfelt thanks to my juniors Dr(s) Sanyav, Anjana, Stanzin, Yash, Ripsha, Smriti, Sukriti and Stuti for their constant support throughout the journey.

I would like to express my sincere thanks to Mr Ravikant, Mr Prem Chand, Mr Narender, Mr Roshan, Mr Uttam, Mr Ravi, Mr Karam Chand and Mrs Shivani for their cooperation and precious assistance in one way or the other. The technical expertise and assistance provided by the technical officer (Radiology) Mr. Virender Kumar was very valuable.

I express my overwhelming reverence towards my parents and grandparents whose constant encouragement and dedication have helped me to sustain all sorts of pressure during the study. I would also like to thank Atish, Radhika and Nandika.

In the end, numerous individuals have contributed, both directly and indirectly, reaching this significant milestone in my academic journey, even if their names were not mentioned here. I wish to extend my heartfelt appreciation to all those who have supported me along the way. Thank you.

Place: Palampur (Mridula Sharma)

Date:

Table of Contents

LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviations	Meaning
%	Percent
@	At the rate
CT	Computed Tomography
=	equal to
CHD	Canine Hip Dysplasia
Penn HIP	University of Pennsylvania Hip Improvement Program
≤	Less than equal to
≥	More than equal to
BVA/KC	British Veterinary Association and Kennel Club
OFA	Orthopaedic Foundation of Animals
UCHD	Unilateral Canine Hip Dysplasia
±	Plus-Minus
B. Wt.	Body weight
b.i.d.	Twice a day
GRF	Ground Reaction Forces
COP	Centre of Pressure
FCI	Federation Cynologique Internationale
IVDD	Intervertebral Disc Disease
EHR	Extended Hip Radiograph
CBC	complete blood count
DI	Distraction Index
Cms or cm	Centimetres or centimetre
DLS	Dorsolateral Subluxation
CCO	Caudolateral Curvilinear Osteophyte
OA	Osteo Arthritis
CSK	Chronic superficial keratitis
CSKHPKV	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya
CST	Culture sensitivity test
CT	Computed tomography
Dept	Department
DGCN COVAS	Dr. G.C. Negi College of Veterinary and Animal sciences
DJD	Degenerative Joint Disease
e.g.	Example given
E-collar	Elizabeth collar
FHO	Femoral Head Osteotomy
DAR	Dorsal Acetabular Rim
DPO	Double Pelvic Osteotomy
et al.	et alia (and others)
etc.	Et cetera (and so on)
F	Female
TPO	Triple Pelvic Osteotomy

OPD	Out patient department
GA	General anaesthesia
AR	Angle of Reduction
AS	Angle of Subluxation
NA	Norberg Angle
JPS	Juvenile Pubic Symphysiodesis
HP	Himachal Pradesh
HR	Heart rate
i.e.	That is
CF	Coxofemoral
II	two (roman numeral)
III	three (roman numeral)
IM	Intramuscular
K-wire	Kirschner-wire
Inj.	Injection
USP	United States Pharmacopeia
IV	Intravenous
IV	four (roman numeral)
Pvt	Private
SOP	Standard Operating Protocol
Kg.	Kilogram
CFSL	Coxofemoral Subluxation
Ltd.	Limited
M	Male
mg/kg	Milligram/kilogram
MHz	mega hertz
Min	Minutes
MM	Mucous membrane
mm	Millimetre
CrAE	Cranial Acetabular Edge
DAE	Dorsal Acetabular Edge
CrEAR	Cranial Effective Acetabular Rim
AF	Acetabular fossa
MR	Menace response
CaAE	Caudal Acetabular Edge
n	Number of cases
FHNE	Femoral Head Neck Exostosis
FHR	Femoral Head Recontouring
AE	Acetabular Edge
No.	Number
DISH	Diffuse idiopathic spine Hyperostosis
NSAID	Non-steroidal anti-inflammatory drug
s.i.d.	Semel in die (once daily)
GSD	German Shepherd Dog
p.o.	per os (orally)

PO	Postoperative
q.i.d.	four times a day
RR	respiratory rate
Rs.	rupee
RT	Rectal temperature
SC	Sub-cutaneous
SOS	as and when required
t.i.d.	three time a day
ut supra	as above
Viz.	namely

LIST OF TABLES

LIST OF PLATES

Department of Veterinary Surgery and Radiology
CSK Himachal Pradesh Krishi Vishvavidyalaya
Palampur-176062 (H.P.)

Title of the thesis : "A Clinical appraisal of the orthopaedic conditions of coxofemoral joints in dogs"
Name of the student : Mridula Sharma
Admission number : V-2021-030-034
Major Discipline : Veterinary Surgery and Radiology
Minor Discipline : Veterinary Medicine
Date of thesis submission : 13-02-2024
Total pages of thesis : 117
Major Advisor : Dr. SP Tyagi

ABSTRACT

The study was conducted to diagnose and manage the conditions of coxofemoral (CF) joints in dogs and to record its regional hospital occurrence. During the study period, 61 dogs were diagnosed with CF joint conditions with the incidence rate of 3.07%. The conditions were broadly classified into 'Fractures' (13) and the 'Other conditions' (48). Among the CF fractures, the standalone involvement of femoral head and neck was observed in 8, acetabulum in 4 and simultaneous femoral neck and acetabulum in 1 dog. In 'Other conditions' category, the CF luxations was observed in 14 dogs, Canine Hip Dysplasia (CHD) in 33 and CF tumours in 1. The properly positioned radiographs of dogs above 1 year of age diagnosed with CHD were subjected to hip scoring as per British Veterinary Association/Kennel Club (BVA/KC) guidelines. BVA/KC takes in to account 9 different anatomical parameters while scoring hip joints so, it is a more precise and effective method of diagnosing CHD. Management of coxofemoral joint conditions was done either surgically or conservatively. Surgical correction of femoral head and neck fracture was done in 7 CF joints of 5 dogs. Triple pinning was performed in 4 instances and excision of femoral head and neck in 3. Though, interfragmentary compression cannot be achieved but fixation of femoral head and neck fractures by triple pinning was considered an effective method in providing adequate fixation at site to bring about fracture healing. The conservative management of fresh cases of CF luxations was done by closed reduction and Slocum sling application. Surgically reduction and fixation of CF luxation was done using Toggle pinning technique. Closed reduction of CF luxations was considered suitable only for fresh cases in co-operative animals in remaining cases toggle pinning was considered an effective method. Femoral head osteotomy was performed in cases where the femoral head was damaged beyond repair. The conservative management of Canine Hip Dysplasia improved the clinical signs to some extent but it did not halt the progression of the disease.

(Mridula Sharma) (Dr. SP Tyagi)
Student Major advisor

Head of the Department

Chapter 1

INTRODUCTION

Joints are the point of connection between two or more bones. They are composed of cartilage, subchondral bone, joint fluid, synovium, and associated ligaments. Animals have different types of joints ranging from immovable joints in the skull to highly flexible synovial joints in the limbs. Joints play a crucial role in locomotion and overall mobility of the animal. Clinically healthy joints are paramount to the welfare and performance of dogs. Joint diseases are the leading cause of lameness among small animals so a thorough understanding of diagnosis and treatment options is important.

The coxofemoral joint also known as the hip joint is a diarthrodial articulation between the femoral head and acetabulum. This joint connects the spherically shaped femur head (the ball) with a corresponding acetabular cavity in the pelvis (the socket). The acetabulum is a cartilage-lined deep cup like structure which is formed by the contribution of all the three bones of pelvis namely ilium, ischium and pubis. The deep-seated fossa within the acetabulum is non-articular and serves as a point of attachment for the round ligament, which attaches the femoral head and acetabulum.

The ball-and-socket configuration provides stability while allowing a wide range of joint motion, including flexion, extension, adduction, abduction and rotation. Factors contributing to the stability of joint are congruency (femoral head is an almost perfect hemisphere which is deeply seated in acetabular cup), joint capsule, round ligament and surrounding muscles. Primary stability of the joint comes from the joint capsule, which stretches from the acetabulum to the neck of the femur. Secondary support for the hip joint is provided by the femoral head ligament (round ligament), which runs from the femoral fovea capitis to the acetabular fossa. A suggested hydrostatic stability element, which results in negative pressure in the joint and several surrounding muscles that function as flexors, extensors, abductors, adductors, and internal rotators of the limb, also contributes to secondary support (Trostel 2000).

Interruption of normal joint mechanics leads to painful osteoarthritis and physical incapacity, thereby reducing animal's quality of life. Fracture of acetabulum, luxation of hip, capital femoral physeal fracture, fracture of femoral head and neck, hip dysplasia disease are the conditions associated with hip joint. These conditions prevent stabilization of hip (Prasad 2015).

The acetabulum is the most likely location for pelvic fractures in dogs, and it needs to be accurately reduced and fixed rigidly in order to prevent the onset of degenerative joint disease. The surgical methods to stabilize acetabular fractures include use of dynamic compression plates, veterinary acetabular plates, mini plates, reconstruction plates, and use of screws and wire, with or without polymethyl methacrylate. However, regardless of the implant used anatomic reduction of the articular surface is essential to promote primary bone healing and prevent the onset of coxofemoral osteoarthritis (Anderson 2002).

Luxation or fracture might occur due to trauma. Coxofemoral luxation is a common traumatic injury in dogs. Unilateral craniodorsal luxation was most common, occurring in 78.1% of dogs out of 95 cases with 59% attributed to motor vehicle accidents (Basher 1986). Coxofemoral luxation may be managed with closed manipulation to replace the femoral head within the acetabulum or with open surgical manipulation. The surgical options for the management of hip luxation are synthetic capsular reconstruction, trans articular pinning and toggle pin fixation.

Fracture of proximal femur can be intracapsular or extracapsular. Intracapsular fractures include epiphyseal, physeal, subcapital and transcervical. Extracapsular fractures include basilar neck, intertrochanteric and subtrochanteric. Epiphyseal fractures are generally linked with femoral head luxation, with the avulsed epiphyseal fragment commonly found connected to the femoral head ligament. Capital physis fractures are prevalent in skeletally immature animals and can be seen with varying degrees of displacement. Because of the larger bending moments at the level of the fracture, subcapital and transcervical fractures are more unstable than physeal fractures.

Canine hip dysplasia (CHD) was first described in 1935 by Dr. Gerry B Schnelle. It was initially called "bilateral congenital subluxation of coxofemoral joint. It is now defined as a polygenic and multifactorial developmental disorder characterized by coxofemoral (hip) joint laxity, shallow acetabulum and subluxation of femoral head leading to degenerative joint disease in the longer run. CHD is considered multifactorial with both genetic and environmental causes such as diet, obesity and exercise playing a role in its phenotypic expression. It should be diagnosed at a very early stage of life to take corrective surgical interventions to prevent development of severely debilitating lameness in later life. University of Pennsylvania Hip Improvement Program (Penn HIP), British Veterinary Association (BVA), and Orthopedic Foundation of Animals (OFA) have all established several screening tests for determining the status of hip joint to reduce the frequency of disease. Penn HIP measures the degree of hip joint laxity in dogs as early as 16 weeks of age by calculating distraction index whereas OFA grading system classifies hips of the dogs older than 2 years as excellent, good, fair, borderline, mild, moderate or severe hip dysplasia (Powers 2010). BVA/KC hip scheme examine hips of skeletally mature dogs for nine different anatomic features for both underlying laxity and for secondary changes due to wear and tear using hip-extended ventrodorsal view (Dennis 2012).

Regardless of the etiology, diagnosis of the lameness may be achieved by analysing history, clinical signs and physical examination of the patient while at rest and during exercise. Further the diagnosis can be substantiated by various imaging techniques like radiography, CT scanning, ultrasonography, arthroscopy, collection of biopsies for cytology as well as cultural sensitivity. The radiographic images of coxofemoral joints in dogs is difficult to interpret as compared to CT images. The type of fracture, its location and the number of bone fragments were all described more precisely by the CT scan than by radiographic inspection (Amort 2015). Moreover, specific radiographic positions are essential in making a correct diagnosis. Depending on the type of condition, coxofemoral joint conditions in dogs may be managed either by conservative, medical, surgical or combination methods.

Thus, this study intends to diagnose and manage the conditions associated with coxofemoral joint and to make an effort to improve them. The study also intends to record the regional occurrence of the conditions of coxofemoral joint.

Chapter 2

REVIEW OF LITERATURE

The available literature has been reviewed under following headings

2.1 Occurrence of coxofemoral joint affections in dogs

2.2 Diagnosis of coxofemoral joint affections in dogs

2.2.1 Orthopaedic examination

2.2.2 Neurological examination

2.2.3 Radiological examination

2.3 Management of coxofemoral joint affections in dogs

2.3.1 Management of canine hip dysplasia

2.3.2 Management of hip luxation

2.3.3 Management of femoral head and neck fractures

2.3.4 Management of acetabular fractures

2.1 Occurrence of coxofemoral joint affections

Citi et al. (2005) conducted a retrospective study to record the incidence of Unilateral Canine Hip Dysplasia (UCHD). They reviewed radiographs of 891 dogs and found that 149 (16.7%) dogs were affected. Highest incidence was found in the age group of 12 months (37.6%), between 12 and 24 months (22.8%), between 25 and 72 months (25.5%), and over 73 months (14.1%).

Demko et al. (2006) reported that the mean age of the 62 cases chosen for toggle rod treatment of hip joint luxation was 5.3 ± 3.4 years, with 19 (31%) of the dogs being intact-sex males, 21 (34%) being castrated males, 9 (14%) being intact-sex females, and 13 (21%) being spayed females with average body weight of 29 ± 14 kg. Breed-wise, there were 14 mixed breed dogs, 12 Labrador Retrievers, 8 German Shepherd dogs, and 7 Cocker Spaniels among other variety of breeds.

Smith et al. (2006) observed that the prevalence of radiographic changes of hip joint osteoarthritis ranges from 15% at 2 years to 67% by 14 years of age. They also reported that restricted-fed dogs have later onset and lower prevalence of osteoarthritis.

Genevois et al. (2008) studied the prevalence of breed susceptibility for hip dysplasia in France. It was discovered that more than 59.7% of Cane Corso examined dogs had the condition. Hip dysplasia was more prevalent in Berger Picard (40%), Espagneal Picard (39.6%), Gordon Setter (35%) and Chow-chow (32.6%). Eleven breeds, including the Spaniel (25.2%), Rottweiler (23.4%), Great Dane (23.1%), and German Shepherd Dog (22.1%), have a 20–30% frequency of hip dysplasia. The incidence ranged from 10% to 20% in 29 breeds, including the Weimaraner (16.8%) and Irish Setter (16.4%). The prevalence of hip dysplasia was less than 10 per cent in three breeds which included Belgium Shepherd (8.3%), Doberman Pincher (6.7%) and Siberian Husky (3.9%).

Prasad et al. (2012) recorded incidence of coxofemoral joint affections in dogs in a clinical study of 575 patients. Out of 575 dogs, disease wise involvement includes hip dysplasia 54% (310), osteoarthritis 28% (159) and fracture luxation 18% (106). Among them 61% (352) were male and 39% (223) were females. Labrador Retriever was the most affected breed with incidence of 34% followed by German Shepherd (23%), Spitz (11%), Great Dane (6%), Rottweiler (4%), Doberman (3%), Boxer (2%), Pug (2%) and Non descript (8%). Three age groups were classified- active period of growth (less than 1 year), adult stage (1 to 4 years) and aging stage (more than 4 years). The most affected age group was less than 1 year of age (45%) followed by more than 4 years (36%) and 1 to 4 years (19%).

Maruthi et al. (2017) conducted a retrospective study to record the occurrence of hip dysplasia in dogs. They recorded age wise distribution, sex wise distribution and breed wise distribution of hip dysplasia. A total of 2418 cases were presented to outpatient unit of which 726 (30.02%) were orthopaedic cases, among them 67 (9.22%) cases was diagnosed with hip dysplasia. Age wise distribution of hip dysplasia in dogs less than one year, one to four years and above four years were 32 (47.76%), 24 (35.82%) and 11 (16.14%) respectively. Among them 39 (58.20%) were males and 28 (41.80%) were females. Labrador retrievers were the most commonly effected breed with 27 (40.29%) cases, followed by German shepherd dog with 19 (28.36%) cases, Rottweilers 9 (13.44%) cases, Pugs 4

(5.98%) cases, St. Bernards 2 (2.99%) cases, Lhasa Apso 1 (1.49%) case, Doberman Pinscher 1 (1.49%) case, Cocker Spaniel 1 (1.49%) case, French Mastiff 1 (1.49%) case, Golden Retriever 1 (1.49%) case and Sptiz 1 (1.49%) case.

2.2 Diagnosis of coxofemoral joint affections

2.2.1 Orthopaedic Examination of hind limbs

McLaughlin (1995) describes the physical examination findings in cases of hip luxation. He found that limb was adducted and externally rotated in cases of craniodorsal luxations and abducted and internally rotated in cases of ventral luxations. Hip joints will also appear asymmetric because of the displacement of greater trochanter when viewed from behind. Palpation of the hip joint reveals crepitus and decreased range of motion.

Fox (2007) describes the orthopaedic examination of rear limbs to diagnose the cause of lameness in dogs. Examination starts from paws followed by examination of tarsus, tibia & fibula, stifle, femur, hip joint and pelvis. He reported that hip dysplasia and cranial cruciate ligament disease are the most common conditions of joints causing hind limb lameness. He concluded that to elucidate orthopaedic conditions of rear limb, thorough neurological examination and systemic palpation of anatomic structures of hind limb along with gait evaluation is required.

Ginja et al (2010) reviewed the diagnosis, genetic control and preventive management of canine hip dysplasia. They describe the clinical examination to diagnose canine hip dysplasia and group them in two categories- test that provide information on hip joint laxity and signs that detect osteoarthritis. The first category includes Ortolani, Barden’s and Barlow tests and second category include palpation and range of motion tests.

Virag et al (2022) screen dogs for CHD by objectively evaluating gait patterns. They measure ground reaction forces (GRF) and centre of pressure (COP) using pressure plate for 32 labrador retrievers and 17 golden retrievers at 4, 8 and 12 months of age. At the age of 12 months radiological examination of dogs were performed according to FCI and dogs were grouped as sound (FCI grade A or B) and diseased (FCI grade C or worse). Their results revealed that COP values in both breeds in diseased limb groups were higher at any measurement point during walking. In both sound and diseased groups, the COP values during walking were significantly higher at 4 months of age than at 8 and 12 months of age, indicating increase in stability of gait pattern. They suggest that COP measurements in young pups could be utilised to obtain valuable indications of possible CHD development.

2.2.2 Neurological Examination

McDonnell et al. (2001) describes the neurological conditions causing lameness in companion animals. Neurologic disease-causing lameness includes myopathies, intervertebral disc disease (IVDD), lumbosacral disease, nerve root tumours, spinal cord tumours, and traumatic neuropathies. They summarise that orthopaedic and neurologic causes of lameness are extremely important to distinguish as diagnostic and therapeutic plans vary. Nye and Troxel (2017) explains the neurological examination under five main sections- mental status, gait analysis and body postures, cranial nerves, postural reactions, and spinal and withdrawal reflexes. Evaluation of postural reactions include proprioception test and wheel barrow test. Patellar reflex and withdrawal reflex are tested in lateral recumbency and are part of spinal nerve reflexes. Patellar reflexes and withdrawal reflexes are most reliable spinal reflexes. Other ancillary test includes evaluation of muscle tone and atrophy, cutaneous trunci reflex, perineal reflex, nociception, and neck or back pain.

2.2.3 Radiological examination

Slocum and Slocum (1992) explained the different radiographic projections for hip joint and changes observed in each of them during canine hip dysplasia. The changes observed in different radiographic views were- in dysplastic hips osteophyte on caudal aspect of femoral neck and lateral margin of cranial acetabulum were observed in ventrodorsal projection, white-black-white hip line indicate normal hips in lateral radiograph, white-black-grey hip line indicates dysplastic hips and white-grey-grey line indicates severely dysplastic hips, space between femoral head and acetabulum increases in dysplastic hips in frog-legged view and increase in slope of acetabulum is observed in dorsal acetabular rim view.

Fluckiger et al. (1999) explained a novel stress radiographic technique to quantify hip joint laxity in dogs. During exposure, the femoral heads of anaesthetized dogs were physically moved in a craniodorsal manner while they were in dorsal recumbency. The authors found that this method produced substantially more femoral head subluxation than the typical ventrodorsal hip extended projection.

Lust et al. (2001) compared three radiographic methods for the diagnosis of hip dysplasia in eight-month-old dogs. The study was conducted on 129 dogs consisting of Labrador retrievers, Greyhounds, and Labrador Retriever-Greyhound crossbreds. The extended-hip radiographic (EHR) score, the distraction index (DI), and the dorsolateral subluxation (DLS) score calculated at 8 months age were found significantly correlated with the degree of articular cartilage degeneration and signs of osteoarthritis at necropsy. The sensitivity and specificity were 38 and 96% respectively for EHR score (scores >3 were considered abnormal), 50 and 89% respectively for DI (values >0.7 were considered abnormal) and 83 and 84% respectively for DLS score (scores ≤55% were considered abnormal). They concluded that specificities of the 3 methods for diagnosing hip dysplasia in dogs at 8 months of age were similar.

Kapatkin et al. (2004) compare two radiographic techniques (hip extended radiography and distraction radiography) or evaluation of hip joint laxity in 10 breeds of dogs and discovered that distraction radiography detected greater range and magnitude of passive hip laxity than the hip extended view. Breed-specific differences in the Hip Extended Index were shown to be significant. The degree of breed differences was lower when compared to Distraction Index.

Powers et al. (2004) conducted a longitudinal cohort study on 24 pairs (sex and size matched) of Labrador retrievers from 7 different litters to determine the association between caudolateral curvilinear osteophyte (CCO) and radiographic and histologic signs of osteoarthritis due to hip dysplasia. They stated that the hip-extended view is the most sensitive view to detect the presence of CCO. The study reveals that CCO had high sensitivity to determine the prediction of osteoarthritis. Therefore, presence of CCO represents the early sign of osteoarthritis but lack of CCO does not confirm that the dog is not susceptible to the development of osteoarthritis of hip joint.

Armbrust (2009) describes tips and technique for pelvic radiography and stated that proper radiographic positioning is necessary to make accurate radiographic interpretation. To localize the disease such as fracture location and coxofemoral luxation, lateral views of pelvis are taken. Sedation is recommended for pelvis radiography especially for ventrodorsal hip-extended view for both diseased and normal dogs. He explains the positioning for ventrodorsal hip-extended view, lateral view and frog legged view. Improper positioning in ventrodorsal hip-extended view leads to false assessment of femoral head coverage by dorsal acetabular rim.

Ginja et al. (2010) opined that radiographic studies for hip joint can be separated into two categories – 1) to evaluate joint congruence and to detect signs of osteoarthritis using the standard ventrodorsal hip extended view (SVDV) and 2) to provide information on HJL demonstrated by stress radiography (PennHIP, dorsolateral subluxation [DLS], Flückiger and Half-Axial Position [HAP] methods). Radiographic techniques in practice to score hip dysplasia are mainly based on the degree of subluxation, joint congruence and remodelling of the bone. They suggested that all the techniques should be performed under anaesthesia or heavy sedation to facilitates accurate positioning, laxity and decreases the need for repeat exposures.

Dennis (2012) describes the process of scoring in BVA/KC scheme using extended VD hip radiographic view. The nine anatomical features assessed in scheme are Norberg angle, Subluxation, Cranial acetabular edge, Dorsal acetabular edge, Cranial effective acetabular rim, Acetabular fossa, Caudal acetabular edge, Femoral head and neck exostoses, Femoral head recontouring. BVA/KC scoring scheme assesses hip for both underlying laxity and for secondary changes due to wear and tear and subsequent osteoarthritis. Total hip score, Norberg angle and Subluxation are found to be predictors of osteoarthritis and are significantly heritable.

Verhoeven et al. (2012) reviewed the different screening systems used for canine hip dysplasia (CHD) and their impact on the prevalence of the disease. The results showed that the screening methods that use hip extended radiographic projection like OFA, FCI and BVA/KC have relatively minor success on CHD prevalence. The distraction methods (PennHIP and dorsolateral subluxation) have not reported prevalence but seems to be important heritable traits in genomic screening of dysplastic dogs.

Guillard (2014) described and compare the theory and methodology of PennHIP (University of Pennsylvania Hip Improvement Programme) technique with BVA/KC (British Veterinary Association/ Kennel Club) Hip Dysplasia Scheme. In this screening test three different radiographic views- standard hip extended view, compression view and distraction view were taken. The distraction index (DI) is then calculated by dividing the distance between the centre of femoral head in compression and distraction by the radius of femoral head. A DI of less than or equal to 0.3 is considered normal. He reported that by PennHIP pups can be screened as early as 16 weeks of age and therefore it is a good predictor of development of OA.

Schachner and Lopez (2015) reviewed diagnosis, prevention and management of hip dysplasia and quoted that radiography is the gold standard to assess and quantify the joint changes associated with CHD joint remodelling. There are five popular standardized evaluation systems with different grading patterns that are used worldwide to grade radiographic confirmation of coxofemoral joint and degenerative joint changes.

Sadan et al (2015) conducted a prospective and retrospective study on 14 dogs with acetabular fractures to compare the diagnostic accuracy of two view radiography and CT scanning in acetabular fractures. They found that CT is more accurate in describing fracture type, location and number of bone fragments. So, CT is superior as it allowed more detailed visualization of fracture.

Franco-Goncalo et al. (2023) describe the femoral neck thickness index in 53 randomly selected dogs to quantify femoral neck width and to study its association with degree of hip dysplasia. Scoring of hips were done as per FCI scheme in 5 different grades. A total of 19 hips were scored grade A, and their mean femoral neck thickness index was 0.809 ± 0.024; for grade B (21 hips), 0.835 ± 0.044; for grade C (23 hips), 0.868 ± 0.022; for grade D (23 hips), 0.903 ± 0.033and for grade E (15 hips), 0.923 ± 0.068. They concluded that the FNTi shows adequate intra- and inter-examiner measurement agreement and reliability. Mean FNTi values are gradually higher in the different FCI categories, with statistically significant differences.

2.3 Management of coxofemoral joint affections

El-Seddawy et al. (2022) performed femoral head and neck ostectomy (FHO) for different conditions of coxofemoral joint in 12 male dogs of different breeds weighing between 14- 52 kgs. The technique was satisfactorily used in dogs with coxofemoral luxation, dysplasia, avascular necrosis, DJD, and femoral neck fracture. They concluded that FHO is a very good salvage economic satisfactory technique with minimal complications. Using an oscillating saw and sharp osteotome was found better than using of Gigli saw to cut the femoral head.

Engstig et al. (2022) conducted a study to evaluate long term effect of Femoral Head and Neck Osteotomy on canines' functional pelvic position and locomotion. The study comprises of orthopaedic examination, anatomical measurements, and pressure-sensitive walkway analysis and owner questionnaire. Ten dogs were included in the study with a median of 2.5 years since unilateral FHO. The coxofemoral joint showed decreased extension ($p = 0.003$), there was less static weight bearing on the FHO limb ($p = 0.003$), and there was muscle atrophy ($p = 0.005$). When measuring the height of the tuber ischii, no discernible trend in the tilt or position of the pelvis was found ($p = 0.39$). When measured using a Myrin goniometer from the tuber sacrale, five of the dogs leaned away from, and five towards, the FHO side. No differences regarding stance time, swing time, or peak pressure between the FHO and non-FHO limb were seen in trot ($p = 0.70$, $p = 0.26$, and $p = 0.91$, respectively). Over the long term, the FHO limb has muscle atrophy, decreased coxofemoral extension, and decreased static weight bearing. Dog owners considered the outcome of surgery to be good or excellent

2.3.1 Management of Canine Hip Dysplasia

Slocum and Slocum (1992) gave the prognosis of triple pelvic osteotomy at different severity level of disease. Severity of disease was assessed on the basis of age of the animal, DAR slope, angle of reduction/ subluxation, trochanteric compression test, condition of joint capsule and articular cartilage. For a dog to have very good prognosis and fully active future after pelvic osteotomy, age of the animal was found to be 6 to 7 months with a combined DAR of 20 degrees, an angle of reduction 25 degrees, angle of subluxation 5 degrees, negative trochanteric compression test, a torn joint capsule and intact articular cartilage. Prognosis of the surgery decreases as the severity and age of the animal increases.

Rawson et al. (2005) performed simultaneous bilateral femoral head and neck ostectomy in 15 dogs with severe hip dysplasia. FHO was performed with standard craniolateral approach to the hip joint and owners was contacted for follow up survey between 6 to 48 months post-operatively. All the dogs had normal activity level, improved exercise tolerance, better use of stairs and no signs of pain. Based on the results of the study they concluded that bilateral femoral head and neck ostectomy was a viable surgical option for dogs with severe hip dysplasia when other surgical options were declined by the owner.

Deuland et al (2010) performed a controlled clinical case study to determine the effect of Juvenile Pubic Symphysiodesis treatment in hip dysplasia prone puppies. A total of 39 dysplastic puppies were subjected to study out of which 6 were the part of control group with positive Ortolani and distraction index of ≥0.40. Ortolani sign, hip reduction angle, gait evaluation, osteoarthritis, hip pain and three Norberg angles (angle- extended mode, angle- compression mode and angle- distracted mode) were eight clinical tests performed preoperatively. JPS was performed at 12 to 24 weeks of age. The results showed no significant increase in osteoarthritis level and there were 74% reversal of preoperative positive Ortolani sign. Other clinical parameters like Hip reduction angle, DI and N-DIS also increased significantly. Osteoarthritis increased significantly in control group with no improvement in Ortolani incidence, N-OFA and N-COM angles. They concluded that Jucvenile Pubic Symphysiodesis at 12 to 24 weeks of age was an effective and safe pre-emptive bilateral treat for mild to moderate hip laxity.

Vezzoni et al. (2010) conducted a study to evaluate the feasibility of double pelvic osteotomy (DPO) in comparison to triple pelvic osteotomy (TPO) to treat clinical cases of hip dysplasia in young dogs. The study was conducted on 53 joints of 34 dogs including 4.5 to 9 months old dogs. The relationship between angle of reduction (AR) and angle of subluxation (AS) with Ortolani's sign, Norberg angle (NA), percentage of femoral head coverage and pelvic diameters were measured clinically and radiographically. Immediate postoperative and 1 to 2 months postoperative values of AS and AR were found significantly lower than the preoperative values. PC and NA values significantly increased at first and second follow-up examination. They concluded that DPO reduces joint laxity and improve joint congruity (PC from 50 to 72%) by creating ventroversion of the acetabulum similar to TPO. There was less pelvic narrowing as compare to TPO.

Boiocchi et al. (2013) studied radiographic changes of pelvis after juvenile pubic symphysiodesis in dogs. The study was conducted on 42 Labrador retrievers and 16 Golden retrievers that had undergone surgery and that had not undergone surgery. Various pelvic measurements were taken to objectively assess the radiographs. Subjective evaluation of radiographs was based on five criteria relating to acetabular fossae, pubic symphysis, margin of the cranial pubic area, pubic rami and obturator foramen. The radiographic measurement of the shape of the obturator foramen and two different ratios of length to width of the pubic rami were found significantly smaller in digs after JPS. They concluded that the standard radiographic changes observed in ventrodorsal radiograph of dogs that had undergone JPS were fusion of the pubic symphysis, arrest of the growth of the pubic rami resulting in a stocky appearance, ventroflexion of the acetabula and widening of the obturator foramina.

Prasad et al. (2015) performed cemented total hip arthroplasty in 6 dogs with hip dysplasia with luxation (3), severe osteoarthritis (2) and hip luxation (1). The average body weight of animals was 30 kg and average age were 4 years. Craniolateral approach of thigh was performed. Hip prosthesis was of four different sizes viz. 5-9 and designed indigenously made up of 316 L stainless steel with head sizes of +0 or +3. Acetabular cup was made from ultra high molecular weight polyethylene (UHMWPE) used in this study range from 20 to 25 mm outer diameter with radio opaque wire defining the lateral angle of the cup. Ventrodorsal radiographs were taken for preoperative template measurement to select the implants. The bone cement used in this study was PMMA. Post operatively numerical scoring system modelled on Western Ontario and McMaster University Osteoarthritis Scoring Index (WOMAC score) were used for orthopaedic clinical and radiological assessment. The outcome of the procedure was assessed excellent in three cases, good in one case and poor in two cases.

Balima and Rajasekaran (2020) managed hip dysplasia with conservative management using chondro-protective agents, non-steroidal anti-inflammatory drugs (NSAID), weight reduction and monitored exercise. Chondroprotective agent used was tablet cosequin (chondroitin sulphate, Hyaluronic acid & Glucosamine) for two months and NSAID used was tablet carprofen at the dose of 4.4mg/Kg for a period of 14 days. For weight reduction animal was kept on veterinary prescription diet for obesity.

2.3.2 Management of Hip luxation

Martini et al. (2001) evaluated the effectiveness of extra-articular surgical technique using absorbable suture material for the stabilization of traumatic coxofemoral luxation in dogs. Luxations was reduced surgically in 14 client owned dogs and maintained with extra-articular iliofemoral multifilamentous absorbable suture (3 to 6 strands of 2 USP Polyglactin 910) without any external support. Post-operative follow-ups were conducted at variable period of time at 2 to 22 months. Results revealed no surgical complications and reluaxtions, no lameness and no significant limitation in range of motion was present at last post-operative examination. They concluded that this is a simple and effective method to treat acute and chronic coxofemoral luxation. For large breed dogs absorbable suture material should be large enough to maintain articular stability during the period of scar tissue formation.

Ash et al. (2012) reported the use of braided polyblend toggle constructs for stabilization of traumatic craniodorsal coxofemoral luxation in cats and small to medium breed dogs; the two systems used were the TightRope (TR) with polyblend FiberTape (FT) and the Mini Tight-Rope (mTR) with polyblend Fiber. They performed six-week post-operative ventrodorsal and mediolateral radiograph after correction of craniodorsal coxofemoral luxations in cats and small breed dogs and confirmed consistent and unaltered hip reduction quality, toggle position, and no coxofemoral remodelling or periarticular osteophytosis.

Belge et al. (2014) performed modified synthetic capsule technique for the repair of coxofemoral joint luxation in six dogs. For joint stability two cortical screws were placed in the dorsal acetabular rim to secure the suture and a tunnel was drilled in the femur at the level of greater trochanter to pass the suture material from it in crisscross manner. Post-operatively Ehmer sling was applied to all dogs for 1 week. Post-operative radiological and clinical examination were performed at 1, 2 and 4 weeks. They reported that lameness was not present in 5 cases after 4 weeks except one case with bilateral luxation and greater trochanter fracture.

Schlag et al. (2019) performed close reduction and application of Ehmer Sling for coxofemoral joint luxation in 92 dogs. They describe the outcome of management and reported that 42 (43.5%) dogs out of 92 had reluxation of the affected hip joint at the time of sling removal. 46 (50%) dogs suffer from soft tissue injuries as a result of sling use and 17 among them suffer from serious soft tissue injuries along with one dog undergoing limb amputation. They concluded that close reduction of craniodorsal hip luxation along with sling application resulted in low success rate and high complication rate.

Trostel and Fox (2020) conducted a retrospective study to determine the complications and outcomes of open reduction and internal fixation of coxofemoral luxation using toggle rod stabilization in 58 dogs. Luxations was repaired using commercial toggle rods and different sutures- OrthoFiber, FiberWire, or monofilament nylon suture. Postoperative complications eveloped in 25 of the 58 (43%) dogs, with major complications in 9 cases (15.5%). The most common major complication was reluxation, which occurred in 6 dogs (10%). Five of the 6 cases of reluxation received monofilament suture, although there was not a statistically significant relationship between suture type and reluxation

Gomaa et al. (2023) compare three different suture materials for toggle pin technique in induced hip luxation in dogs. The study was conducted on 12 dogs divided into three groups as per the suture material used. Three different materials used were- monofilament polypropylene 2 USP, multifilament polyester 5 USP and stainless-steel wire size 0.5 mm. They use craniolateral approach to expose hip joint and femoral head luxation was induced by cutting the round ligament. They found that monofilament polypropylene suture used in 4 dogs was easy handle during the surgery and no post-operative complications were noted. Stainless steel wire was difficult to be manipulated during the surgery and cut post-operatively. They reported that Monofilament polypropylene suture material 2 USP was material to be used in toggle pin technique followed by multifilament polyester suture material 5 USP and finally stainless-steel wire of size 0.5mm.

2.3.3 Management of femoral head and neck fractures

Fisher et al. (2012) conducted an in-vitro biomechanical comparison of three methods for internal fixation of femoral neck fractures in dogs. fifty cadaveric femora of beagle dogs were used to compare fracture repair with two medium Orthofix pins, a 2.7 mm cortical bone screw placed in lag fashion and three divergent 1.1 mm Kirschner wires. They concluded that stiffness and load to failure are similar for canine femoral neck fractures stabilized with a 2.7 mm cortical screw placed in lag fashion (with an anti-rotational K-wire), two medium Orthofix pins, and three 1.1 mm divergent K-wires.

Heo et al. (2023) compared single-cycle axial load and stiffness between inverted triangle and vertical configurations of three Kirschner wires (K-wires) for femoral neck fracture fixation in small dog cadaveric models. Both the limbs of eight cadavers were used, one for inverted triangle and other for vertical configuration. Results suggest that the inverted triangle configuration of three K-wires is more stable than vertical configuration e for fixation of canine femoral neck fracture because former was more resistant to failure under axial loading and had greater lateral spread and more cortical supports of three K-wires.

2.3.4 Management of acetabular fractures

Boswell et al. (2001) conducted a retrospective study on acetabular fracture reduction and temporary stabilization using a specialized forceps (ASIF mandibular reduction forceps, Synthes USA, Paoli, PA) in 25 dogs. Mandibular reduction forceps (MRF) uses screws placed on both sides of the fracture to reduce it anatomically and fix it temporarily to ease plate application. The use of MRF were successful in 24 cases out of 25. The reduction was anatomical in 17 dogs, near anatomical in 6 dogs and non-anatomical in 1 dog. They concluded that use of MRF maintains reductions as well as provide uninterrupted assess to dorsal acetabular rim for plate contouring and application.

Blakely et al. (2019) conducted an ex vivo study to compare fracture reduction accuracy, biomechanical characteristics, and mode of failure between string of pearls, veterinary acetabular plates and screw/ wire/ polymethylmethacrylate construct in a simulated acetabular fracture model. The study was conducted on 36 hemipelvis divided into 3 groups with 12 hemipelvis each consisted of 7 spayed females, 2 intact females, 6 neutered males and 3 intact males. They concluded that although the ease of application for the String-of-Pearls implant was subjectively superior than other implants but no significant differences were there in fracture reduction scores. In comparison to the three constructs, SOP constructs were found stiffer and exhibit greater failure and ultimate loads.

Chapter 3

MATERIALS AND METHODS

The study was conducted on the clinical cases of dogs presented to the Department of Veterinary Surgery and Radiology, DGCN College of Veterinary and Animal Sciences, CSKHPKV Palampur from August 2022 to September 2023. The technical program of the work was divided into the following phases:

3.1 Phase one: Diagnosis and management of the conditions of coxofemoral joints in dogs

3.2 Phase two: Ascertaining the regional occurrence of the coxofemoral joints conditions in dogs

3.1 Diagnosis and management of the conditions of coxofemoral joints in dogs

To ascertain the involvement of coxofemoral (CF) joints in dogs, all the patients presented with hind limb lameness or in a non-ambulatory state were systematically examined to record the relevant case details as per a specially designed proforma (Table 3.1). Detailed physical, orthopaedic, radiological and other findings were noted down and analysed to make a diagnosis as follows-

3.1.1 Signalment and anamnesis

First of all, the breed, age, sex, weight of the animal, the description of the clinical symptoms as observed by the owner, their duration, previous treatment, if any and its impact on the condition were recorded.

3.1.2 Clinical examination

The general physiological parameters of the patients such as heart rate, pulse rate, respiration rate and rectal temperature were recorded. A quick general assessment of the physical status of patients was done to ascertain their mentation and categorized them as alert, dull, stupor and comatose. If the condition of the patient was considered serious, immediate steps were taken to stabilize the condition as per the need of the case. In other cases, or after stabilization of serious cases, the detailed examination followed.

<table>
<tr><td colspan="8">Table 3.1: Case record proforma</td></tr>
<tr><td>Case no.</td><td></td><td>Date</td><td></td><td>Owner’s name & contact no</td><td colspan="3"></td></tr>
<tr><td>Breed</td><td></td><td>Sex</td><td></td><td>Age</td><td></td><td>Weight</td><td></td></tr>
<tr><td colspan="8">Presenting problem:</td></tr>
<tr><td colspan="8">Previous treatment if any:</td></tr>
<tr><td colspan="8">Clinical Examination</td></tr>
<tr><td>HR</td><td></td><td>RR</td><td></td><td>RT</td><td></td><td>MM colour</td><td></td></tr>
<tr><td>Mentation:</td><td colspan="7">Alert/ Dull/ Stupor/ Comatose</td></tr>
<tr><td colspan="8">Orthopaedic examination</td></tr>
<tr><td>Lameness Score</td><td colspan="3"></td><td>Pain Score</td><td colspan="3"></td></tr>
<tr><td>Inflammation Score</td><td colspan="3"></td><td>Crepitation (Yes/No)</td><td colspan="3">Site-</td></tr>
<tr><td>Muscle Mass (Normal/Atrophied)</td><td colspan="3">Mild/Moderate/Severe</td><td>Ortolani Sign (Yes/No)</td><td colspan="3">Left/Right/Both</td></tr>
<tr><td colspan="8">Neurological Examination</td></tr>
<tr><td>Wheel Barrow</td><td colspan="3"></td><td>Proprioception</td><td colspan="3"></td></tr>
<tr><td>Cutaneous Trunci</td><td colspan="3"></td><td>Withdrawal</td><td colspan="3"></td></tr>
<tr><td>Perianal</td><td colspan="3"></td><td>Patellar</td><td colspan="3"></td></tr>
<tr><td colspan="8">Radiological Examination</td></tr>
<tr><td>Fracture- Yes/No</td><td colspan="3">Side- Right/Left/Both</td><td colspan="4">Site-</td></tr>
<tr><td>Luxation- Yes/No</td><td colspan="3">Side- Right/Left/Both</td><td colspan="4">Direction-</td></tr>
<tr><td>CHD - Yes/No</td><td colspan="3">Side- Right/Left/Both</td><td colspan="4">BVA/KC Score-</td></tr>
<tr><td colspan="8">Other radiological findings:</td></tr>
<tr><td colspan="8">Management:</td></tr>
<tr><td colspan="8">Postop follow up and outcome:</td></tr>
</table>

3.1.3 Orthopaedic examination

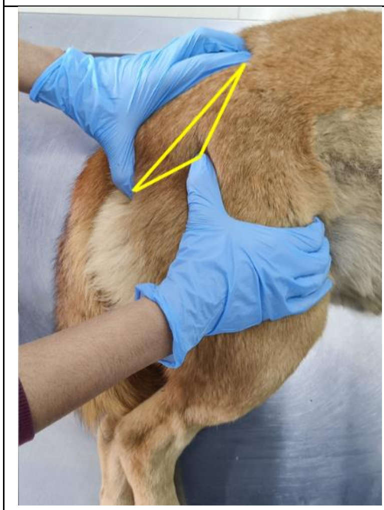
The orthopaedic examination started by observing the dogs' locomotor status whether recumbent or ambulatory. The weight-bearing scoring was done in ambulatory patients for the affected limb. For that, the affected limbs were observed in standing and walking phases of the dogs. The status of the lameness was assessed as per Kumar (2016) on the basis of weight-bearing score as follows-

Table 3.2: Recording weight-bearing score of the affected limb

Score	During Standing Phase	During Walking Phase
0	Test limb not touching the ground	
1	Toe of the test limb touching the ground occasionally	
2	Toe of the test limb touching the ground frequently	
3	The paw of the test limb touching the ground occasionally	
4	The paw of the test limb touching the ground frequently	
5	The paw of the test limb touching the ground regularly	
Net weight-bearing score	Score in standing + Score in walking	

The lameness in the affected limb was deemed 'Complete' if the net weight-bearing score was '0' and 'Partial' if the score was between 0 and 10. The lameness was considered 'Nil' if the score was 10.

Plate 3.1: Orthopaedic examination of CF joints in dogs



Assessment of the relationship among iliac wing, ischial tuberosity and greater trochanter of femur

Evaluating the extent of extension and flexion of CF joint of dogs

The relationship among the ilial wing, ischial tuberosity and the greater trochanter of the femur was visually inspected by drawing an imaginary triangle. If the shape of the triangle was lost, coxofemoral luxation was suspected (Fox 2007).

The patient was then subjected to the palpation of the whole limb to pinpoint the seat of lameness. The presence of pain, swelling, crepitus and or reduction of muscle mass was noted down. The status of the degree of pain and inflammation was categorized on the scale of 0 to 3 (Table 3.3) as per Kumar (2016).

Table 3.3: Assessment of the degree of inflammation and pain

Score	Degree of Inflammation	Degree of Pain
0	Nil	No pain on moderate digital pressure at the fracture site (Nil)
1	Mild	Pain on moderate digital pressure at the fracture site (Mild)
2	Moderate	Pain on slight digital pressure at the fracture site (Moderate)
3	Severe	Pain on just touching the fracture (Severe)

All joints of hindlimbs were flexed and extended and any change in the normal range of joint motion was recorded to assess the involvement of other joints along with coxofemoral joint conditions. The hindlimbs were physically adducted and abducted to observe the status of pain in hip joints in any particular angle.

To determine the laxity of hip joint in suspected cases of Canine Hip Dysplasia (CHD) and Coxo-femoral luxations, Ortolani's test was performed as described by Ginja et al. 2010. For this, the dogs were positioned in lateral recumbency with the examiner standing behind the animal grasping the stifle. The hip joint was kept in a neutral position with the femur parallel to the table top. While supporting the pelvis with the other hand, a proximally directed force was applied to the femur to subluxate the femoral head from the acetabulum. Stifle was then slowly abducted to reduce the subluxated femoral head back into the acetabulum. If a palpable or audible 'clunk' was present during reduction, the Ortolani test was considered positive otherwise the test was considered negative.

Plate 3.2: Ortolani's test in dogs

A force is applied on femur proximally to try sub-luxating its head followed by abduction of CF joint to listen to any 'clunk' sound indicative displaced femoral head falling back into the acetabulum

3.1.4 Neurological examination

A systemic neurological examination was performed in all cases presented with the history of trauma to rule out the involvement of spinal injury. Additionally, it was also done in cases presented with the history of difficulty in getting up from rest and waddling gait to assist in the diagnosis and to rule out the presence of any peripheral neuropathy, intervertebral disc disease (IVDD), lumbosacral disease etc. The routine neurological examination included tests for checking proprioception and different types of reflexes like patellar, withdrawal, perineal, cutaneous trunci and superficial and deep pain reflexes.

3.1.5 Laboratory examination

As per the need of the case and to assess the suitability of the animal for sedation and anaesthesia, complete blood count of the patients was performed. Dogs with lower platelets counts were further subjected to parasitological examination to rule out lameness because of haemoprotozoan infection. Additionally, the dogs requiring surgical intervention were subjected to biochemical examination which included liver function test, kidney function test, total protein and glucose levels.

3.1.6 Radiological examination

To determine the type and location of the injury and to know the status of the joint, radiographic examination of the patient was done. In order to achieve quality radiographs, preparation of the animal was done as per the standard operating protocol (SOP) developed by Ankit (2020). A high frequency X-ray machine (Allengers HF MARS 80' of Allengers medical systems, India) was used for radiographic exposures and computed radiographic machine (Regius 110, Konika Minolta Healthcare Pvt. Ltd., India) was used for scanning the X-ray cassettes for obtaining the radiographic images digitally (Plate: 3.3).

Plate 3.3: X-Ray and computed radiography machines

(i) Patient preparation

A day before the radiographic examination, laxative (Cremaffin, Abbott) was administered @ 5ml PO thrice a day. The adult and senile dogs were fasted for 12 hours and kept off water for 4 hours whenever possible whereas, the younger dogs (<6 months of age) were fasted for 6 hours. Wherever possible, the enema was done to clear the colon an hour before radiographic examination in all dogs above 6 months of age using Sodium Phosphate enema (10% sodium dihydrogen phosphate and 8% Disodium hydrogen phosphate, Nice Pharmaceuticals Pvt Ltd., India).

(ii) Sedation and anaesthesia

In order to attain the proper radiographic positioning and keeping in mind the radiographic safety protocol, dogs were either deeply sedated or anaesthetized before the exposure.

Sedation was achieved with a combination of inj. Butorphanol (Butodol-2, Neon Laboratories, India) administered @ 0.02 mg/kg IM, inj. Acepromazine (Ilium Acepril-10, Troy Animal Healthcare, Australia) @ 0.05 mg/kg IM and inj. Glycopyrolate (Pyrolate, Neon Laboratories, India) @ 0.01 mg/kg IM about 40 minutes before the intended radiographic procedure.

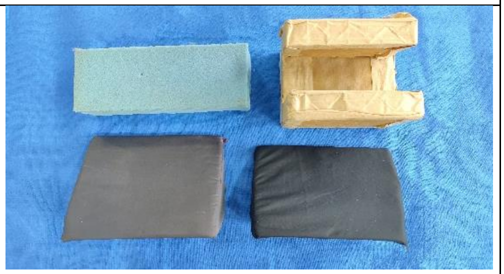
Whenever general anaesthesia required, dogs were premedicated half hour before with inj. Atropine sulphate (Tropine, Neon Laboratories, India) @ 0.02 mg/kg SC and then induced by administering inj. Xylazine (Xylaxin, Indian Immunological Ltd.) @ 1.5 to 2.0 mg/kg and inj. Ketamine (Aneket, Neon Laboratories) @ 7.5 to 10 mg/kg intramuscularly. The endotracheal intubation was done using disposable cuffed tubes.

(iii) Radiographic positioning

Neck collars, leashes, body braces, and any other foreign material, if sticking to the body were removed before radiographic exposure.

Plate3.4: Radiographic positioning devices

Different sizes of floppy sandbags



Other positioning devices

Foam ‘U’ and ‘V’- troughs of different sizes

The radiographic exposures were usually done without manual restraint using assorted radiographic positioning aids like U and V-troughs, floppy sandbags, foam wedges and rectangular polyethylene foam (Plate 3.4). These devices also helped in attaining the desirable alignment of the spine, pelvis and limbs of the dogs in different radiographic positions. Wherever un-assisted restraint of dogs wasn't feasible, protective gears (lead aprons, thyroid shields) were used to reduce the radiation exposure to the person assisting in positioning.

The exposures were done to obtain following radiographic views-

a) Extended hip ventro-dorsal (VD) view

The dogs were placed in the supine position on the X-ray table in U or V-troughs in such a way that the upper part of the body up to the thoracic spine was supported by it and the lower part of the body (pelvis and hindlimbs) outside it. Both femurs were then rotated internally and abducted to make them parallel to each other and, Velcro straps or adhesive tape was then tied over the stifles to keep them in such position. Limbs were then extended slowly to make the femurs parallel to the X-ray table (Armbrust 2009). The limbs were then kept in such extended position with the help of heavy floppy sandbags placed over the hock joint (Plate 3.5).

Plate 3.5: Positioning of dogs for extended hip ventro-dorsal radiographic view

b) Lateral view

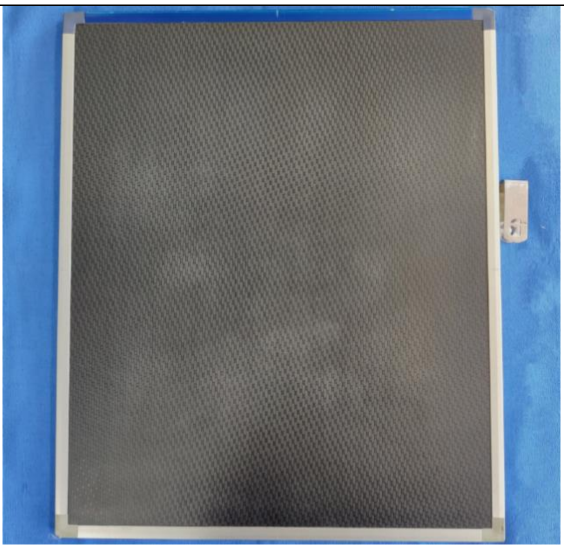
Dogs were kept in lateral recumbency with forelimbs extended forward with the help of a floppy sandbag. The hindlimbs were kept slightly away from each other by placing the limb close to the X-ray table cranially and stifle of the upper limb in flexed position as shown in the plate 3.6.

In addition, medio-lateral radiographic view of coxofemoral joint were also obtained in cases of coxofemoral fractures. For this, the dogs were kept in lateral recumbency with the affected limb down. The forelimbs were pulled forward with the help of floppy sandbags in the same manner as described above. Thereafter, the unaffected hindlimb was pulled backward in such a manner so as allow unhindered radiographic exposure of the femoral neck of the affected hind limb (Plate 3.6)

<table>
<tr><th colspan="2">Plate 3.6: Obtaining standard lateral and medio-lateral radiographic views</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Lateral view</td><td>Medio-lateral view</td></tr>
</table>

(iv) Miscellaneous radiographic accessories

Radiographic exposure factors were chosen as per the technique chart developed in the same institution by Ankit (2020). To measure the thickness of the pelvis of the dogs, measuring scales and carbon fibre scales were used (Plate 3.7). Other radiographic aids like lead markers were used during radiographic exposure to mark the side of the dog in different positions. The stationary linear grid (grid ratio 8:1 and grid frequency 103 lines/inch) was used in cases where thickness of the exposed part exceeded 10 cms.

Plate 3.7: Miscellaneous radiographic accessories	
	
CR cassette and lead markers	Stationary grid and measuring caliper

The radiographs so obtained were evaluated critically and the diagnosis was ascertained. The conditions associated with the coxofemoral joint were first broadly categorized into 'Fractures' and the 'Other conditions' and which were further subcategorized as follows-

CF fractures

Details of the fractures were noted to subcategorize the condition on the basis of:

a) Side affected: whether right/ left or both
b) Site affected: acetabulum or femoral head and neck
c) Any additional fracture

Other conditions

This category included conditions of the CF joint other than fractures like CF luxation, Canine hip dysplasia (CHD) and miscellaneous.

CF luxations were further categorised based on the displacement of the femoral head relative to acetabulum into four categories viz: craniodorsal, caudodorsal, caudoventral and medial as per Moores (2006).

The dogs diagnosed with CHD were assigned to different age groups as per Ankit (2020) as shown in table 3.4.

Table 3.4: Age group classification of dogs with hip dysplasia

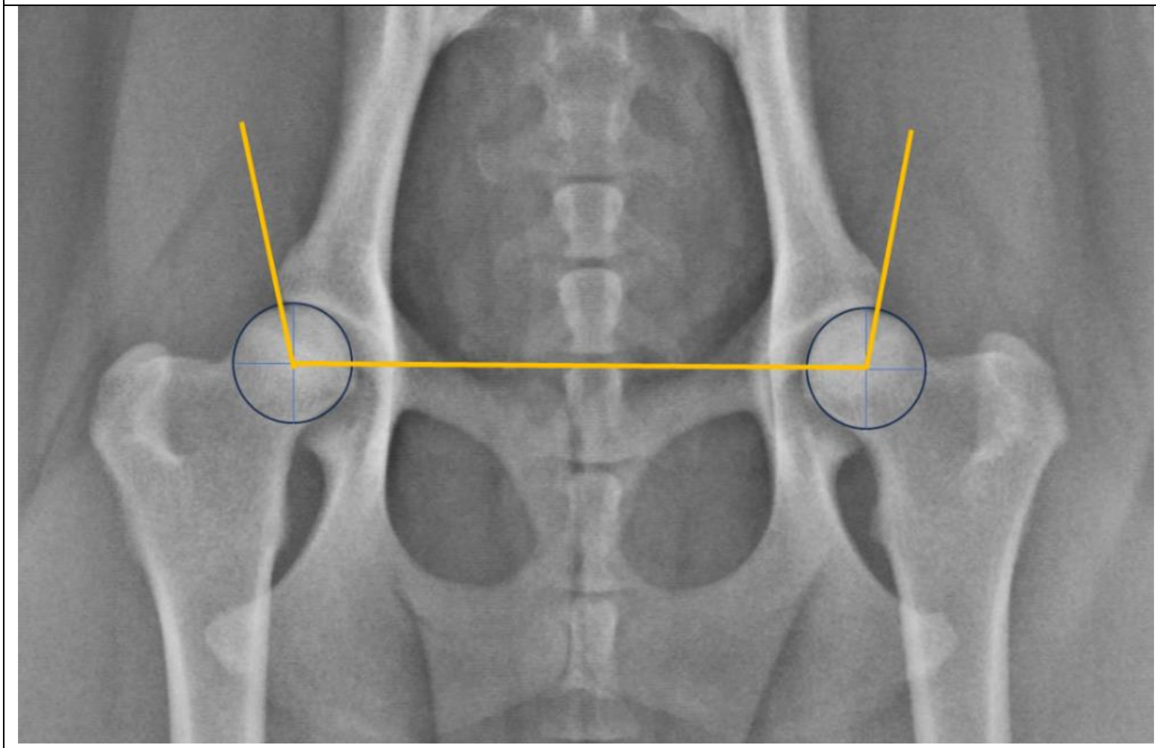
Class 1	<3 months
Class 2	3-6 months
Class 3	6-24 months
Class 4	>24 months

The pelvic radiographs of dogs above 1 year of age were subjected to scoring as per British Veterinary Association and Kennel Club (BVA/KC) scoring system of CHD. For that, the radiographs of properly positioned animals were evaluated in the standard extended hip ventro-dorsal views. Each hip was then examined for nine different anatomical features viz: Norberg angle (NA), subluxation, cranial acetabular edge (CrAE), dorsal acetabular edge (DAE), cranial effective acetabular rim (CrEAR), acetabular fossa (AF), caudal acetabular edge (CaAE), femoral head/neck exostosis (FHNE) and femoral head recontouring (FHR). A numerical score was given to each feature as described in table 3.5. Score varied from 0 to 6 for each anatomical feature except for caudal acetabular edge for which it varied from 0 to 5. The total hip score was then calculated by adding scores given to each hip (Dennis 2012).

i) Norberg Angle

The Norberg angles of the hip joints were determined as per the technique described by Comhaire and Schoonjans (2011). To do so, a circle was first drawn around the centres of the left and right femoral head’s arc. Then a horizontal line was drawn to link the centres of both the circles. Two other intersecting lines were then drawn from both the centres to connect them with the corresponding cranial effective acetabular rim. The angle formed between the line connecting circles and line connecting acetabular rim was measured with the help of protractor and noted down as “Norberg angle”. A score of 0 to 6 was then given to the hip joint based on the angle so noted.

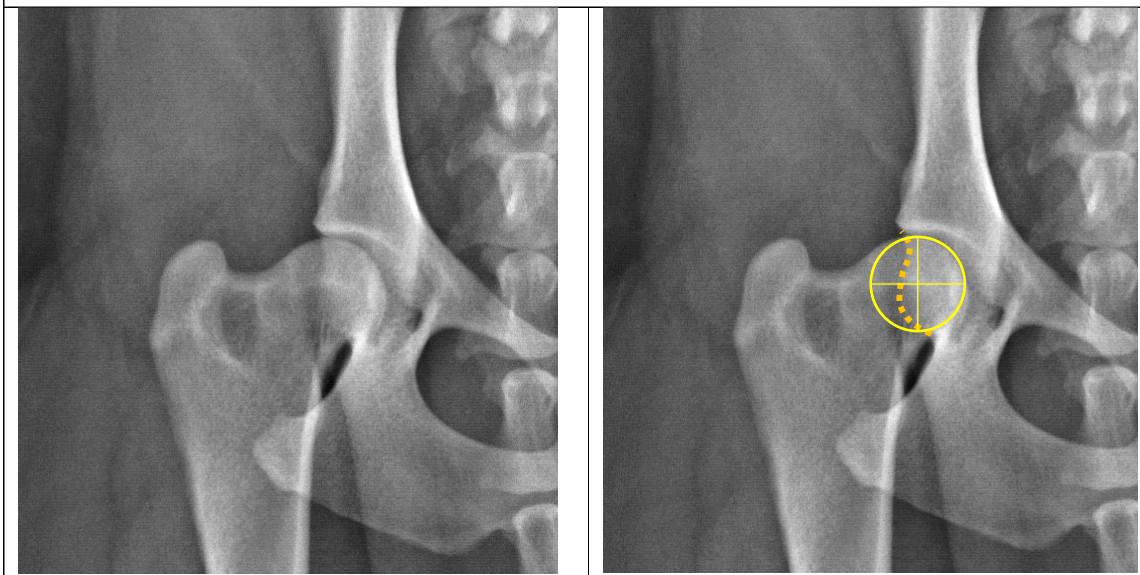
Plate 3.8: Measurement of Norberg angle in dogs



ii) Subluxation

The position of the femoral head centre in relation to the dorsal acetabular edge and the congruency of the fit between the femoral head and the cranial acetabular edge were taken into consideration when assessing subluxation.

Plate 3.9: Assessment of position of femoral head centre in relation to DAE



iii) Cranial acetabular edge

It was identified as the part of acetabulum which continued with the dorsal acetabular edge and was separated from the caudal acetabular edge by the acetabular fossa (Plate 3.9). Radiographs were assessed for any change in its shape and contour with the femoral head or increase in joint space.

iv) Dorsal acetabular edge

The part of the acetabulum superimposed by the femoral head was considered as the dorsal acetabulum edge (Plate 3.9). Any deviation from the normal "S" shape due to exostosis or bone loss of the dorsal acetabulum edge was noted.

v) Cranial effective acetabular rim

It was viewed as a sharp point where the dorsal acetabular edge curves to form the cranial acetabular edge. Radiographs were assessed for any spur formation or bone loss at CrEAR.

vi) Acetabular fossa

Acetabular fossa was seen as a radiolucent area in the acetabulum where the round ligament attaches. To assess any change in the acetabular fossa, radiographs were examined for the production of any new bone in the depth of the acetabular fossa.

vii) Caudal acetabular edge

Radiographically it was appreciated as a shorter edge of acetabulum lateral to the radiolucent acetabular notch. Radiographs were examined for any variation in the appearance of CaAE due to exostosis.

viii) Femoral head and neck exostosis

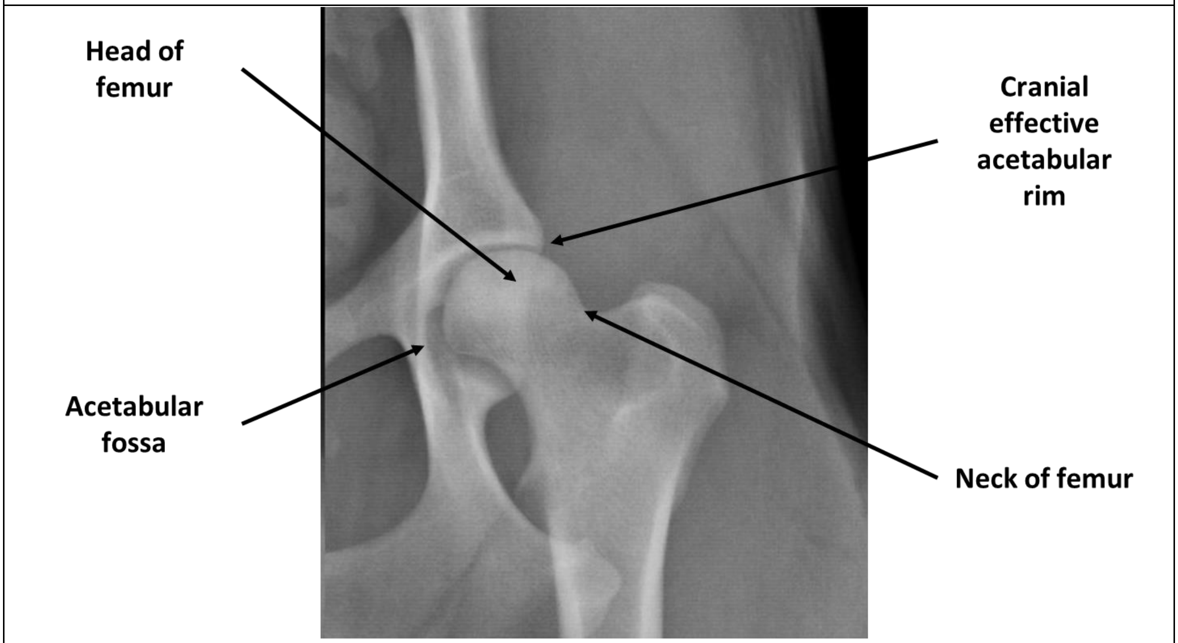
Femoral neck was examined for a fine radio-opaque line called as Morgan's line which appears at the attachment of the joint capsule to the femoral neck as a result of osteophyte formation.

ix) Femoral head recontouring

In non-dysplastic hip joints femoral head had a smooth and round profile. The criteria described by BVA/KC was used to record the extent to which the shape of the femoral head had altered.

Any change in the normal radiographic appearance of the above mentioned nine parameters were compared with the details explained in table 3.5 and scores were assigned to each hip joint accordingly.

Plate 3.10: Features assessed by BVA/KC soring scheme



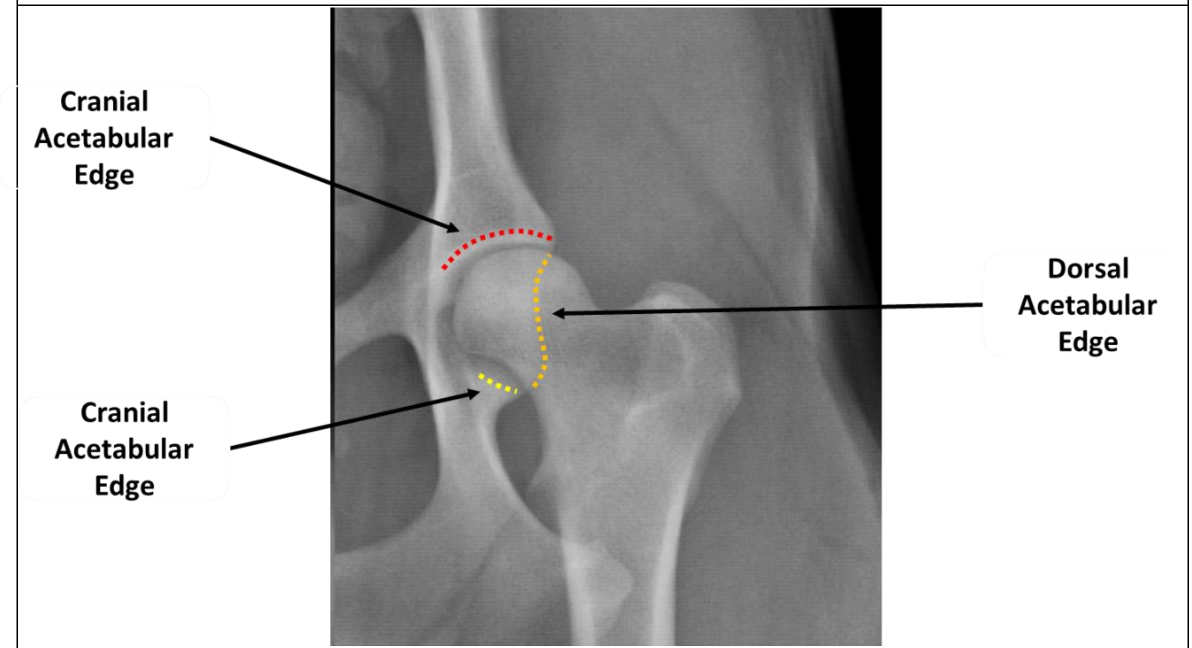


Table 3.5: Criteria for scoring hips as per BVA/KC scoring							
Score	0	1	2	3	4	5	6
Norberg Angle	+ 15 and over	+10 to +14	+5 to +9	0 to +4	–1 to –5	–6 to –10	–11 and over
Subluxation	Femoral head is well centred in acetabulum	Femoral head centre lies medial to DAE. Lateral or medial joint space increased slightly	Femoral head centre is superimposed on the DAE. An obvious increase in the medial joint space	Femoral head centre is just lateral to the DAE. Half of the femoral head is within the acetabulum	Femoral head centre is clearly lateral to the DAE. A quarter of the femoral head is within the acetabulum	Femoral head centre is well lateral to, and just touches, the DAE	Complete pathological dislocation
Cranial Acetabular edge	Even curve, parallel to the femoral head throughout	Lateral or medial quarter of the edge is flat and the lateral or medial joint spaces diverge slightly	Flat throughout most of its length	Slight bilabiation	Moderate bilabiation	Gross bilabiation	Entire edge slopes cranially

Dorsal Acetabular edge	Slight curve	Loss of S curve only in the presence of other dysplastic change	Very small exostoses cranially	Obvious exostoses, especially cranially, and/ or minor 'loss of edge'	Exostoses well lateral to the edge and/ or moderate 'loss of edge'	Marked exostoses all along the edge and/ or gross 'loss of edge'	Massive exostoses from the cranial to caudal edge
Cranial effective acetabular rim	Sharp, clean-cut junction of the DAE and CrAE	Indistinct junction of the DAE and CrAE	Very small exostosis or very small facet	Facet and/or small exostosis and/or slight bilabiation	Obvious facet and/or obvious exostosis and/or moderate bilabiation	Gross exostosis and/or facet and/or gross bilabiation	Complete remodelling. Massive exostosis and/or gross facet
Caudal acetabular edge	Clean line	Small exostosis at the lateral edge	Small exostosis at the lateral and medial edge	Large exostosis and narrow notch	Marked exostosis and 'hooking' of the lateral end	Gross distortion due to mass of the new bone in acetabulum. The notch is lost completely	Void

Femoral head and neck exostoses	Smooth, rounded profile	Slight exostosis in ‘ring form’ and/or dense vertical line adjacent to trochanteric fossa (‘Morgan line’)	Slight exostosis visible on the skyline and/or density on the medial femoral head	Distinct exostosis in ‘ring form’	Obvious complete collar of exostosis	Massive exostosis giving a mushroom-like appearance	Massive exostosis and infill of the trochanteric fossa and below the femoral head
Femoral head recontouring	Nil	Femoral head does not fit in a circle due to exostosis or bone loss	Some bone loss and/or femoral head/neck ring of exostosis	Obvious bone loss and distinct exostosis giving a slight conical appearance	Gross remodelling. There is obvious bone loss and exostosis give a mushroom-like appearance	Very gross remodelling with marked bone loss and much new bone	Femoral head is improperly shaped due to dysplasia of the femoral head centre
Acetabular fosssa	Fine bone line curves medial and caudal from the caudal end of the CrAE	Slight increase in medial bone density. The ‘fine line’ is hazy or lost	‘Fine line’ is lost and the ventral AE is hazy due to new bone. The notch at the CaAE is clear	Incomplete remodelling of the acetabulum, with the medial face lateral to the AF. The ventral AE is lost, the AF is hazy and the notch is irregular	Marked remodelling. The medial face of the acetabulum is clearly lateral to the AF. The ventral AE is lost and the notch is partly closed	Gross remodelling, with dense new bone throughout the acetabulum. The CaAE notch is lost and the AF is obscured	Complete remodelling and new articular surface, well lateral to the AF. The notch is lost

The score for nine different anatomical parameters was noted down in the proforma (Table 3.6) and the total hip score was calculated by adding them together. The interpretation of total hip scores were done as per the criterion described by BVA/KC hip scoring system (Table 3.7).

Table 3.6: Proforma to record hip scores as per BVA/KC

Anatomical feature	**Right limb score**	**Left limb score**
Norberg angle		
Subluxation		
Cranial acetabular edge		
Dorsal acetabular edge		
Cranial effective acetabular rim		
Acetabular fossa		
Caudal acetabular edge		
Femoral head and neck exostosis		
Femoral head recontouring		
Total score		
	Total score (both hips)	

Table 3.7: Categorization of Canine hip dysplasia as per BVA/KC

Hip score	**Grade of hip dysplasia**
0 to 4	Perfect or near perfect hips
5 to 10	Borderline changes that are unlikely to worsen with age
11 to 20	Mild changes that may worsen with age, sometimes developing into osteoarthritis
21 to 50	Moderate to marked hip dysplasia with osteoarthritis or severe hip dysplasia before arthritic changes
Above 50	Severe to very severe osteoarthritis secondary to hip dysplasia

3.1.7 Management of conditions of coxofemoral joints in dogs

Following diagnosis, course of management of coxofemoral joint conditions were decided based on the prognosis and owner's compliance. Management was either done non-surgically or surgically. Whereas, euthanasia was also carried out in few cases where recovery was not anticipated.

3.1.7.1 Non-surgical management

Conservative management of canine hip dysplasia was done with non-steroidal anti-inflammatory drugs (NSAIDs), joint supplements, weight management and restricting the activity to leash walking. NSAID used was tab carprofen (Carodyl, Savavet, India) @ 2-4 mg/kg BW s.i.d. and glucosamine and chondroitin sulphate joint supplement (Synopet, Intas, India) was administered @ 4gm/10 kg BW s.i.d.. Joint supplements were used for variable periods extended up to 2-3 months. Overweight dogs were put on weight management diet. Dog owners were advised against keeping their dogs on slippery surfaces and dogs with osteoarthritic changes secondary to CHD was advised to be kept at warm places.

Other than canine hip dysplasia, acute cases of CF luxations were also managed non-surgically by closed reduction and Slocum sling application. Closed reduction of the hip joint was done in anaesthetized dogs under fluoroscopy. For this, the dogs were premedicated half hour before the procedure with inj. Atropine sulphate (Tropine, Neon Laboratories, India) @ 0.02 mg/kg SC and then induced by administering inj. Xylazine (Xylaxin, Indian Immunological Ltd.) @ 1.5 to 2.0 mg/kg IM and inj. Ketamine (Aneket, Neon Laboratories) @ 7.5 to 10 mg/kg IM.

Reduction was performed as per the technique described by Brinker et al. (2006). For this, a long cotton rope was positioned in the groin region where it was held by the assistant to provide counter traction to the pull. With one hand on greater trochanter and other hand holding the leg at hock region, the femur was rotated externally. Then the leg was pulled downwards to bring the femoral head at the level of acetabulum. The stifle was then rotated inwards followed by abduction and firm pressure over the greater trochanter to guide the femoral head into the acetabulum. A 'thud' was heard on reduction of femoral head into the acetabulum.

The reduced hip joint was then supported with Slocum sling. The material required for application of Slocum sling are shown in plate 3.10.

Plate 3.11: Material required for Slocum sling application

1. Cast padding
2. Adhesive crepe bandage
3. Cotton bandages
4. Crepe bandage
5. Boric acid
6. Adhesive bandage

For application of Slocum sling the belly area and metatarsal region of the dog was clipped with the help of clipper. A belly bandage was then applied with cast pad and secured at place with the help of adhesive tape. At metatarsal region first a double-sided adhesive tape was applied and then cast padding. The adhesive tape was applied over this padding at metatarsal region and passed over the stifle from medial side to lateral side in such a manner to keep both hock and stifle in flexed position. A second strap of adhesive tape was rolled over the belly bandage involving the flexed stifle and hock joint after keeping a role of bandage at stifle as shown in plate 3.11. All this was then doubly secured with the help of adhesive crepe bandage.

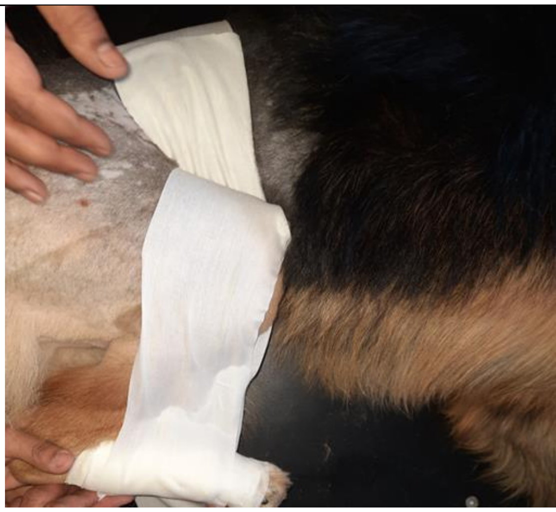
After close reduction, pain management was done with the help of NSAIDS like tab. Carprofen (Carodyl, Savavet, India) @ 2-4 mg/kg BW po s.i.d for 5 days. Besides, antibiotics like tab. Amoxycillin and Potassium clavunate (Amoxyclav, Abott, India) @ 20mg/kg BW po b.i.d. for 5 days, anxiolytic drugs- tab Trazodone (Trazonil- 100, Intas, India) @ 2- 20 mg/kg BW po b.i.d., antacids-tab Pantoprazole (Pantosec, Cipla, India) @ 1mg/kg BW po s.i.d. for 5 days and laxatives (Cremaffin, Abbott, India) were also given. To aid in urination after the application of Slocum sling and to prevent the sling from being soiled, urinary catheterization was also done in male dogs. Dog owners were also advised to apply E-collar to the animal to avoid sling removal.

Plate 3.12: Application of Slocum Sling

Application of belly band

Double-sided tape over metatarsal region

Padding of metatarsal region



Taping of stifle and hock in flexed position

Taping of flexed limb with belly band after keeping bandage roll over stifle

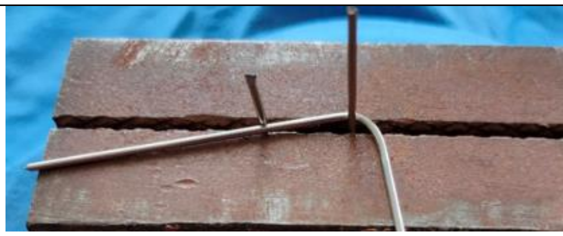
Application of adhesive crepe bandage and crepe bandage.

3.1.7.2 Surgical management

Cranio-lateral approach was used to expose the hip joint while the patient was kept in lateral recumbency with affected side upward. This approach was used for management of femoral head and neck fractures, open reduction of CF luxations and femoral head osteotomy. The details of each procedure are given in ‘Result and Discussion’ chapter.

Chronic cases of CF luxation and cases where closed reduction and external coaptation failed were managed with toggle pin fixation. Toggle pins were prepared from different size K-wires as described by Brinker et.al (2006). The pins were made from the wire bent around a jig clamped in a vise. Different width of jigs was made to prepare different size of toggle pins. Comparable size of K-wire was used to make both jig and toggle pin. A smaller jig of width 0.5 cm made from 1.2 mm K-wire was used to make toggle pins for dogs weighing less than 10 kgs. Large jig of width 1cm to 1.2 cm was used to make toggle pins from 1.5mm K-wire for dogs weighing more than 10 kgs. Jig was mounted on a vise with bent portion clamped in between the jaws of vise and unequal free ends projecting upwards. Using long arm of jig as fulcrum one end of another K-wire of similar size was bent 360 degrees forming a circle in the centre of wire as shown in plate 3.12. After repositioning the bent wire, its other end was bent 180 degrees around the short arm of jig. Bend other end in similar manner. Cut both the extra ends at the level of circle and press the arms of toggle pin to flatten them as much as possible (Plate 3.12)

Plate 3.13: Preparation of toggle pin

360 degrees bending of K-wire to make the central hole


Central hole of the K-wire and its repositioning to the smaller post

Creating arms of toggle pin by bending the side by 180 degrees

Different sizes of toggle pins

Braided polyester thread used in toggle pinning

Post operative management of surgical cases was done with NSAIDS- tab. carprofen (Carodyl, Savavet, India) @ 2-4 mg/kg BW po s.i.d for 5 days, antibiotic therapy using tab. Amoxycillin and Potassium clavunate (Amoxyclav, Abott, India) @ 20mg/kg BW po b.i.d. for 7 days, opioid analgesics e.g., tramadol (Supridol, Neon Laboratories Ltd.) @ 2-5 mg/kg SC b.i.d. for 5 days, proteolytic enzymes like tab. serratiopeptidase (Lyser, Comed Chemicals Ltd.), proton pump inhibitors e.g., tab Pantoprazole (Pantosec, Cipla)) @ 1mg/kg BW po s.i.d. for 5 days, laxatives (Cremaffin, Abott) @ 5 to 10ml po b.i.d. and anxiolytics like Trazadone (Trazonil, Intas Pharmaceuticals Ltd.) @ 2-20 mg/kg BW po for 15 days. Besides, strict cage rest was advised in cases of multiple fractures. Dog owners was advised to keep the animal on soft bedding to avoid bed sores and to apply E-collar to prevent self-mutilation of the surgical site.

3.1.8 Post-operative observations

The surgical cases were followed for variable period to record the efficacy of treatment for future analysis. Improvement in weight bearing were noted down and radiographs were also taken to assess the efficacy of treatment. Additionally, physical appearance and healing status of surgical site was also examined. Any complication presented was noted down and treated as per the need.

3.2 Ascertaining the regional occurrence of the coxofemoral joints conditions in dogs

All the cases of dogs presented to Department of Veterinary Surgery and Radiology, DGCN College of Veterinary and Animal Sciences were utilised to record the regional occurrence of conditions of coxofemoral joint. Data recorded was used to calculate the sex and age wise incidence of coxofemoral joint affections. Besides, the data of cases diagnosed with coxofemoral joint conditions were utilised to calculate the sex, age, breed and condition-wise distribution of CF joint cases. Age group wise categorisation of animals was done as per Kumar (2016) as shown in table 3.8

Table 3.8: Age-group classification in dogs

Juvenile	< 1 year
Adult	1-7 years
Senile	>7 years

To record the regional occurrence of canine hip dysplasia in different age groups, dogs presented to Department of Veterinary Medicine for vaccination and Department of Veterinary Surgery and Radiology for elective surgeries were subjected to radiographic screening as per the SOP described above after taking consent from owners. Breeds susceptible for hip dysplasia like Labrador retrievers, Golden retrievers, Rottweilers and German shepherds were screened. Scoring of radiographs of dogs was done according to BVA/KC.

Chapter 4

RESULTS AND DISCUSSION

The results are being discussed under the following two sections-

4.1 Diagnosis and management of the conditions of coxofemoral joints in dogs.

4.2 Ascertaining the regional occurrence of the coxofemoral joints conditions in dogs

4.1 Diagnosis and management of the conditions of coxofemoral joints in dogs

During the study period spanning from August 2022 to September 2023, overall 1989 clinical cases of dogs were presented to the Department of Veterinary Surgery and Radiology, DGCN College of Veterinary and Animal Sciences, CSKHPKV Palampur. Out of these, one or other coxofemoral (CF) conditions were found in 61 dogs. These conditions were broadly categorized into 'CF fractures' and 'Other CF conditions' which are discussed under two separate heads of their diagnosis and management as follows-

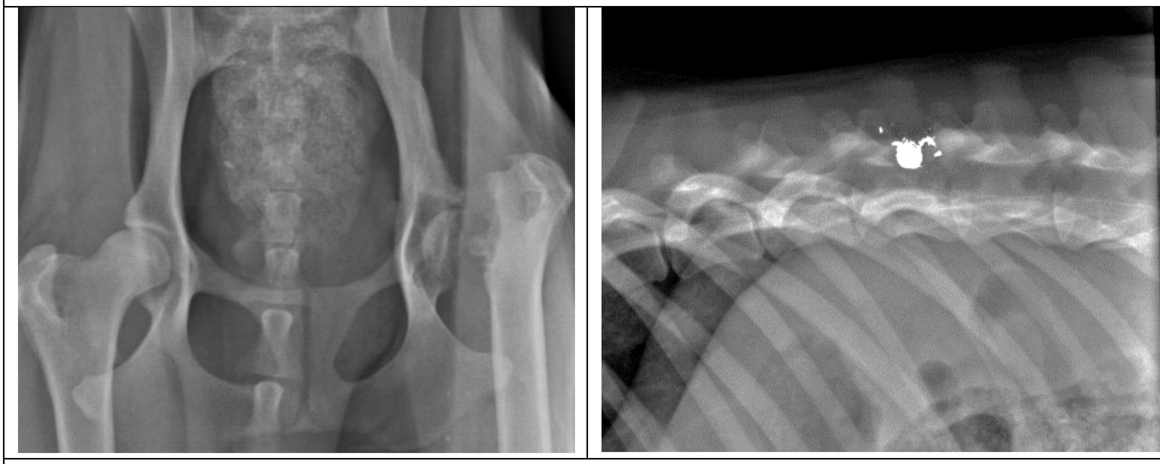
4.1.1 Diagnosis of the coxofemoral fractures in dogs

The fractures of CF joints included those involving femoral head, neck or acetabulum alone or in combinations. Such fractures were diagnosed in 13 dogs; their brief case record is presented in table 4.1. The dogs were presented with the history of either varying degrees of lameness in hind limbs or with a complaint of not getting up completely ranging from the previous 1 to 10 days. The state of recumbency was attributed to spinal nerve injury in 2 cases (Cases 1 and 11), sciatic neuralgia in one case (Case 9) and due to multiple injuries of pelvis bilaterally in 5 cases (Cases 3, 5, 6, 10 and 13). However, one dog (Case 12) was ambulatory despite affected with multiple bilateral pelvic injuries. The aetiology was vehicular trauma in 10 and unknown in others (Case 1, 2 and 9). As the clinical and other findings were different in different cases, these are being presented case-wise as follows-

Case 1 was a mixed-breed adult female dog presented in a recumbent state, the orthopaedic examination of hind limbs revealed crepitus on palpation of left CF joint but pain and inflammation at the site were absent. Neurological examination showed absence of cutaneous trunci reflex in lumbar region; the withdrawal reflex was also absent in both hind limbs.

On radiological examination it was found to be a case of old capital physeal fracture of left femur. Structural loss of femoral neck was observed reduced bone opacity in femoral head however, osteosclerotic changes were present in nearby structures. Additionally, a metallic gun-shot pellet like opacity was observed in the centre of T-13 vertebrae just above the spinal canal and the paralysis was ascribed to the spinal cord injury caused by it.

Plate 4.1: Radiographic appearance of pelvic and lumbar region in Case 1



Left femoral capital physeal fracture with structural loss of femoral neck, decreased bone opacity of femoral head and osteosclerotic changes in nearby structures and a metallic gun-shot like opacity in the centre of T-13vertebrae just above the spinal canal.

Case 2 was a 3-month-old mixed-breed male pup presented in ambulatory state but with complete lameness of the affected limb. There was moderate inflammation at the level of right CF joint and its palpation revealed pain and crepitus.

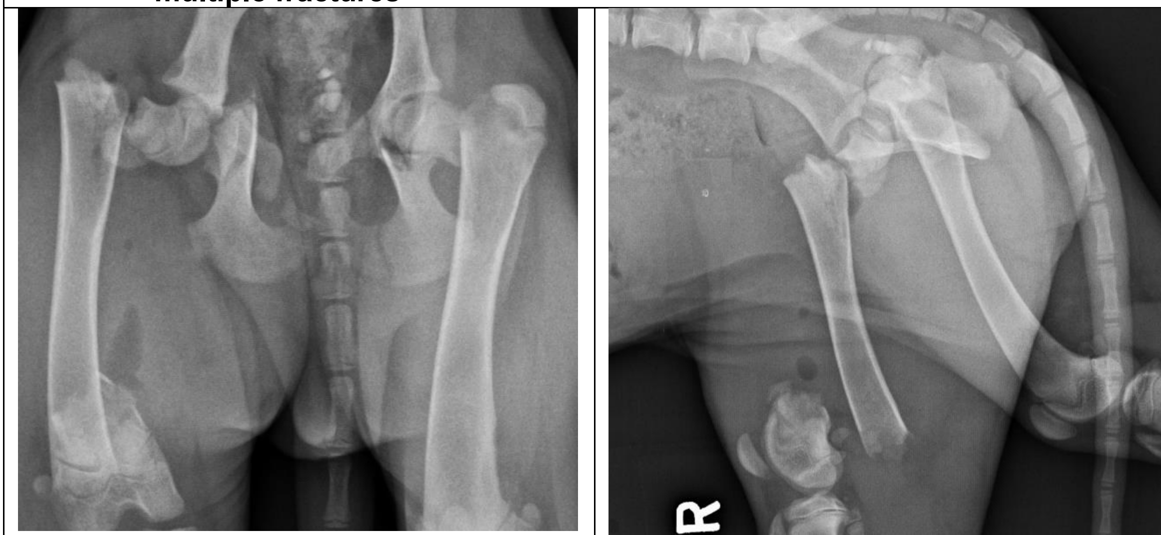
The radiological examination confirmed right femoral neck and capital physeal fracture. No neurological deficit was present.

Plate 4.2: Different radiographic views of pelvis in Case 2

Right femoral neck and capital physeal fracture

Case 3 was a 5-month-old mixed-breed female pup presented in recumbent state. On clinical and orthopaedic examination, crepitus was felt at the level of both CF joints and right distal femur. Pain and inflammation at the level of CF joints were severe. Withdrawal reflexes in both the hind limbs were sluggish. Radiological examination revealed bilateral femoral neck fractures, right distal metaphyseal short oblique femoral fracture, right trochanter major fracture, right acetabular fracture, cranial and caudal pubic rami fracture.

Plate 4.3: Different radiographic views of pelvis and femur in Case 3 depicting multiple fractures



Bilateral femoral neck fractures; right distal metaphyseal short oblique femoral fracture; right femoral trochanter fracture; right acetabular fracture; cranial and caudal pubic ramus fracture

Case 4 was a 6-month-old male Shih Tzu pup presented with partial lameness of right hind limb. On palpation, crepitus was felt at the level of right CF joint. Pain and inflammation at the site were mild.

Radiological examination revealed an un-displaced healing femoral neck fracture. The radiolucent fracture line was observed extending obliquely from the femoral neck laterally in to the trochanter major. The girth of femoral neck was smaller than the contralateral side and an osteophyte was present at the dorsolateral border of femoral head. The right femoral capital physeal line and the right CF joint margins towards caudal acetabular edge were not as distinct as on left side.

Plate 4.4: Different radiographic views of pelvis in Case 4

An un-displaced healing fracture of femoral neck with fracture line extending obliquely from the femoral neck laterally in to the trochanter major and an osteophyte was present at dorsolateral border of femoral head; right femoral capital physeal line and the right CF joint margins towards caudal acetabular edge were not as distinct as on left side.

Case 5 was a 5-month-old mixed-breed male pup presented in recumbent state. The orthopaedic examination of the animal revealed crepitus at the level of proximal femur. Animal showed severe pain on palpation of CF joint and pelvic region. Withdrawal reflexes in both the hind limbs were sluggish.

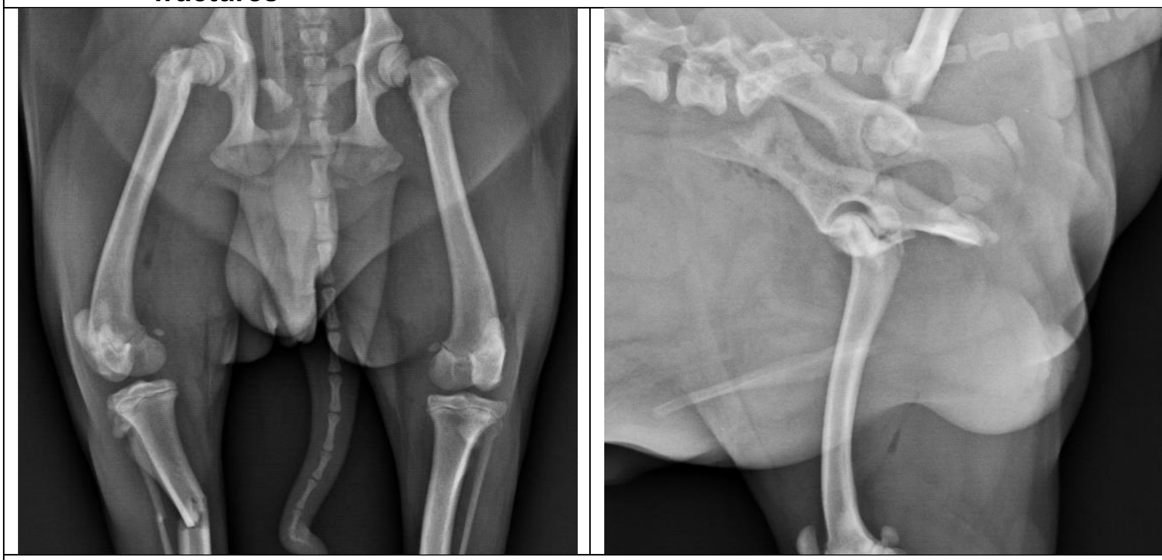
Radiological examination revealed right femoral neck fracture, comminuted right proximal femur fracture, incomplete ilial body fracture on right side & complete on left, cranial and caudal rami fracture of left pubis.

Plate 4.5: Different radiographic views of pelvis in Case 5 depicting multiple fractures

Right femoral neck fracture; comminuited proximal fracture of right femur; incomplete ilial body fracture on right side & complete on left; cranial and caudal rami fractures of left pubis

Case 6 was 6-month-old male Pug presented in a recumbent state. On orthopaedic examination crepitus was felt at the level of both CF joints and right mid tibial region. Pain and inflammation at these sites were severe; the withdrawal reflexes were sluggish in both hind limbs.

Plate 4.6: Different radiographic views of pelvis in Case 6 depicting multiple fractures

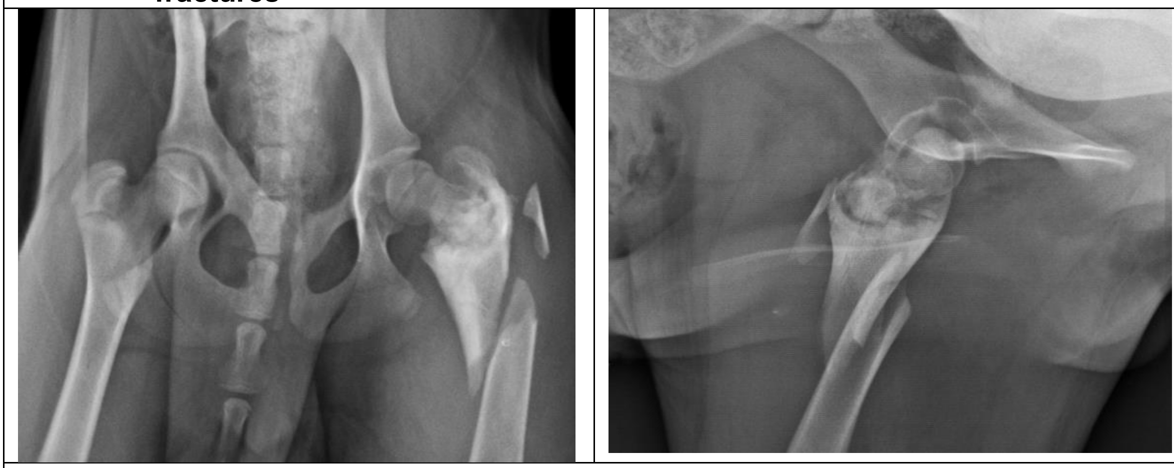


Left femoral head and right femoral neck fractures; multiple pubic fractures (right cranial, caudal rami, symphysis and cranial left rami); right mid diaphyseal short oblique fracture of tibia

Radiological examination revealed left femoral head and right femoral neck fracture, multiple pubic fractures and right mid diaphyseal short oblique fracture of tibia. The pubis was fractured at right cranial and caudal rami, symphysis and left cranial rami regions.

Case 7 was 9-month-old mixed-breed male presented in a recumbent state. There was severe inflammation and pain at the level of proximal left femur. The palpation revealed crepitus at the site. No neurological deficit was observed. Radiological examination revealed left femoral neck fracture along with comminuted fracture of same femur involving its proximal diaphyseo-metaphyseal region and trochanter major.

Plate 4.7: Different radiographic views of pelvis in Case 7 depicting multiple fractures



Left femoral neck fracture along with proximal diaphyseo-metaphyseal spiral fracture of femur with a butterfly segment; trochanter major fracture is also apparent

Case 8 was a 7-month-old male Beagle pup presented in an ambulatory state but with non-weight-bearing lameness of the left hind limb.

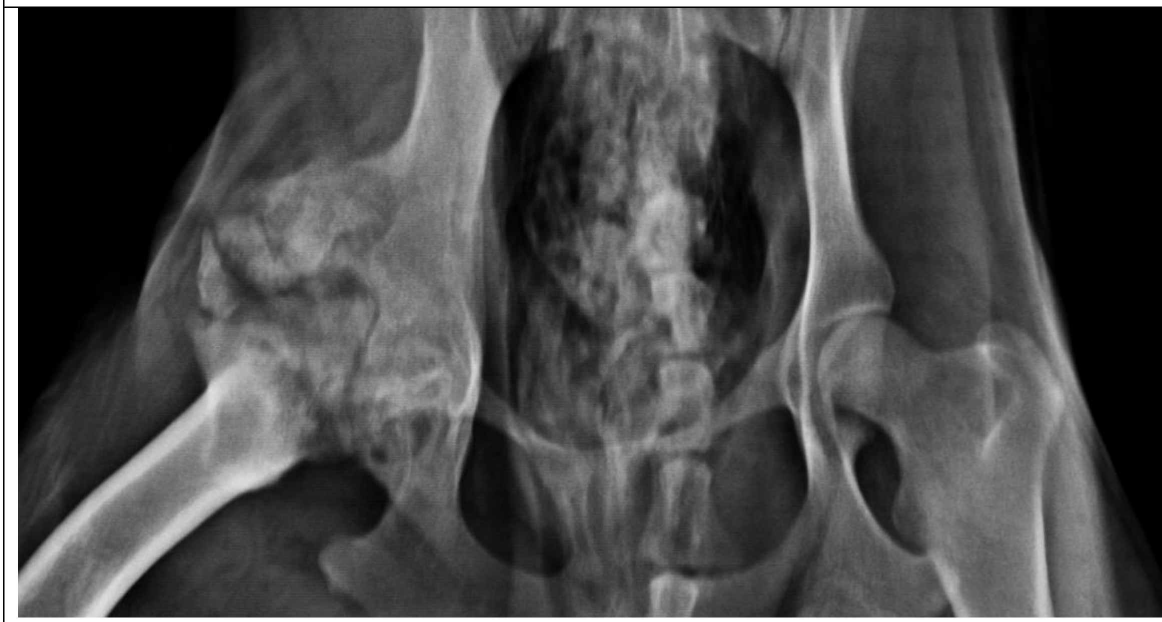
Plate 4.8: Different radiographic views of pelvis in Case 8

Left femoral neck fracture

On orthopaedic examination, crepitus was felt at the level of CF joint, with moderate inflammation and pain. Radiological examination revealed left femoral neck fracture.

Case 9 was an adult mixed-breed female dog presented in an ambulatory state but without weight-bearing on the right hind limb. There was hard swelling at right CF joint. No pain was evinced by the animal on palpation of the affected site and no mobility at CF joint was observed. There was substantial quadriceps muscular atrophy along with neurological deficit in the affected limb. Radiological examination revealed the presence of extensive osseous callus at right CF joint with complete loss of the details of proximal femur and CF joint. It was thus diagnosed as an old healing fracture of proximal femur and CF joint resulting into CF arthrodesis.

Plate 4.9: Radiograph of pelvis and proximal femur in case 9



Extensive osseous callus encompassing femoral head, neck and acetabulum with loss of radiographic details of individual components in right side

Case 10 was a 4-month-old mixed-breed female dog presented in a recumbent state. On orthopaedic examination, crepitus was felt at the level of pelvis and mid femur in both the hind limbs. Pain and inflammation at the site were severe. Sluggish withdrawal reflexes were present in both the hind limbs.

Plate 4.10: Different radiographic views of pelvis in Case 10 showing multiple fractures

Right acetabular multiple fractures along with right ilial body fracture; bilateral femoral diaphyseal fracture

On radiological examination, right acetabulum was found fractured at two places with separation of central fragment. Concurrent right ilial body and bilateral femoral diaphyseal fractures were also present.

Case 11 was a 3.5-month-old mixed-breed female presented in recumbent state. On palpation, crepitus was felt at the level of both CF joints and right mid femur. Pain and inflammation at the site were also severe. Neurological examination revealed absence of cutaneous trunci reflex in lumbar region. The withdrawal reflexes in both hind limbs and perineal reflex were also absent.

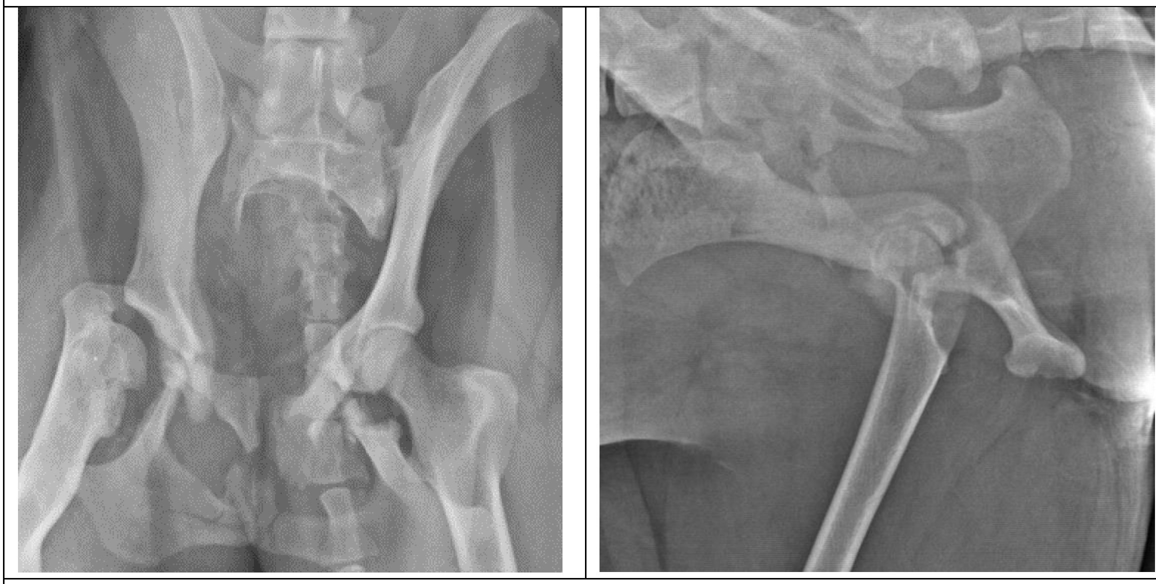
Plate 4.11: Pelvic and lumber radiographs of Case 11 showing multiple fractures

Bilateral acetabular fractures; comminuited right femoral fracture; right ischial tuberosity fracture; left ilial body fracture; incomplete fracture of L-5 involving caudal end plate

Radiological examination of pelvis revealed bilateral acetabular, comminuted right femoral, right ischial tuberosity, left ilial body fractures. Concurrent incomplete fracture of fifth lumbar vertebra involving its caudal end plate was also observed in lateral lumber radiograph.

Case 12 was a 2-year-old mixed-breed female dog presented in ambulatory state with partial lameness of right hind limb. Severe inflammation was present on both CF joints whose palpation elicited pain. Crepitus could be felt at left CF joint only. No neurological deficit was observed. Radiological examination revealed bilateral acetabular fractures, bilateral sacroiliac luxations; reverse Y shape pubic symphyseal fracture; bilateral incomplete caudal rami fracture of pubis, left cranial ramus fracture of pubis and remodelled old fracture of right femoral neck.

Plate 4.12: Different radiographic views of pelvis in Case 12 showing multiple fractures



Bilateral acetabular fracture; bilateral sacroiliac luxation; reverse Y shape pubic symphyseal fracture; bilateral incomplete caudal rami fracture of pubis; left cranial ramus fracture of pubis; remodelled old fracture of right femoral neck

Case 13 was a 3-month-old mixed-breed male pup presented in recumbent state. Severe pain and inflammation were present in pelvic region on both sides. Withdrawal reflexes were sluggish in both the hind limbs. On radiological examination, a transverse radiolucent fracture line was observed across right acetabulum in its cranial aspect. On lateral radiographic view, this fracture line was seen extending to body of right ilium obliquely. Additionally, pubic symphyseal and left ilial fractures were also observed.

Plate 4.13: Different radiographic views of pelvis in Case 13 showing multiple fractures

A transverse radiolucent line in cranial aspect of right acetabulum (ventrodorsal view) extending towards right ilial body (lateral radiograph); pubic symphyseal fracture and left ilial fracture

Out of 13 dogs presented with CF fractures, the standalone involvement of femoral head and neck was observed in 8, acetabulum in 4 and simultaneous femoral neck and acetabulum in 1 dog. Bilateral femoral head and neck fractures were identified in 2 and unilateral in 7 dogs (total 11 fractures). Acetabular fractures were bilateral in 2 and unilateral in 3 dogs (total 5 fractures).

The majority of dogs (10) presented with CF fractures were juvenile (below 1 year of age) except 3 that were adult dogs. The sex-wise distribution was 53.84% (7 dogs) for males and 46.16% (6 dogs) for females. The maximum number of dogs belonged to mixed breed category (10 dogs) followed by Shih Tzu, Pug, and Beagle (1 each).

In the present study, eight out of 13 dogs (61.53%) were presented with concurrent injuries which included fractures of different bones of ipsilateral and contralateral hind limbs as described above. Almost similar findings were observed by Ankit (2020) who reported that 22 out of 28 cases (78.57%) of pelvic region had multiple concurrent injuries. In a study conducted on 16 acetabular fractures, Dyce (1993) reported that concurrent injuries of ipsilateral ilial fracture were present in 7 cases, contralateral pelvic fractures in 8 cases, sacroiliac luxation in 4 cases, pubic fracture in 1 case and sacral fracture in 1 case.

Table 4.1: Case details of CF fractures in dogs

Case No.	Age	Sex	Breed	Weight (kg)	Duration of condition (days)	Whether recumbent or ambulatory	Affected side	Weight-bearing score on affected limb	Inflammation and Pain score	Description of CF fractures and concurrent injuries based on radiological observations
1	Adult	Female	MB	15	Not known	Recumbent	Left	NA	0 (Nil)	Left femoral capital physeal fracture with structural loss of femoral neck, reduced bone density of femoral head and osteosclerotic changes in nearby structures. Additionally, a metallic gun-shot pellet like opacity in the centre of T-13 vertebra just above the spinal canal
2	3 months	Male	MB	9	Not known	Ambulatory	Right	0	2 (Moderate)	Right femoral neck and capital physeal fracture
3	5 months	Female	MB	6.5	1	Recumbent	Bilateral	NA	Right- 3 (Severe); Left- 3 (Severe)	Bilateral femoral neck fractures; right distal metaphyseal short oblique femoral fracture; right femoral trochanter fracture; right acetabular fracture; cranial and caudal pubic ramus fracture
4	6 months	Male	Shih Tzu	4	10	Ambulatory	Right	7	1 (Mild)	An un-displaced healing femoral neck fracture with fracture line extending obliquely from the femoral neck laterally in to the trochanter major; right femoral capital physeal line and the right CF joint margins towards caudal acetabular edge were not as distinct as on left side; an osteophyte is present at dorsolateral border of femoral head
5	5 months	Male	MB	6	4	Recumbent	Right	NA	3 (Severe)	Right femoral neck fracture; comminuted proximal fracture of right femur; incomplete ilial body fracture on right side & complete on left; cranial and caudal ramus fracture of left pubis

6	6 months	Male	Pug	9	3	Ambulatory	Bilateral	0	Right- 3 (Severe); Left- 3 (Severe)	Left femoral head and right femoral neck fractures; multiple pubic fractures (right cranial and caudal rami, symphysis and cranial left rami); right mid diaphyseal short oblique fracture of tibia
7	9 months	Male	MB	12	2	Recumbent	Left	NA	3 (Severe)	Left femoral neck fracture along with proximal diaphyseo-metaphyseal spiral fracture of femur with a butterfly segment; trochanter major fracture
8	7 months	Male	Beagle	11	3	Ambulatory	Left	0	2 (Moderate)	Left femoral neck fracture
9	Adult	Female	MB	18	Not known	Ambulatory	Right	0	2 (Moderate)	Extensive osseous callus encompassing femoral head, neck and acetabulum with loss of radiographic details of individual components
10	4 months	Female	MB	6.5	2	Recumbent	Right	NA	3 (Severe)	Right acetabular multiple fractures along with right ilial body fracture; bilateral femoral diaphyseal fracture
11	3.5 months	Female	MB	6	1	Recumbent	Bilateral	NA	Right- 3 (Severe); Left- 3 (Severe)	Bilateral acetabular fracture; comminuited right femoral fracture; right ischial tuberosity fracture; left ilial body fracture; incomplete fracture of L-5 involving caudal end plate
12	2 years	Female	MB	18	3	Ambulatory	Bilateral	6	Right- 3 (Severe); Left- 3 (Severe)	Bilateral acetabular fracture; bilateral sacroiliac luxation; reverse Y shape pubic symphyseal fracture; bilateral incomplete caudal rami fracture of pubis; left cranial ramus fracture of pubis; remodelled old fracture of right femoral neck
13	3 months	Male	MB	5.8	2	Recumbent	Right	NA	3 (Severe)	Right acetabular fracture with fracture line extending towards ilial body; pubic symphyseal fracture and left ilial fracture

4.1.2 Diagnosis of other coxofemoral conditions in dogs

In this category, the CF luxations, Canine Hip Dysplasia (CHD) and CF tumours were included. Their diagnostic findings are as follows-

4.1.2.1: Coxofemoral luxations in dogs

During the study period, 14 dogs were diagnosed with CF luxations, their brief case record is presented in table 4.2 and plate 4.14. All the dogs were presented with the history of either variable degree of lameness (7) or complaint of not getting up (7) from the past 1 to 60 days. The aetiology was vehicular trauma (n= 8) and fall from the height (n= 1) whereas, in remaining cases (5), it remained unknown.

The orthopaedic examinations in ambulatory dogs revealed non-weight bearing complete lameness of the affected-limb in 2 (case nos. 2 and 7) and partial lameness in 5 patients (case nos. 3, 4, 9, 10 and 11). Whereas, 7 patients (case nos. 1, 5, 6, 8, 12, 13 and 14) were presented in recumbent state due to multiple concurrent injuries, vertebral compression, paralysis and systemic reasons (Table 4.3). The affected limb appeared shorter than the contralateral hind limb in all dogs.

The lack of symmetry between iliac wing, ischial tuberosity and the greater trochanter of the femur was visually observed in 5 cases only as in remaining cases greater trochanter was not visible due to substantial swelling at the affected CF joint. External rotation of stifle with adduction of affected limb was observed in 7 cases presented in ambulatory state. Neurological deficit (absence of withdrawal, cutaneous trunci and perianal reflexes) was observed in 2 patients (case nos. 5 and 14)

Based on the location of femoral head in relation to acetabulum on radiological examination of ventrodorsal views of pelvis, the luxations were categorized as either cranio-dorsal or caudo-dorsal. The direction of CF luxations was found to be predominantly cranio-dorsal (13 as against only 1 caudo-dorsal luxation). The location of the femoral head in some of the dogs diagnosed with craniodorsal CF luxations in VD radiographic views of pelvis differed a little in lateral views. In case 1, the head was found dorsocaudally, in case 2, it was dorsal and in case 4 it was just cranial. As on physical palpation, the primary displacement of femoral head was observed to be craniodorsal, all such cases were categorized in craniodorsal CF luxation category. In case 1 and 2, such wide displacement of femoral head was considered to be because of a bigger tear in joint capsule of CF joint. Whereas, in case 4, the difference in location of femoral head in different radiographic views of CF joint was attributed to the different method used to restrain the dog in lateral recumbency as compared to all other dogs. In this dog (Case 4), the contralateral hind limb was kept in a flexed position whereas, in remaining dogs, both the hind limbs were kept in neutral positions. Though, a better view of affected CF joint could be obtained by restraining the contralateral limb in flexed position and keeping it away from the radiographic field, the resultant pull on the pelvis might have displaced the affected femoral head a bit ventrally to lie just cranial to acetabulum. Such findings reflect the observations of Brinker et al. (2006) who reported that Caudodorsal CF luxation in dogs was a rare condition and might simply be a craniodorsal luxation with a great deal of instability, allowing the femoral head to move caudally. Hence, it is suggested that the observations of different radiographic views of CF joints should be combined with the physical examinations to conclude the type of CF luxation on the basis of position of femoral head in relation to acetabulum.

Schlag et al. (2019) reported that in 18 out of 92 cases of hip luxation aetiology of luxation was unknown and traumatic causes of luxation were vehicular accident in 46 dogs, jump or fall in 21, owner induced injury in 4, dogfight injury in 2 and leash injury in 1 dog.

Brinker et al. (2006) reported that craniodorsal luxation was the most common type of CF luxation, seen in 78% of the affected dogs. He further reported that in craniodorsal luxations, the affected limb appeared shorter than the contralateral limb with adducted thigh and external rotation of stifle as observed in the present study. However, the adduction of thigh and external rotation of stifle can only be seen in ambulatory animals in the present study.

Hip luxations are known to occur in dogs mainly in the cranial direction due to greater pulling force of the gluteal and iliopsoas muscles. The luxations in other directions viz. caudo-dorsal or ventral occur only rarely (Bozkan et al. 2020). The findings of the present study further corroborate such stipulation.

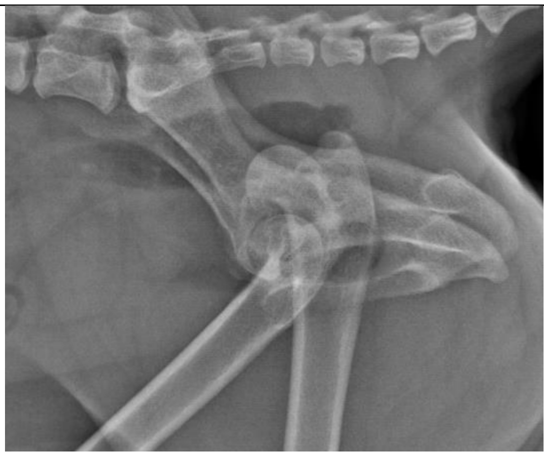
Deviation in the triangle made by ilial wing, ischial tuberosity and greater trochanter of femur had been reported to be a sign of CF luxations in dogs (Fossum et al. 2019). However, in the present study such deviation of the triangle could not be visually inspected in more than 50% of the cases due to presence of swelling at the site caused by trauma. Even palpation of the site failed to conclusively detect such deviation in the triangle in many cases.

Seven cases of CF joint luxation were presented with concurrent injuries. The most common concurrent injury was tibial fracture of ipsilateral limb observed in 3 dogs. Other concurrent injuries were vertebral compression fracture (1), iliac fracture (1), femur fracture of contralateral limb (1) and greater trochanter fracture (1). One dog was presented with concurrent diffuse idiopathic spinal hyperostosis (DISH).

Plate 4.14: Radiographs of CF luxations in dogs

Case 1- Craniodorsal luxation of left CF joint in VD view; the head of the femur seen displaced a bit caudally in lateral view

Case 2- Craniodorsal luxation of right CF joint in VD view; the head of the femur is seen displaced dorsally in lateral view

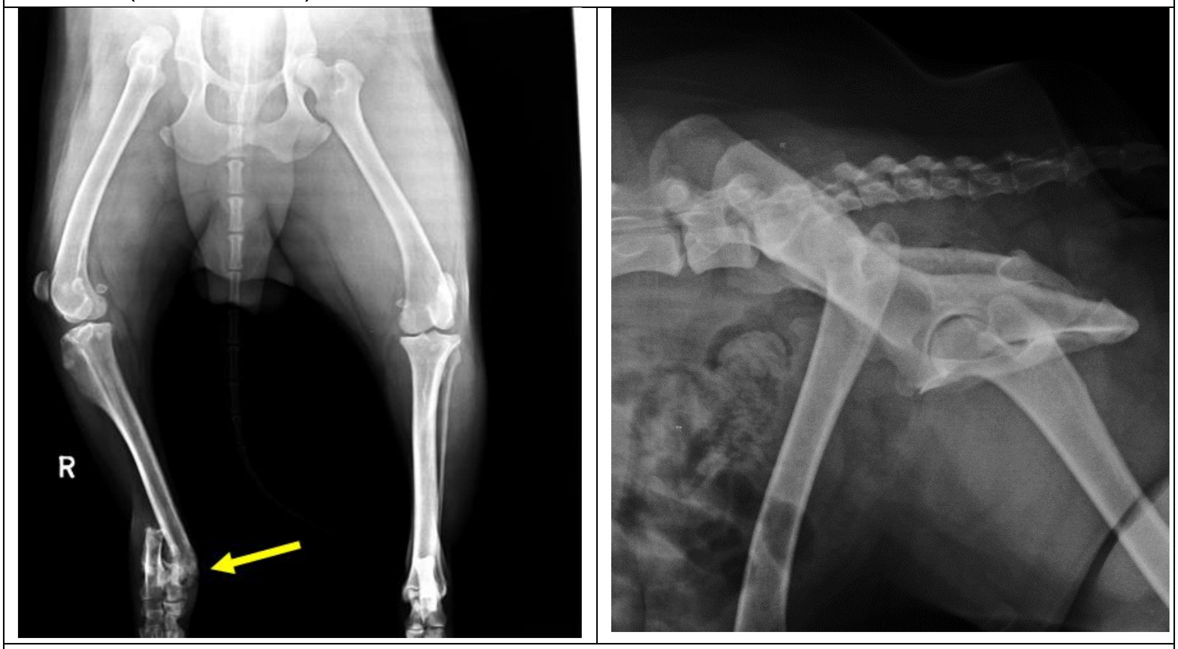


Case 3- Craniodorsal luxation of right CF joint in both VD and lateral views

Case 4- Cranio-dorsal luxation of right CF joint in VD view; the head of the femur assumed almost a cranial location relative to acetabulum when lateral radiograph was taken by keeping the left hind limb in a flexed position

Case 5- Craniodorsal luxation of left CF joint along with osteophytes at right femoral neck and cranial effective acetabular rim; complete remodelling of femoral head, cranial and acetabular edge and completely obscured acetabular fossa.

Case 6- Caudo-dorsal luxation of left CF joint along with greater trochanter fracture (Yellow arrow); distal left tibial metaphyseal fracture (Red arrow) and proximal right femur fracture (Dotted arrow)

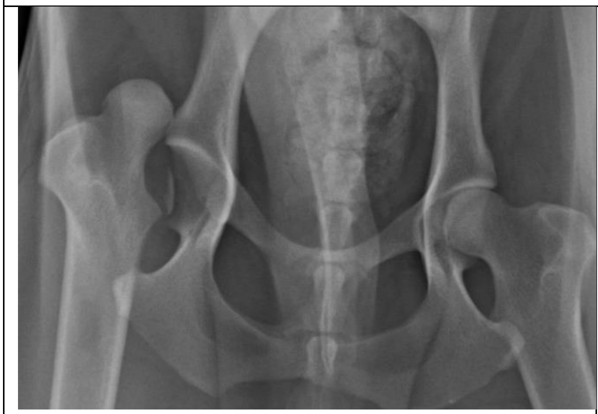


Case 7- Cranio-dorsal luxation of right CF joint in both VD and Lateral views; distal right tibial metaphyseal fracture (Yellow arrow) along with osseous callus

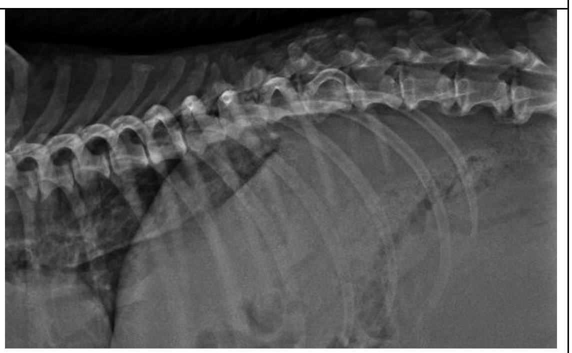
Case 8- Cranio-dorsal luxation of left CF joint; complete mid diaphyseal fracture of left radius and ulna


Case 9- Cranio-dorsal luxation of right CF joint along with femoral head epiphyseal fracture


Case 10- Cranio-dorsal luxation of left CF joint

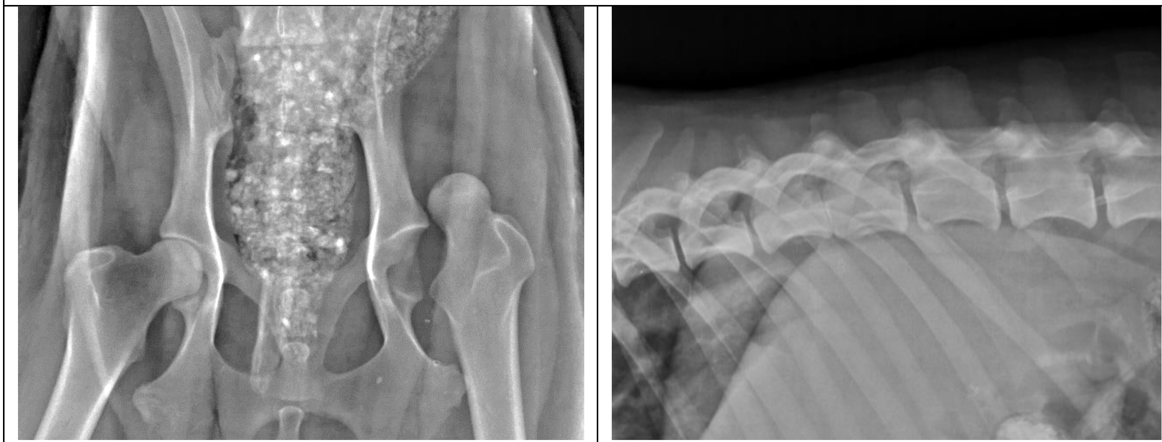



Case 11- Cranio-dorsal luxation of right CF joint

Case 12- Cranio-dorsal luxation of left CF joint; Diffuse idiopathic spine hyperostosis in thoracic region

Case 13- Cranio-dorsal luxation of left CF joint; comminuted fracture of left tibia



Case 14- Cranio-dorsal luxation of left CF joint; compression between T-12 and T-13 vertebrae

The CF luxations were predominantly observed in male dogs (71.43% in males vs 28.57% in females). Age-wise CF luxations were more commonly observed in adults (71.43%) followed by juvenile (21.43%) and senile (7.14%) dogs. The majority of the dogs belonged to mixed breed category (7) whereas, among the well-established breeds, the maximum number of cases were observed in German Shepherds (3), followed by Spitz, Pug, Labrador Retriever and Siberian Husky (1 each).

Schlag et al. (2019) reported that the most commonly affected breeds among 92 cases of CF luxation were mixed breed, Labrador Retriever, Yorkshire Terriers, German Shepherd and Pomeranians. They also reported that 45.9% dogs had polytrauma, 5.4% dogs had chip fractures of acetabulum or femoral head of the luxated joint, 5.4% had fractures involving the weight-bearing axis elsewhere in the pelvis and 5.4% had fracture of the contralateral limb.

Table 4.2: Case details of CF luxations in dogs

Case No.	Age	Sex	Breed	Weight (kg)	Duration of condition (days)	Whether recumbent or ambulatory	Affected side	Wt-bearing score on affected limb	Description of CF luxations and concurrent injuries based on radiological observations
1	Adult	M	MB	25	Not known	Recumbent	Left	NA	Craniodorsal luxation of left CF joint in VD view; caudally displaced femoral head in lateral view
2	3 years	M	GSD	22	17	Ambulatory	Right	0	Craniodorsal luxation of right CF joint in VD view; dorsally displaced femoral head in lateral view
3	5 years	M	Spitz	8	5	Ambulatory	Right	4	Cranio-dorsal luxation of right CF joint
4	1 year	M	GSD	23	1	Ambulatory	Right	5	Cranio-dorsal luxation of right CF joint in VD view; the head of the femur assumed almost a cranial location relative to acetabulum in medio-lateral radiograph
5	4 years	F	Pug	15	Not known	Recumbent	Left	NA	Craniodorsal luxation of left CF joint along with osteophytes at right femoral neck and cranial effective acetabular rim; complete remodelling of femoral head, cranial and acetabular edge and completely obscured acetabular fossa
6	6 months	F	MB	9	0	Recumbent	Left	NA	Caudo-dorsal luxation of left CF joint along with greater trochanter fracture; distal left tibial metaphyseal fracture and proximal right femur fracture
7	3 years	M	Labrador Retriever	42	60	Ambulatory	Right	0	Cranio-dorsal luxation of right CF joint; distal right tibial metaphyseal fracture along with osseous callus
8	3 months	F	Husky	18	0	Recumbent	Left	NA	Cranio-dorsal luxation of left CF joint; complete mid diaphyseal fracture of left radius and ulna
9	2 years	M	GSD	22	15	Ambulatory	Left	8	Cranio-dorsal luxation of right CF joint along with femoral head epiphyseal fracture
10	4 years	M	MB	24	16	Ambulatory	Left	5	Cranio-dorsal luxation of left CF joint
11	2 years	M	MB	23	7	Ambulatory	Right	4	Cranio-dorsal luxation of right CF joint
12	Adult	F	MB	25	4	Recumbent	Left	NA	Cranio-dorsal luxation of left CF joint; DISH
13	15 years	M	MB	24	0	Recumbent	Left	NA	Cranio-dorsal luxation of left CF joint; comminuted fracture of left tibia
14	Adult	M	MB	27	Not known	Recumbent	Left	NA	Cranio-dorsal luxation of left CF joint; compression between T-12 and T-13 vertebrae

4.1.2.2 Diagnosis and classification of Canine Hip Dysplasia

In the present study, 33 dogs were diagnosed with different severity of Canine Hip Dysplasia (CHD). These included the dogs presented with clinical manifestations of hip dysplasia (22) as well as those without any overt signs and were screened randomly (11). For such random screening, the dogs belonging to breeds susceptible for hip dysplasia that were otherwise presented for vaccination or elective surgeries were selected; these were subjected to routine clinical and radiographic examinations to identify sub-clinical hip dysplasia.

Most common clinical signs were difficulty in rising up from rest (30), waddling gait (8), reluctant to climb stairs and run (22), exercise intolerance (15), atrophy of pelvic musculature (12) and bunny hopping (5) ranging from previous 6 to 30 days. Variable degree of lameness and pain was exhibited by all dogs with clinical signs on manipulation of hip joints. Whereas, Ortolani sign was detected only in 3 dogs (bilateral in 2 and unilateral in 1 dog). The confirmatory diagnosis and characterization of CHD as per British Veterinary Association/Kennel Club (BVA/KC) scoring method (Dennis 2012) was done on the basis of radiographic examinations whose details are given later under this topic. Overall, 30 dogs showed almost similar radiographic changes on both CF joints whereas, 3 dogs showed more severe changes on one side.

In a study conducted in same geographical area by Ankit (2020) all 28 dogs diagnosed with CHD had difficulty in rising up from rest, 22 dogs were reluctant to climb stairs and run and wobbling gait was present in 8 dogs.

Fossum et al. (2019) reported that most common clinical signs observed in adult dogs with CHD were difficulty in rising, exercise intolerance, lameness after exercise, atrophy of pelvic musculature and waddling gait.

Citi et al. (2005) reported that out of 472 cases of canine hip dysplasia, 323 (68.4%) had bilateral changes and 149 (31.58%) had unilateral canine hip dysplasia. Right hip was found affected in 52.4% cases of unilateral canine hip dysplasia and left hip was found affected in 47.6% cases. In another study Simon et al. (2010) reported the incidence of bilateral canine hip dysplasia as 88.60% and in cases of unilateral canine hip dysplasia, 54.83% cases had changes on left side.

i. Sex-wise distribution of CHD

During the study, greater number of CHD cases were observed in male dogs (26 cases) as compared to females (7 cases). Though such gender-wise difference in distribution of CHD appeared quite stark (78.78% in male vs 21.21% in female dogs), the incidences were not so much different though it was still higher in male dogs (1.76% in males and 1.36% in females). This was because of overall greater number of male dogs presented to the department during the study period.

Table 4.3: Sex-wise distribution and incidence of CHD

Sex	Total cases	Hip dysplastic dogs	Distribution	Incidence
Male	1475	26	78.78%	1.76%
Female	514	7	21.21%	1.36%

In a similar study conducted in the same geographical area by Ankit (2020), sex-wise distribution of CHD was recorded as 89.28% in males and 10.71% in females. In a study in another geographical area, Maruthi et al. (2017) also reported higher distribution of CHD in male dogs as compared to females (58.20% vs 41.80%), though the difference was not as stark as observed in the studies done in this geographical area.

ii. Age-wise distribution of hip dysplasia

Hip dysplasia was not diagnosed in dogs less than 3 months of age, only 2 cases was found to be in the age-group of 3 to 6 months (6.06%), 7 in 6 to 24 months (21.21%) and remaining 24 in the age-group of above 2 years (72.72%).

Table 4.4: Age-wise distribution of CHD

Age-group	No. of cases	Distribution
Less than 3 months	-	-
3 to 6 months	2	6.06%
6 to 24 months	7	21.21%
Above 24 months	24	72.72%

The age-wise distribution was in line with the findings of Ankit (2020), who reported that maximum cases of CHD were in dogs above 24 months of age (42.85%) followed by 6-24 months (39.20%) and 3-6 months (17.85%) age-groups.

Stanin D et al. (2011) reported the age-group of 48-60 months had the highest percentage of hip dysplastic dogs (23.89%), followed by 36-48 months (21.62%), 24-36 months (21.61 months), >60 months (18.82%), 0-12 months (18.19%), and 12-24 months (17.43%).

Maruthi et al. (2017) reported that the CHD was more common in dogs below 1 year of age (47.76%) followed by in age-group between 1-4 years (35.82%) and above 4 years (16.14%). Almost similar findings were observed by Prasad (2009), who reported that 64% cases of CHD were observed in dogs below 1 year of age, 20% between the age-group of 1 to 4 years and 16% above 4 years.

Difference in such results of different studies may be because of different yardsticks chosen for CHD screening of dogs. There was different categorization of age-groups in different studies; there was different subject selection and there were different radiographic analytical methods like the present study did not use distraction radiography to diagnose CHD rather relied mainly on BVK/KC hip scoring method for dogs above 1 year of age and for other radiographic features for those below 1 year.

iii. Breed-wise distribution of hip dysplasia

Most commonly affected breed with hip dysplasia was Labrador Retriever with the distribution of 27.27% (9 cases), followed by German Shepherd and Golden Retriever, 5 cases each with the distribution of 15.15%. Other breeds found to be affected was Spitz (9.09%, 3 cases), 2 cases each was of Pug, Rottweiler and St. Bernard with the distribution of 6.06%. 1 case each of Shih Tzu, Boxer, Dachshund, French Mastiff and Mixed Breed with the distribution of 3.03%.

The breed-wise distribution was in line with the findings of Kolady (2005) who reported that the maximum distribution of hip dysplasia was found in Labrador Retriever (50%) followed by German Shepherd Dog (23.33%), Rottweilers (10%), Doberman, St. Bernard, Golden Retriever, Great Dane and Neapolitan Mastiff (3.33% each). Prasad (2009) also found Labrador Retriever (43%) to be the most affected breed in total cases of hip dysplasia followed by German Shepherd (25%), Great Dane (9%), Rottweilers (6%), Spitz (4%) and distribution among other breeds like Doberman, Pug, Boxer, Dalmatian, Bull Mastiff, St. Bernard, Bull Dog, Dachshund, Cocker Spaniel, Lhasa apso and Iris Setter was less than 2%. Similar findings were observed by Maruthi et al. (2017) who found the occurrence of 40.29% among Labrador Retriever.

Table 4.5: Breed-wise distribution of CHD

Breed	No. of cases	Distribution
Labrador Retriever	9	27.27%
German Shepherd	5	15.15%
Golden Retriever	5	15.15%
Spitz	3	9.09%
Pug	2	6.06%
Rottweiler	2	6.06%
St. Bernard	2	6.06%
Shih Tzu	1	3.03%
Boxer	1	3.03%
Dachshund	1	3.03%
French Mastiff	1	3.03%
Mixed Breed	1	3.03%

The high incidence in these breeds might be due to low pelvic muscle mass index which may be because of inherent poor thigh muscle development that did not reinforce and provide strength to the hip joint, thus allowing the joint stresses to act over the hip joint causing hip dysplasia (Riser and Shirer, 1969).

iv. BVA/KC scoring of Canine Hip Dysplasia

In order to evaluate the radiographs for BVA/KC hip scoring system, the radiographs of dogs above 1 year only were considered as per the guidelines (Dennis 2012). Further, the radiographs were evaluated for correct patient positioning and only those radiographs were evaluated where the patient was properly maintained in hip extended ventro-dorsal position with their patella centred over the distal femur and both femurs parallel to one another.

Eight out of the 33 hip dysplastic dogs did not meet these requirements because 4 dogs were younger than 1 year of age and proper positioning could not be attained in 4 dogs as dogs' owners did not give consent for sedating the patients. So, scoring of only 25 cases was done as per BVA/KC scoring system and their total hip scores were compared with the breed mean scores published by British Veterinary Association. The total hip score of all the 25 cases were found to be higher than their respective breed mean scores for unaffected animals.

In remaining, 8 cases, the CHD was diagnosed on the basis of radiographic features of CHD like joint congruency and presence of degenerative changes in hip joints of adult animals.

Interpretation of the hip scores was done as per the criteria explained in 'Materials and Methods'. Maximum distribution (44%) of total hip scores in dogs was in the range of 21 to 50, whose approximate interpretation as per BVA/KC classification is- 'Moderate to marked hip dysplasia with osteoarthritis or severe hip dysplasia without osteoarthritis'. Substantial number of cases (10) were also found with hip score above 50 interpreted as 'severe to very severe osteoarthritis secondary to hip dysplasia' whereas, 4 dogs were found with hip score in between 11-20 corresponding to "mild changes in the hip that may worsen into DJD" as per BVK/KC interpretation.

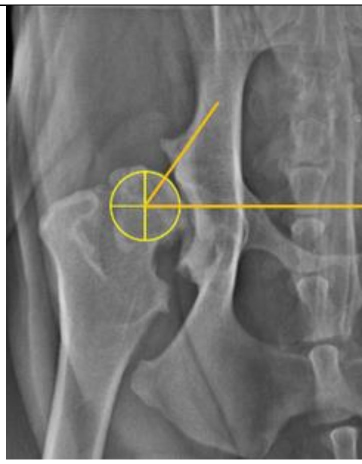
Table 4.6: Characterization of CHD as per BVA/KC guidelines

S.No.	Hip Score	Grade of CHD	Number	Distribution
1	0 to 4	Perfect or near perfect hips	0	0%
2	5 to 10	Borderline changes that are unlikely to worsen with age	0	0%
3	11 to 20	Mild changes that may worsen with age, sometimes developing into osteoarthritis	4	16%
4	21 to 50	Moderate to marked hip dysplasia with osteoarthritis or severe hip dysplasia before arthritic changes	11	44%
5	Above 50	Severe to very severe osteoarthritis secondary to hip dysplasia	10	40%
		Total	25	100

Out of 25 cases of CHD (50 hip joints) scored as per BVA/KC hip scoring system, the Norberg angle scores for 14 hip joints were zero. Among these, a substantial number of hip joints were with score 3 or above for parameters like acetabular fossa, cranial effective acetabular rim and femoral head and neck exostoses (Table 4.7). This finding indicated that secondary changes were present in these hip joints despite Norberg angle remaining unaffected. Therefore, it was deduced that Norberg angle alone is not the accurate measure of evaluating secondary changes occurring in CF joints due to hip dysplasia as also reported by Lust et al. (2001).

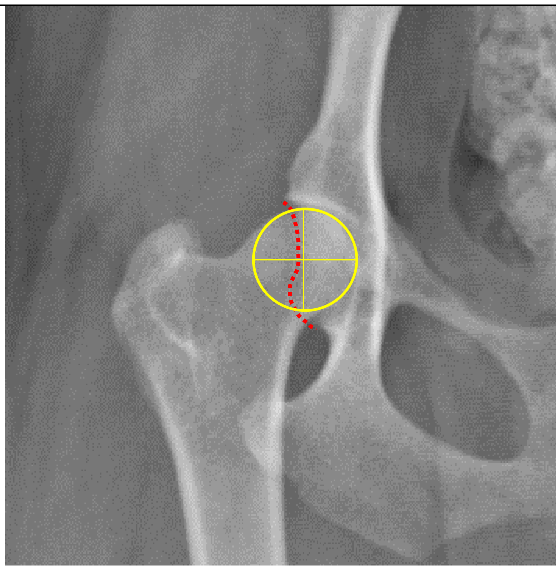
Distribution of hip joints under higher score were as follows- score 1 was given to 13 hip joints, score 2 to 4 hip joints, score 3 and 4 to 5 hip joints and score 6 to 9 hip joints.

Plate 4.15: Norberg angle scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia

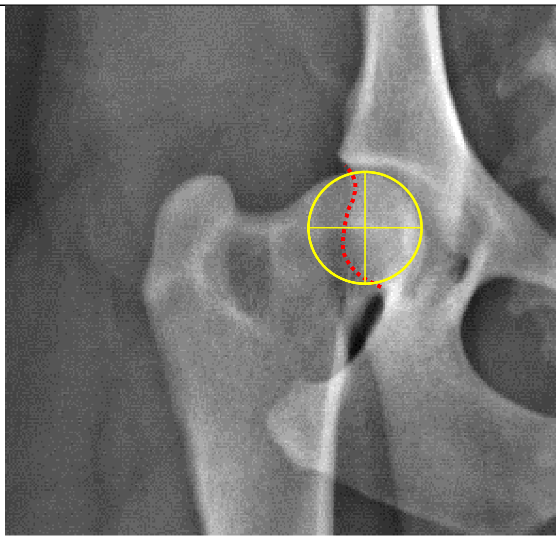
		
NA Score-0 (n=14)	NA score-1 (n=13)	NA score-2 (n=4)
		
NA score-3 (n=5)	NA score-4 (n=5)	NA score-6 (n=9)

Out of 50 hip joints, maximum number of hip joints were given score 1 (12) and 2 (11) for subluxation. In general, if Norberg angle score was high in a hip, then CF subluxation score was also high and *vice-versa* because both these parameters describe the tightness or laxity of hip joints when radiographic appearance is taken into account. However, for a number of cases where the Norberg angle scores were '0', the Coxofemoral subluxation (CFSL) scores were found greater than '0'. This indicates that in some hip joints even if Norberg angle was above 105 degrees, slight increase in joint space was observed laterally resulting in higher scores for CFSL.

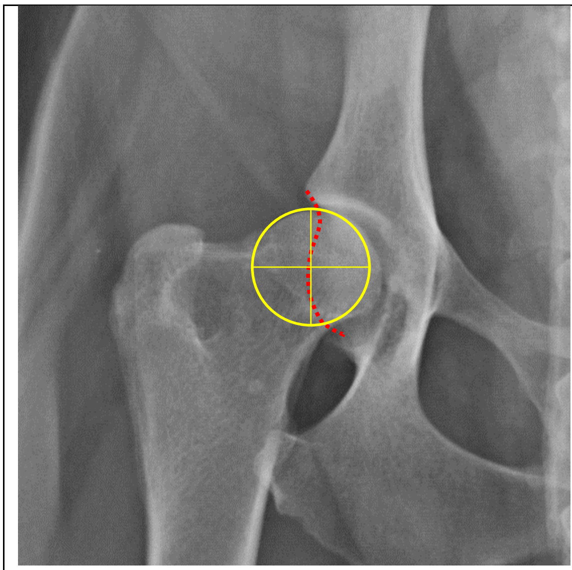
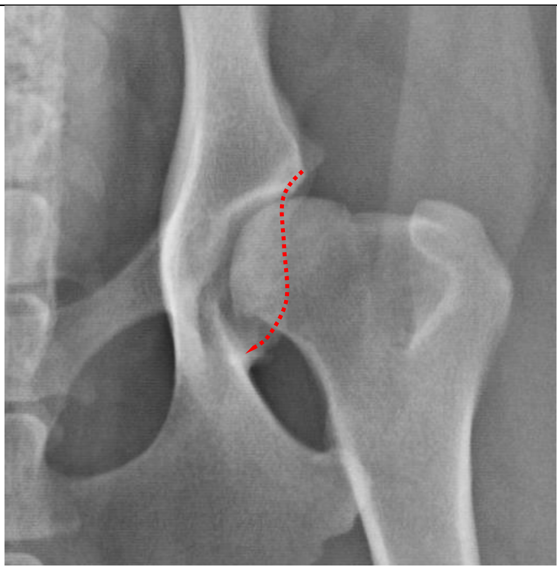
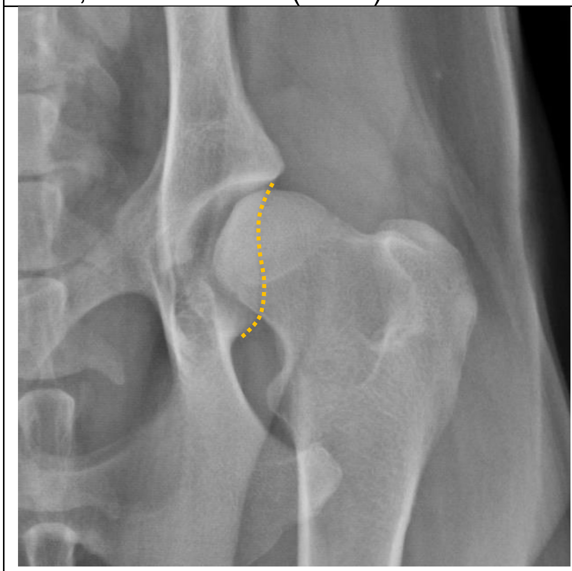
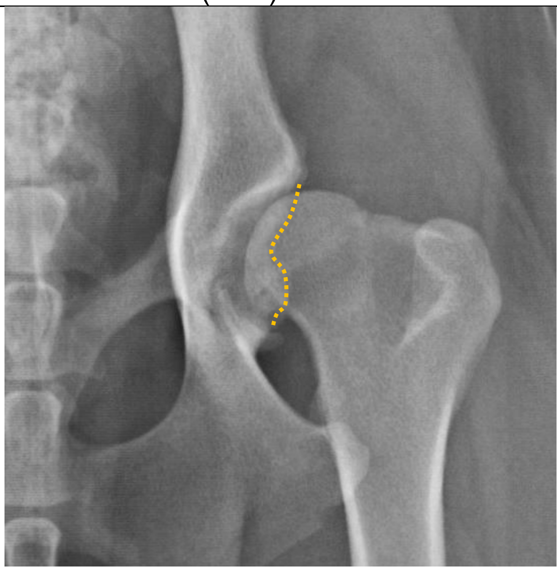
Plate 4.16: Subluxation scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia



Femoral head well-centred in the acetabulum,
CFSL score=0 (n= 4)



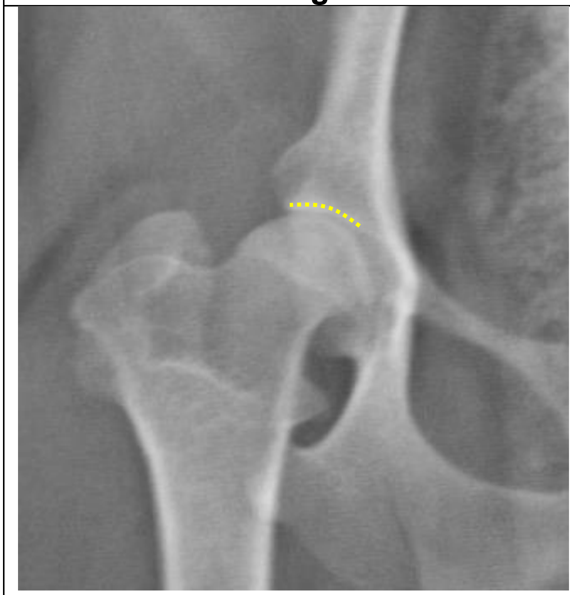
Femoral head centre medial to DAE but increase in medial joint space,
CFSL score=1 (n=12)

	
Femoral head centre superimposed on DAE, CFSL score=2 (n= 11)	Femoral head centre just lateral to DAE, CFSL score=3 (n= 3)
	
A quarter of femoral head is within the acetabulum, CFSL score=4 (n=10)	Femoral head just touches the DAE, CFSL score=5 (n= 8)

Complete pathological dislocation, CFSL score=6 (n=2)

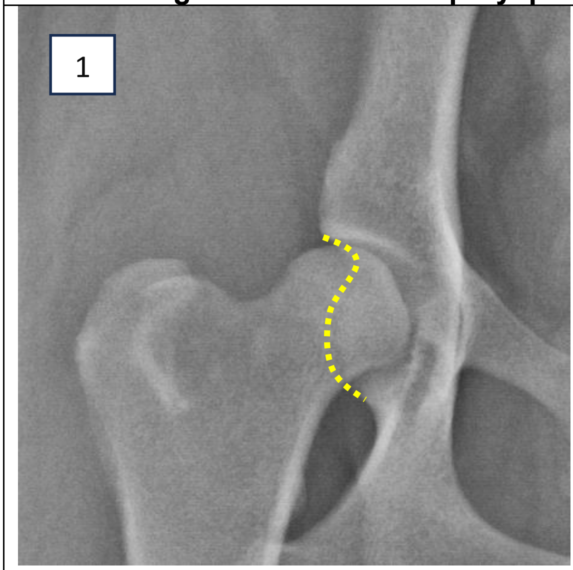
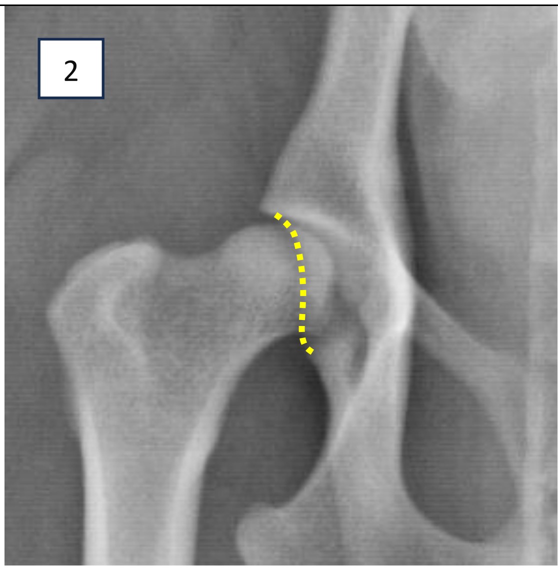
The change in cranial acetabular edge (CrAE) was found to be of less severe category in most cases. CrAE score was 1 in 20 hip joints, followed by 3 in 12, 5 in 8, 2 in 7, 6 in 2 and 0 in 1.

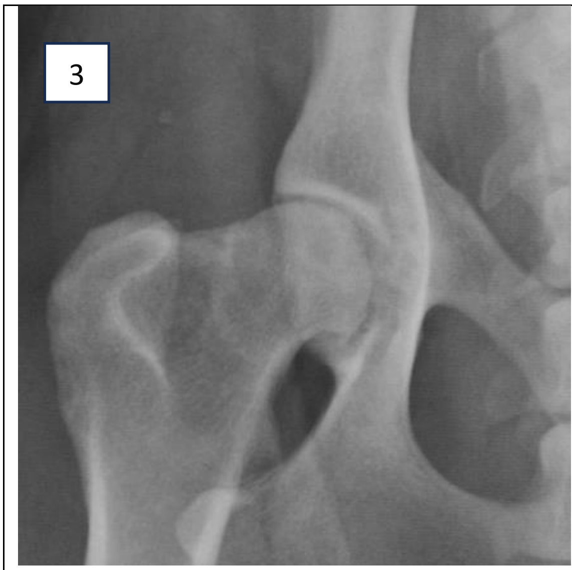
Plate 4.17: Cranial acetabular edge scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia

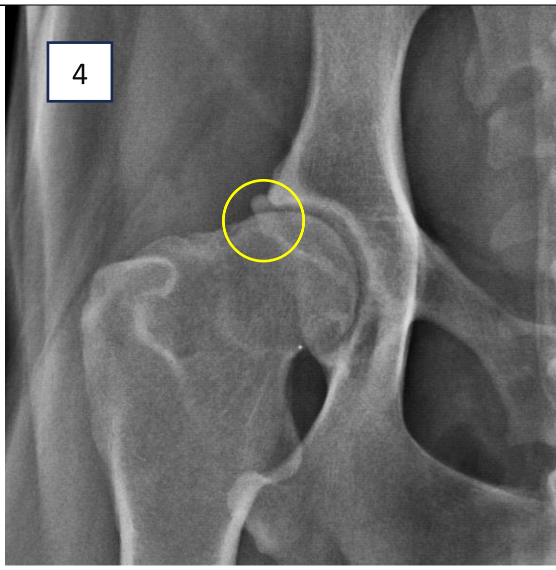
	
Perfectly contoured femoral head and CrAE, CrAE Score= 0 (n= 1)	Divergence of medial joint space, CrAE Score= 1 (n=20)
	
Flat cranial acetabular edge, CrAE Score= 2 (n= 7)	Slight bilabiation, CrAE Score= 3 (n= 12)

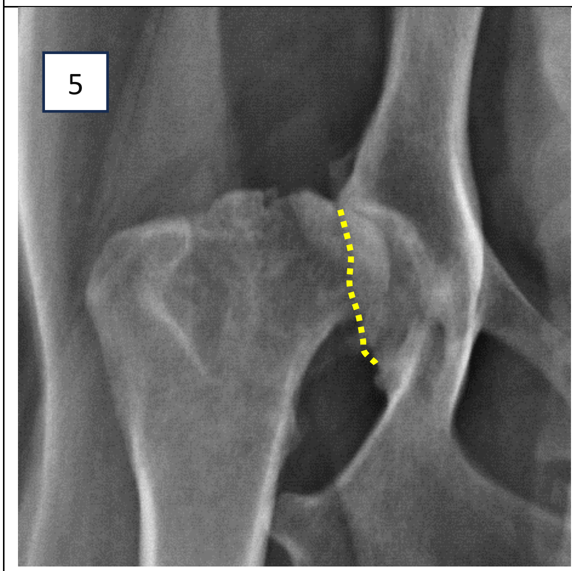
	
Gross bilabiation, CrAE Score=5 (n= 8)	Entire CrAE slopes cranially, CrAE Score=6 (n=2)

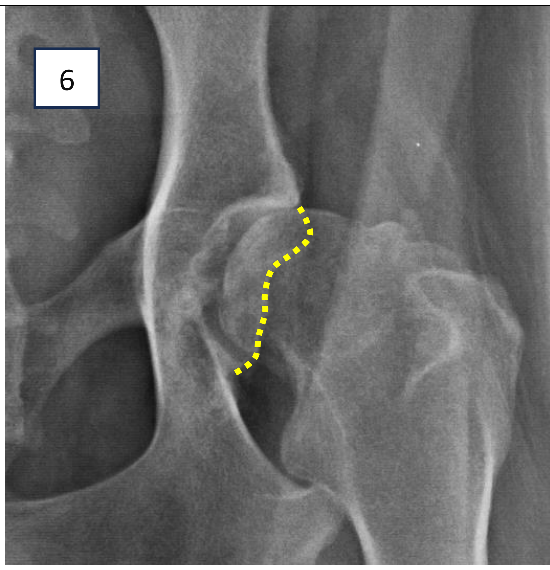
Loss of S curve in the presence of other dysplastic changes (Score 1) was the most commonly found change in dorsal acetabular edge (DAE). It was found in 19 out of 50 hip joints. Variable degrees of exostoses were also observed in some hip joints along with bone loss at the level of dorsal acetabular edge in others. Their representative radiographs and number of hips under different DAE scores are given in plate 4.18

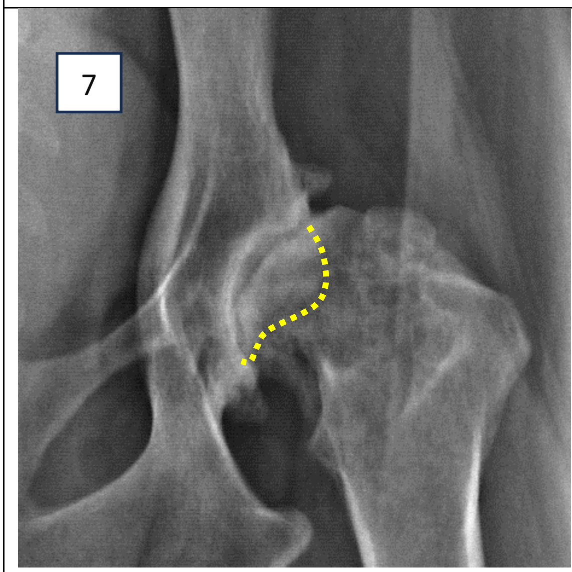
Plate 4.18: Dorsal Acetabular edge scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia	
	











1. Normal S curve, DAE score= 0 (n=3)
2. Loss of S curve, DAE score = 1 (n= 19)
3. Slight exostosis at DAE, DAE score=2 (n= 10)
4. Obvious exostosis, DAE Score = 3 (n= 5)
5. Loss of edge, DAE score= 4 (n= 3)
6. Gross exostosis, DAE score= 5 (n=5)
7. Massive exostosis, DAE score=6 (n=5)

The cranial effective acetabular rim (CrEAR) score of 3 was recorded in 14 hip joints, 4 in 9, 2 in 8, 6 in 6, 0 in 5, 5 in 4 and 1 in 4. CrEAR Scores of 3 and above reflects secondary changes following osteoarthritis whereas, the scores of 1 or 2 may be observed in otherwise normal hips of dogs as well (Dennis 2012). Higher CrEAR score ($\geq$3) in substantial number of hip joints (32/50) in the present study indicates that changes at cranial effective acetabular rim were more severe compared to other anatomical parameters.

Plate 4.19: Representative radiographs of CrEAR score 0, 1 and 2 as per BVA/KC

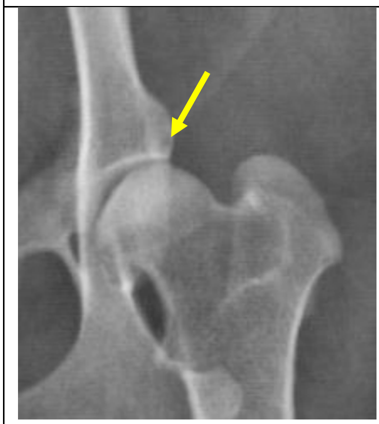
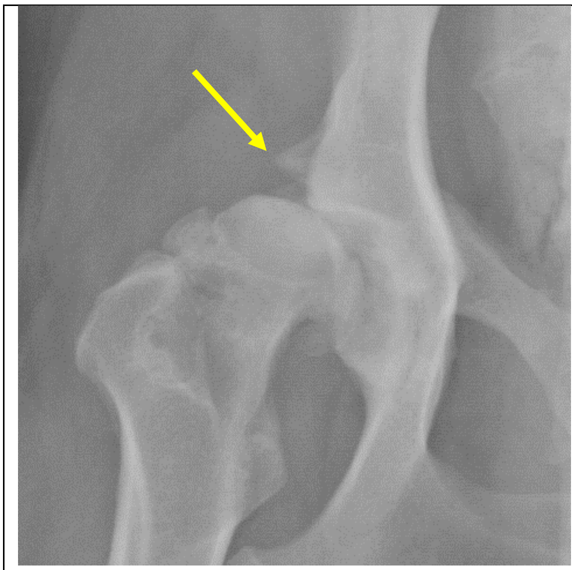
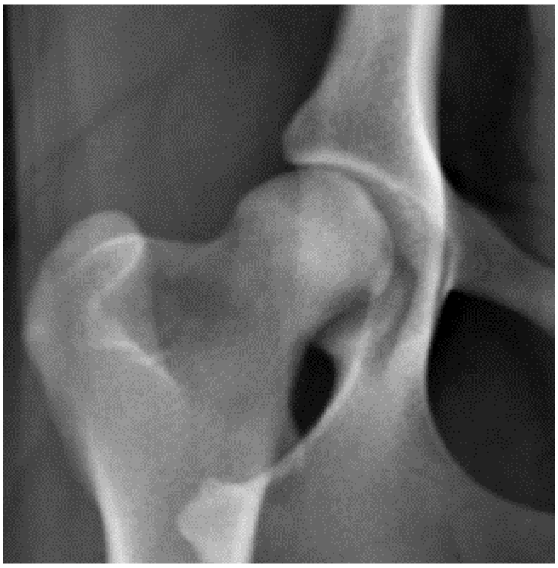
		
Sharp junction of CrAE and DAE, Score=0 (n = 5)	Indistinct junction of CrAE and DAE, Score=1 (n= 4)	Very small exostosis, CrEAR score= 2 (n=8)

Plate 4.20: Different grades of exostoses at cranial effective acetabular margin and their scores as per BVA/KC guidelines

	
Small exostosis and slight bilabiation, CrEAR score= 3 (n=14)	Obvious exostosis, CrEAR score= 4 (n=9)

	
Gross exostosis, CrEAR score= 5 (n=4)	Massive exostosis, CrEAR score=6 (n=6)

In case of acetabular fossa, any score other than zero indicates that osteoarthritis appears to be forming (Dennis 2012) so, in the present study as only dysplastic hips were scored, none of the hip joints scored zero and maximum distribution was found under score 2 for both right and left hip joint (36% and 40% respectively). Distribution of hip joints under different scores were as follows- score 1 was given to 7 hip joints, score 2 to 19 hip joints, score 3 to 5 hip joints, score 4 to 5 hip joints, score 5 to 7 hip joints and score 6 to 9 hip joints.

Plate 4.21: Acetabular fossa scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia	
	
Slight increase in the medial bone density, AF Score=1 (n=7)	Ventral Acetabular edge is hazy, AF Score=2 (n= 19)

	
Incomplete remodelling of acetabulum, AF Score=3 (n=5)	Partly closed notch, AF Score= 4 (n=5)
	
Gross remodelling with dense new bone, Score= 5 (n=7)	Complete remodelling and new articular surface, Score= 6 (n=9)

Caudal acetabular edge (CaAE) is shorter and less well-defined than cranial acetabular edge so it was difficult to identify it. Difficulty was also observed in few cases in assigning a definite score that correlate exactly with the radiographic changes as described by BVA/KC. In all such cases of doubt, a higher score was assigned. Maximum distribution of CaAE score pertained to score 2 in 14 followed by 1 in 12, 0 in 8, 3 in 6, 5 in 6 and 4 in 4 hip joints.

Plate 4.22: Caudal acetabular edge scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia

Fine line of CaAE,
CaAE score=0 (n=8)

Small exostosis at lateral edge of CaAE
CaAE score=1 (n= 12)

Exostosis at lateral and medial edge of CaAE, CaAE score=2 (n=14)

Large exostosis at CaAE
CaAE score=3 (n=6)

Hooking of lateral edge of CaAE
CaAE score= 4 (n=4)

Gross distortion of CaAE
CaAE score=5 (n=6)

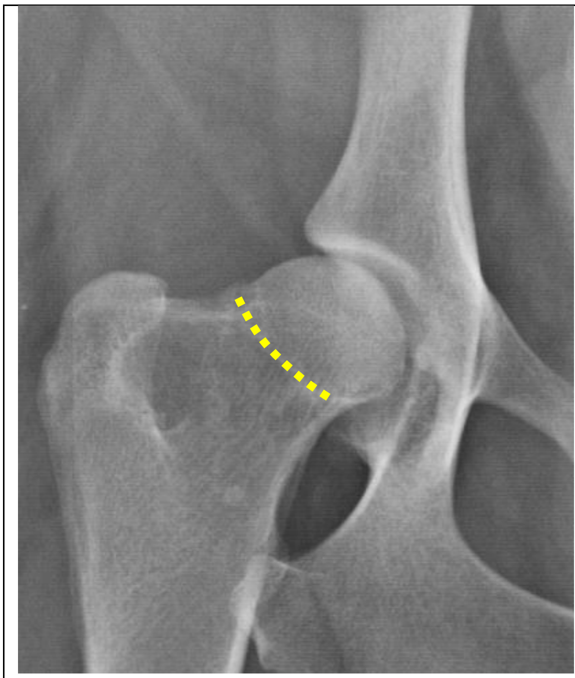
The femoral head and neck exostosis (FHNE) scores were recorded to be 6 in 14, 2 in 13, 1 in 11, 0 in 8, 3 in 2 and 5 in 2 hip joints. Slight exostoses in ring form at the level of femoral neck, the 'Morgan's line' was observed in 11 hips. The femoral head re-contouring (FHR) scores were 2 in majority of hips (13) followed by score of 1 (11), 6 (9), 5 (7), 0 and 3 (5 each).

Plate 4.23: FHNE scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia	
	
Smooth and round profile, FHNE score=0 (n=8)	Morgan's line, FHNE score=1 (n=11)
	
Exostosis at skyline, FHNE score=2 (n=14)	Distinct exostosis, FHNE score=3 (n= 2)

	
Mushroom head appearance, FHNE score=5 (n=2)	Massive exostosis and infill of trochanteric fossa, FHNE score=6 (n=14)

The pattern of FHNE and FHR scores is expected to follow almost similar trend as the different radiographic changes pertain to same region of hip. However, slight variations in such scores as observed in the present study can be attributed to the fact that all the descriptive changes of FHNE and FHR as per BVA/KC may not be found in almost similar cases. It was observed that in some of the hip joints, FHNE score was assigned '0' as there was no Morgan's line but in the same case the FHR score was '1' as the femoral head was not found fitting in the circle.

Plate 4.24: FHR scores as per BVK/KC guidelines in different grades of Canine Hip Dysplasia	
	
Nil femoral head re-contouring FHR score = 0 (n=5)	Femoral head does not fit in a circle, FHR score= 1 (n=11)



Exostosis in ring form,
FHR score= 2 (n=13)

Exostosis at medial side of femoral head
FHR Score = 3 (n = 5)

Very gross remodelling
FHR score= 5 (n=7)

Massive exostosis
FHR score = 6 (n= 9)

The BVA/KC scoring scheme comprehensively assessed hip joints, considering both underlying laxity and secondary alterations due to osteoarthritis. With the analysis of nine distinct anatomical parameters in scoring hip joints, this scheme provides a more inclusive approach, facilitating a more objective evaluation and allowing for the detection of smaller differences (Kolady 2005; Dennis 2012).

The number and distribution of right and left hip joints under different scores of all the nine anatomical parameters are given in table 4.7

Table 4.7: The scores of various coxofemoral parameters as per BVK/KC guidelines

S.No.	Parameters	Side		Score						
				0	1	2	3	4	5	6
1	Norberg angle	Right	Number	8	7	0	3	1	0	6
			Distribution	32%	28%	0%	12%	4%	0%	24%
		Left	Number	6	6	4	2	4	0	3
			Distribution	24%	24%	16%	8%	16%	0%	12%
2	Subluxation	Right	Number	2	4	6	1	6	5	1
			Distribution	8%	16%	24%	4%	24%	20%	4%
		Left	Number	2	8	5	2	4	3	1
			Distribution	8%	32%	20%	8%	16%	12%	4%
3	Cranial Acetabular edge	Right	Number	0	11	3	6	0	4	1
			Distribution	0%	44%	12%	24%	0%	16%	4%
		Left	Number	1	9	4	6	0	4	1
			Distribution	4%	36%	16%	24%	0%	16%	4%
4	Dorsal acetabular edge	Right	Number	2	11	4	2	2	2	2
			Distribution	8%	44%	16%	8%	8%	8%	8%
		Left	Number	1	8	6	3	1	3	3
			Distribution	4%	32%	24%	12%	4%	12%	12%
5	Cranial Effective acetabular rim	Right	Number	3	1	4	8	4	3	2
			Distribution	12%	4%	16%	32%	16%	12%	8%
		Left	Number	2	3	4	6	5	1	4
			Distribution	8%	12%	16%	24%	20%	4%	16%
6	Acetabular fossa	Right	Number	0	3	9	3	3	5	4
			Distribution	0%	12%	36%	12%	12%	20%	8%
		Left	Number	0	4	10	2	2	2	5
			Distribution	0%	16%	40%	8%	8%	8%	20%
7	Caudal acetabular edge	Right	Number	5	5	7	3	3	2	-
			Distribution	20%	20%	28%	12%	12%	8%	Void
		Left	Number	3	7	7	3	1	4	-
			Distribution	12%	28%	28%	12%	4%	16%	Void
8	Femoral head and neck exostosis	Right	Number	5	4	7	1	0	1	7
			Distribution	20%	16%	28%	4%	0%	4%	28%
		Left	Number	3	7	6	1	0	1	7
			Distribution	12%	28%	24%	4%	0%	4%	28%
9	Femoral head recontouring	Right	Number	3	4	7	3	0	3	5
			Distribution	12%	16%	28%	12%	0%	12%	20%
		Left	Number	2	7	6	2	0	4	4
			Distribution	8%	28%	24%	8%	0%	16%	16%

4.1.2 Management of Coxofemoral joint conditions

Management of coxofemoral joint conditions were done either surgically or non-surgically. Surgical intervention was carried out in 11 dogs (5 of femoral head and neck fracture and 6 of CF luxation). Non-surgical management was carried out in 33 cases of CHD, 1 case of CF luxation (closed reduction and Slocum sling application) and 3 cases of CF fractures (strict cage rest). Euthanasia was advised for 5 dogs with fractures and luxation due to presence of severe multiple concurrent injuries and involvement of spine. Besides, 3 dogs died during the initial phase of stabilization. Remaining 5 dogs were not presented for surgery.

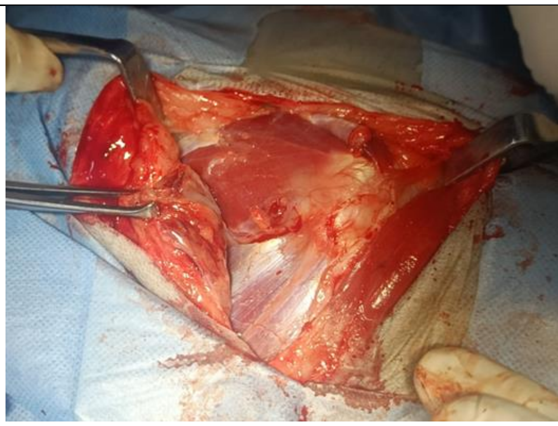
4.1.2.1 Management of CF fractures

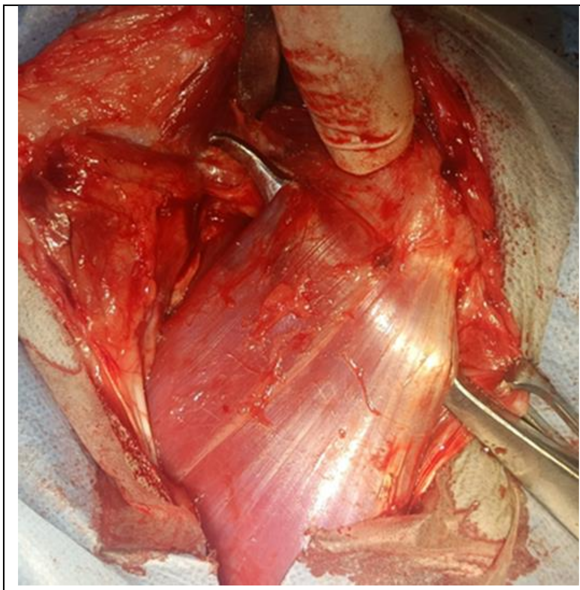
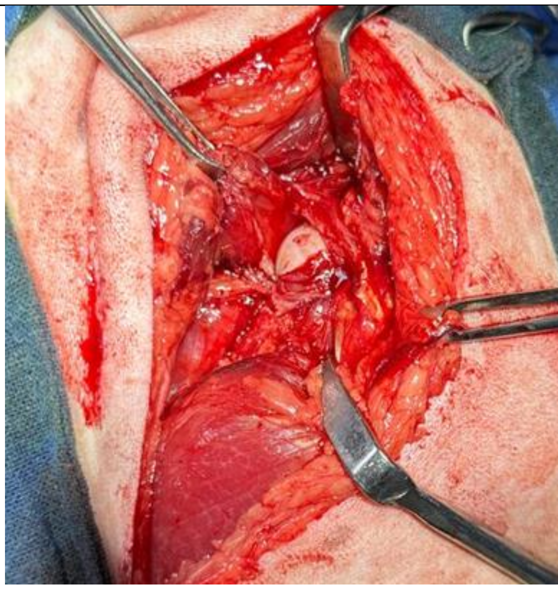
Surgical correction of femoral head and neck fracture was done in 7 CF joints of 5 dogs. Triple pinning was performed in 4 cases where sufficient portion of femoral head and neck was present to accommodate 3 small K-wires. Whereas, excision of femoral head and neck was performed in 3 cases where fracture was considered irreparable. For both the procedures, cranio-lateral approach to hip joint was used as described by Piermattei and Johnson (2004).

Table 4.8: Techniques for repair of femoral head and neck fractures

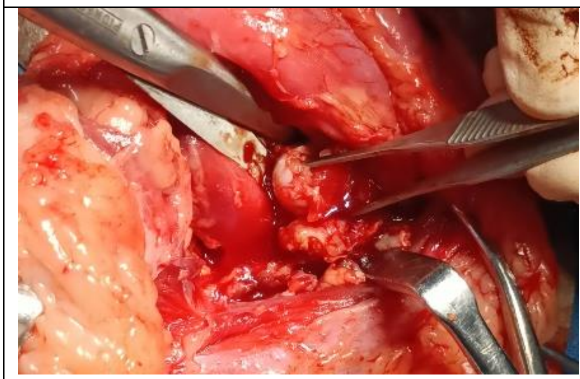
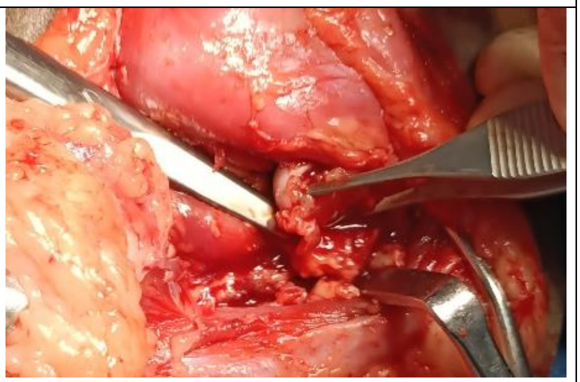
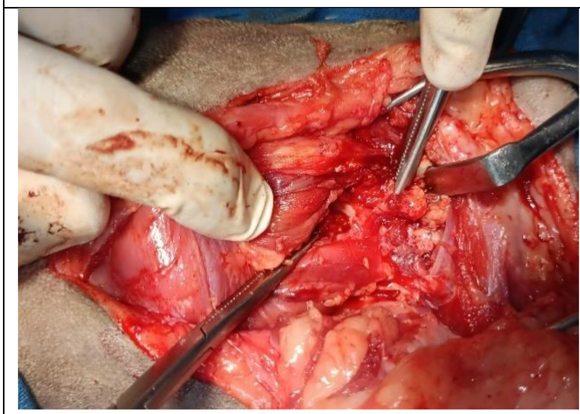
Case no.	Technique
Case 2	Excision of femoral head and neck
Case 3	Bilateral Triple pinning
Case 5	Excision of femoral head and neck
Case 6	Right- Excision of femoral head and neck
	Left- Triple pinning
Case 8	Triple pinning

A craniomedially curved skin incision was made, starting from dorsal midline centred at greater trochanter and extended up to half the length of femur lying over its cranial border. The skin margins were undermined and retracted. An incision was then made through the superficial leaf of the tensor fasciae latae, along the cranial border of the biceps femoris muscle. The biceps femoris muscle was retracted caudally to expose the deep leaf of tensor fasciae latae, incision was then made to free the insertions of tensor fasciae latae. This incision was extended proximally through the intermuscular septum between the cranial border of superficial gluteal muscle and tensor fasciae latae muscle. Tensor fasciae latae was then retracted cranially and superficial and middle gluteal muscle craniodorsally. A reverse 'L' shape incision was made in the deep gluteal muscle close to greater trochanter and it was split in half proximmaly to about 1-2 cms to expose the underlying joint capsule. The CF joint capsule was then incised continuing laterally along the femoral neck through the lesser trochanter to the origin of the vastus lateralis muscle. In all cases of CF luxations and in 1 case of femoral head and neck, the CF joint capsule was already ruptured. The extent of joint capsule rupture differed from case to case. The vastus lateralis muscle was needed to be elevated from its origin at the femoral neck with the help of periosteal elevators in most cases to expose the surgical site sufficiently. The was thereafter reflected distally. In cases of CF luxations, a Hohmann or Lagenback retractor was pushed under the femoral neck and the trochanter major with pointed reduction forceps to manoeuvre the femoral head and neck outwardly (Plate 4.25).

Plate 4.25: Cranio-lateral approach to coxofemoral joint in dogs	
	
Curvilinear skin incision centred over greater trochanter	Incision through fat pad to reach fascia
	
Tensor fasciae latae and biceps femoris	Retraction of tensor fasciae latae cranially and biceps femoris caudally

	
Exposed vastus lateralis and gluteal muscles	Elevation of vastus lateralis and gluteal muscle from their insertions

For excision of femoral head and neck in cases 2, 5 and 6, the fractured femoral head was removed after cutting the round ligament with the help of curved scissors. The fractured femoral neck was cut short with Rongeurs and its end smoothened with bone rasp.

Plate 4.26: Removal of fractured femoral head and neck in dogs	
	
	1. Fractured femoral head 2. Cutting of round ligament with the help of scissors 3. Acetabulum after the removal of femoral head

In case 5, the concurrent comminuted proximal femur fracture was fixed with one cerclage, one hemi-cerclage wiring and one intramedullary End-threaded positive-profile screw-ended pin (ADMIT pin). A 1.2 mm K-wire was inserted obliquely across the bone shaft proximally to support the cerclage wire.

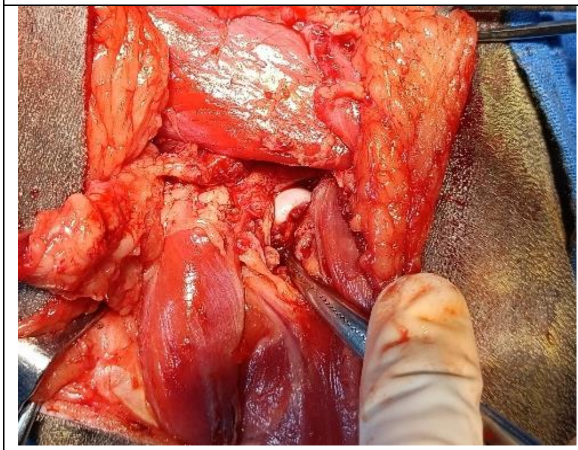
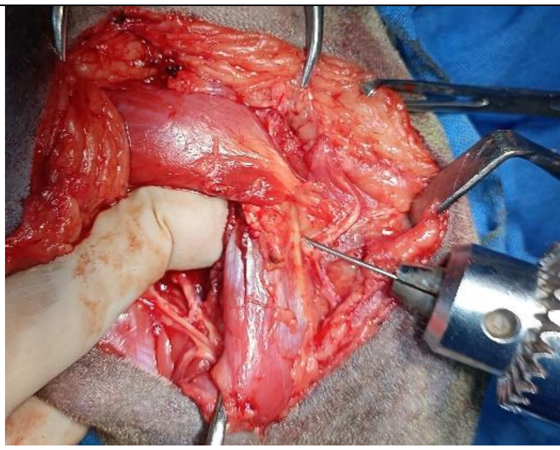
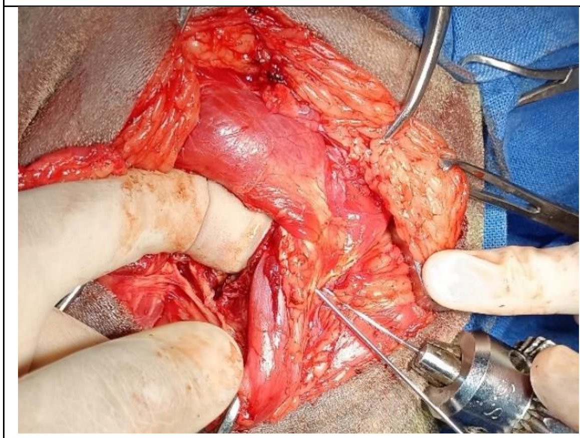
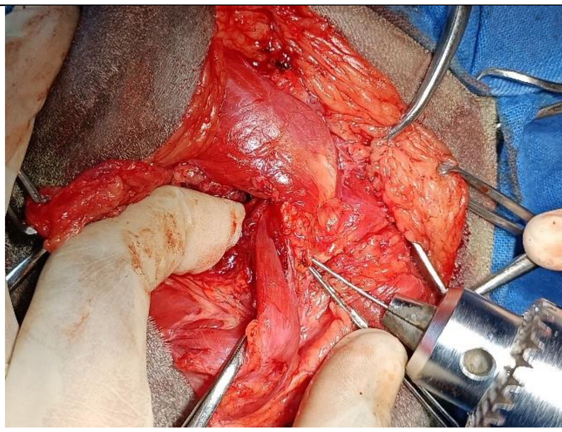
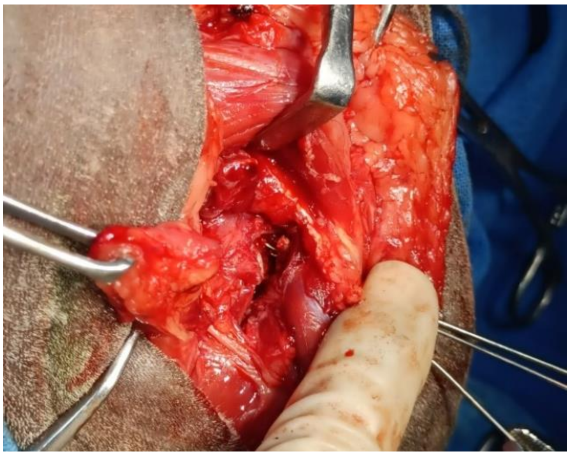
Johnston and Tobias (2012) recommended that salvage procedure like femoral head and neck excision as a treatment to femoral head and neck fractures should be considered in cases of pre-existing hip dysplasia, highly comminuted femoral head and neck fractures and chronic cases.

Plate 4.27: Immediate post-operative radiographs after removal of fractured femoral head

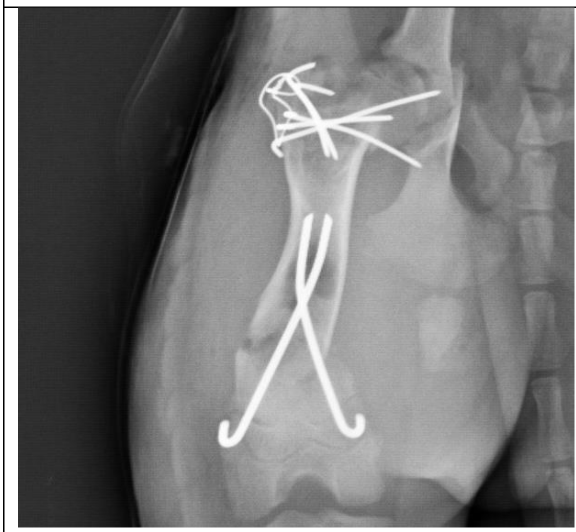
		
Case 2	Case 5	Case 6 (right CF joint)

Triple pinning was performed in case nos. 3, 6 and 8 using three 1.2 or 1.5 mm K- wires. For this, the femoral neck was lifted up using a Lagenback retractor and its fractured surface was exposed sufficiently. Then the K-wires were passed one by one through the base of greater trochanter in a divergent position to exit from the fractured surface of femoral neck. The angles were kept in such a range to allow engaging femoral head without the pin ends projecting too far out. The fracture was then reduced and the wires were pushed towards femoral head one by one up to pre-measured length. After such fixation, the CF joint was moved in flexion and extension to rule out inadvertent piercing of joint. The pin ends were then cut short flush with bone margin at the base of trochanter major.

In cases with other concomitant injuries like greater trochanter fracture of same femur difficulty was faced while placing the pins in divergent manner.

Plate 4.28: Placement of triple pins and reduction of fracture fragments	
	
Exposed fractured femoral head	Placement of first K-wire through the greater trochanter
	
Placement of second K-wire in divergent manner	Placement of third K-wire in divergent manner
	
Reduction of fracture fragments	Cut ends of the pins

Surgical fixation of bilateral femoral neck fractures in case 3 was performed in two phases due to multiple concurrent injuries (distal femur fracture and greater trochanter fracture of right side). Surgical fixation of distal femur, greater trochanter and femoral neck fracture of right side was repaired in first phase. Distal femur fracture was fixed with rush pinning; greater trochanter fracture with tension band wiring and the femoral head fracture with triple pinning. Though three pin were routinely placed and the joint mobility was checked before closure of surgical wound, the immediate postoperative radiograph revealed that only two pins were placed in femoral head in a proper manner; the end of third pin remained partially out of CF joint. As the end of third pin was not causing any hindrance in CF joint movement, it was decided to leave it in situ. The fixation of femoral neck fracture of left side was performed in the second phase of surgery after 15 days again with the triple pinning technique.

Plate 4.29: Immediate post-operative radiographs after triple pinning	
	
Case 3 after first phase of surgery	Case 3 after second phase of surgery
	
Case 6 Inadequate fracture reduction after triple pinning	Case 8 Inadequate fracture reduction after triple pinning

In cases 6 and 8, no difficulty was observed intra-operatively but, the post-operative radiographs revealed the presence of little gap in between the fracture fragments thus indicating suboptimal reduction of fractures. In case 8, the gap was less but, in both cases, revision surgery was not opted as the gap was considered bridgeable by ensuing callous.

Fisher (2012) reported that though interfragmentary compression cannot be achieved but insertion of K-wires is an acceptable method of fixation of femoral neck fractures. Insertion of cortical screw placed in lag fashion is considered to be the gold standard for repairing femoral neck fractures due to creation of inter-fragmentary compression along the fracture line but iatrogenic compression and premature closure of physis is the undesirable possibility in younger patients and hence, Jonston and Tobias (2012) recommended the use of multiple K-wires or small Steinmann pins rather than bone screws for such fractures in dogs.

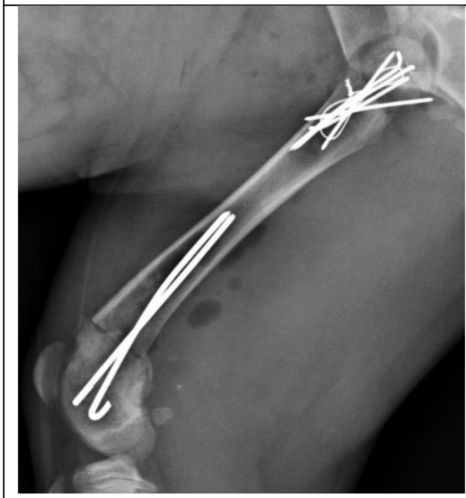
The long-term follow up could be done only in 3 cases (case nos. 3, 6 and 8); the other 2 dogs (Nos. 2 and 5) died within 15 post-operative days due to unrelated reasons and were not included for PO results.

Table 4.9: Status of limb function after femoral head and neck fracture repair in dogs

Case no.	FRD	Weight bearing score		Limb function
		IFD	FRD	
Case 3 (Right)	150	0	0	Nil
Case 3 (Left)	150	0	10	Full
Case 6 (Right)	90	0	10	Full
Case 6 (Left)	90	0	10	Full
Case 8	100	0	10	Full

In case 3, after 7 PO days animal was not bearing weight on right hind limb and serosanguinous exudate was oozing out from the suture line of distal right femur. After further inquiry owner confirmed discontinuity in antibiotic administration. The radiographic examination revealed sequestrum formation (Plate 4.29).

Plate 4.30: Post-operative radiographs of right and left limb of Case 3

		
7 days PO (Right hind limb)	150 days PO (Right hind limb)	135 days PO (Left hind limb)

Before 2nd phase of surgery continuous antibiotic administration was ensured and surgery of the left femoral neck fracture was performed 15 days after the 1st phase of surgery. Animal was then presented after 150 PO days. Complete limb function was there for left limb but animal was not bearing weight in right hind limb. The radiographic examination of right hind limb revealed complete healing at femoral neck but change in configuration of distal femur. For left limb, complete healing was observed at femoral neck (Plate 4.29).

4.1.2.2 Management of coxofemoral luxations

Out of 14 cases of coxofemoral joint luxations, the closed reduction and external coaptation was done in 1 case successfully (case 4) and surgical intervention was carried out in 6 cases. Among surgical interventions, toggle pinning was done successfully in 4 (case nos. 2, 6, 10 and 11) and Femoral Head Osteotomy (FHO) in 2 (case nos. 8 and 9).

Case 8 was a case of closed reduction that failed after 1 week and toggle pin was performed which also failed after 3.5 months and later FHO was performed.

Case 9 was presented with femoral epiphyseal fracture and femoral head articular cartilage was damaged.

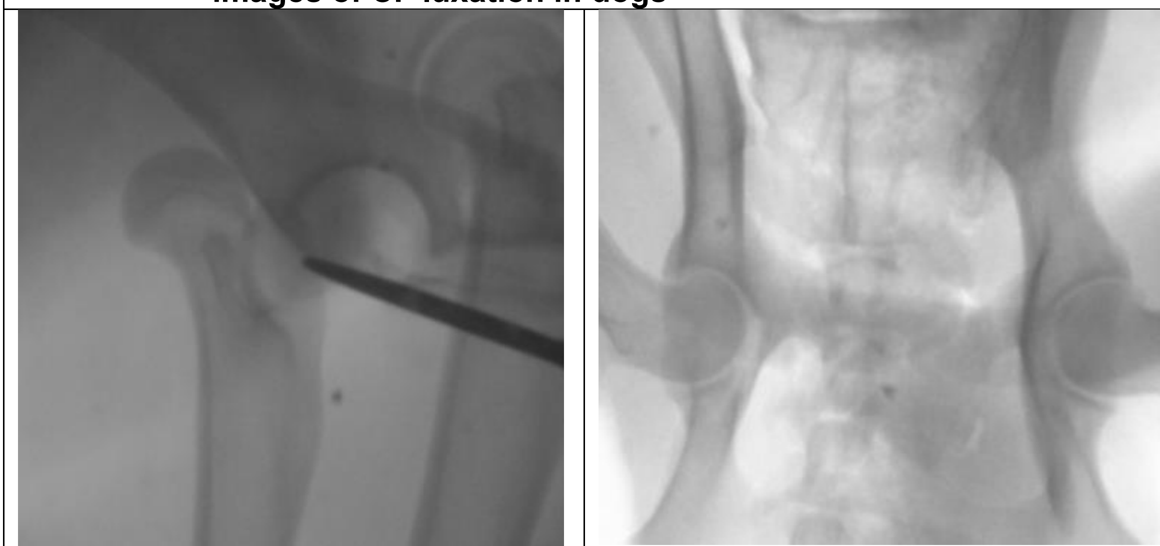
Euthanasia was done in 3 cases due to concurrent major neurological deficits whereas, 2 cases died before surgery during the course of stabilizing the condition. In 2 cases, the owner of the patients declined surgical intervention.

Table 4.10: Different techniques for repair of coxofemoral joint luxations

Case no.	Direction of luxation	Technique used
Case 2	Cranio-dorsal	Toggle pin
Case 4	Cranio-dorsal	Closed reduction with Slocum sling application
Case 6	Caudo-ventral	Toggle pin
Case 8	Cranio-dorsal	Closed reduction followed by toggle pin and then FHO
Case 9	Cranio-dorsal	FHO
Case 10	Cranio-dorsal	Toggle pin
Case 11	Cranio-dorsal	Toggle pin

Closed reduction along with Slocum sling application was performed in case nos. 4 and 8. These cases were presented within a day of the injury. The procedure was performed under fluoroscopy in general anaesthesia as elaborated in 'Materials and Methods'. The reduction of CF luxations could be achieved easily in both cases. The post-fixation movement of CF joints were found satisfactory upon fluoroscopic examinations. The physical and radiographic examinations on subsequent post-operative appraisal days revealed uneventful recovery in Case-4 and re-luxation of CF joint in Case-8.

Plate 4.31: Representative pre and post closed reduction fluoroscopic images of CF luxation in dogs



A 7th day appraisal of the Case-4 revealed that the dog had bitten off the topmost layer of Slocum sling and pulled out the indwelling urinary catheter. However, the major portion of sling was in-place and the radiological examination of the affected hip revealed maintenance of the affected CF joint in reduced position. The dog was sedated and the Slocum sling was re-applied. The frequency of Trazodone administration was increased from b.i.d. to t.i.d. for another 15 days. The dog was evaluated after 15 days and the Slocum sling was removed after ascertaining the stability of affected CF joint radiographically. Minor bandage abrasions were found at penile and metatarsal region which were dressed with Neomicin sulfate, Polymixin-B, and Bacitracin Zinc containing wound dusting powder (Neosporin, GSK India Ltd). The dog also showed lameness in the affected joint with a stiffness of stifle joint during movement. It however improved gradually and had an uneventful recovery.

The dog in Case-8 wasn't as cooperative and removed the Slocum sling within 2 days of application and thus, re-luxating its CF joint in the process. The retention of femoral head proved difficult on repeat attempt of closed reduction. It was felt as if greater damage has occurred at joint capsule which was allowing grater movement of the femoral head. The dog was later subjected to open reduction and internal fixation of CF luxation by Toggle pinning.

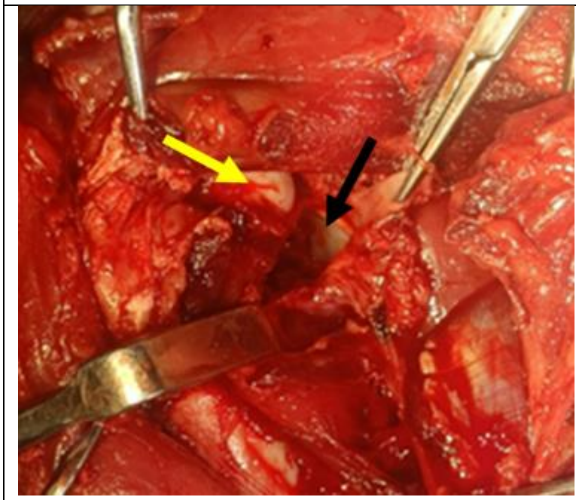
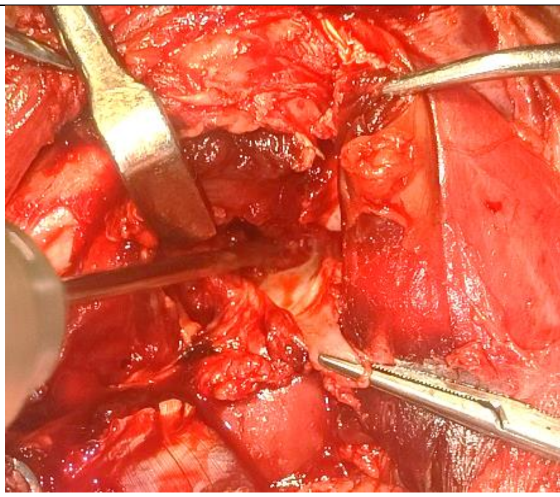
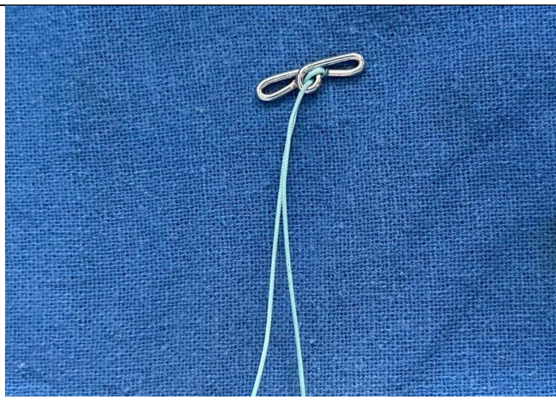
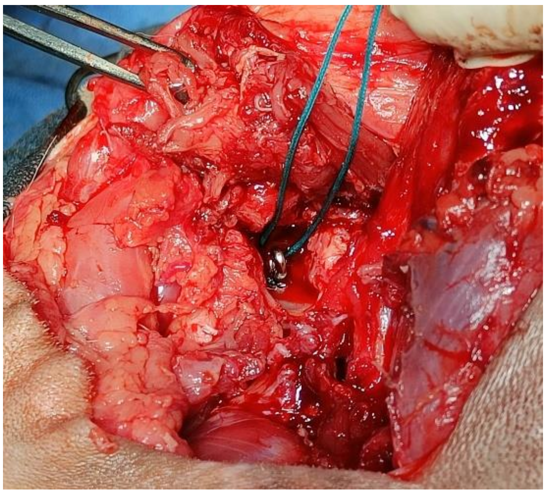
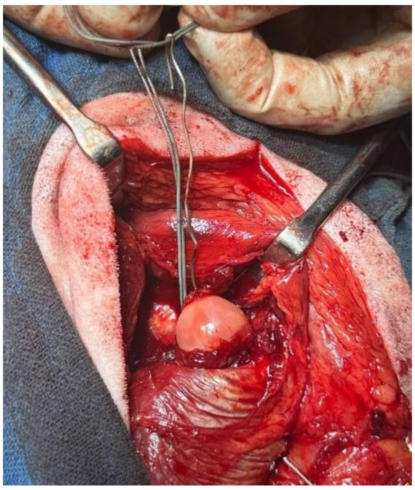
McLaughlin (1995) suggested that in fresh cases of CF luxations in dogs, if there are no concurrent acetabular or femoral head and neck fractures, the first attempt to reduce and fix the luxations should be by employing a 'Closed' method. The open reduction and internal fixation of CF luxations are indicated if closed reduction and fixation fail or if examination of the articular cartilage is necessary.

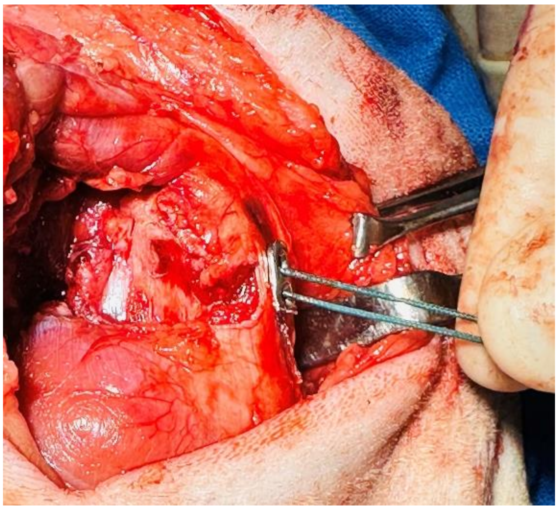
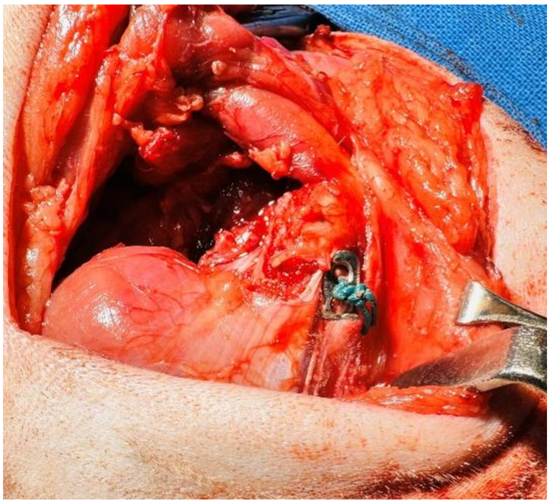
Adamiak (2012) reported that the closed technique for coxofemoral luxation repair has to be performed within 72 hours after trauma, and hip reduction must be performed under general anaesthesia.

Schlag et al. (2019) reported that 50% (46 dogs out of 92) of the dogs experienced soft tissue injuries secondary to sling use including superficial pyoderma (19), pressure necrosis wounds (15), urine scald (5), oedema at the distal aspect of the affected limb (3), self-trauma to the affected foot (2), and vascular compromise to the distal part of the affected limb resulting in tissue loss (2). Dogs that experienced a severe soft tissue injury wore the sling for a median of 12 days, compared with a median of 7 days for dogs that did not have this outcome.

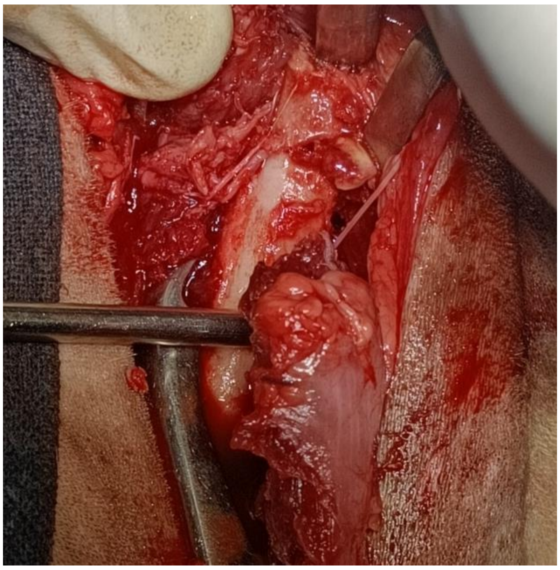
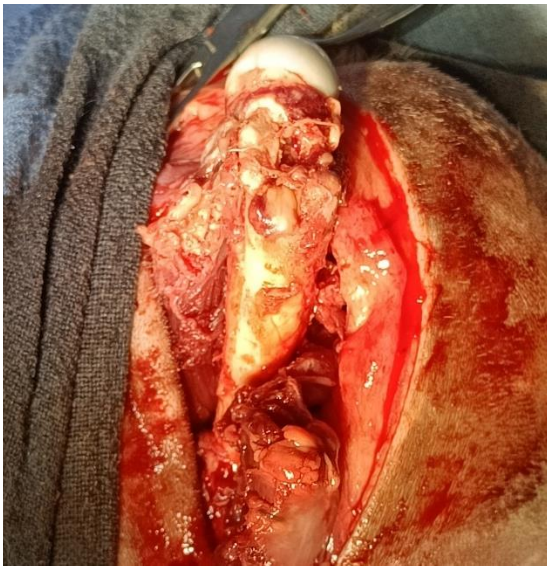
Open reduction and internal fixation of luxated CF joint was performed in dogs that were presented after 72 hrs of injury (case nos. 2, 10 and 11); dog with multiple concurrent injuries (case no. 6) and after failure of closed reduction in case no. 8. This was performed with self-made toggle pins as described in ‘Materials and Methods’ section. Cranio-lateral surgical approach as described *ut supra* for femoral head and neck fracture, was used to reach coxofemoral joint. After exposing the femoral head, leg of the animal was rotated outward from stifle and Hohmann retractors were placed intra-capsularly, ventral to femoral neck to exteriorize the femoral head and to expose acetabulum. Any debris and healing tissue in the acetabular cavity was cleared by scooping followed by flushing the area with normal saline. A hole was then drilled in femoral head and neck starting at the level of the fovea capitis using a 2.5 mm drill bit and exiting at the proximal level of third trochanter of femur. A second hole was drilled in the acetabular fossa with 4.5 mm drill bit. Acetabular hole was enlarged manually using a 6.5 mm end threaded pin in 3 dogs (case nos. 2, 10 and 11) weighing above 15 kgs so that large sized toggle pin can cross the acetabular hole.

Braided polyester suture of size 0-5 was used to secure the toggle pin by applying a half hitch in its centre. Such loaded Toggle pin was held by a long straight artery forceps and pushed though the acetabular hole to lie completely on the medial side. Then, the free ends of the polyester thread were tugged alternatively to change the orientation of the toggle pin so as to lie flat against the medial wall of acetabulum and thereby providing a firm anchorage to the attached threads. The hole in the femoral neck was then flushed with normal saline to clear the debris. A folded 22 gauze orthopaedic wire was then passed from the third trochanter side through this hole. The Toggle pin threads were engaged in the central fold of the orthopaedic wire and were then pulled out of the hole by gentle withdrawing of wire. After ensuring that the acetabular cavity was free from any debris, the femoral head was reduced into the acetabulum. The reduction was ensured by flexing and extending the limb. The Toggle threads were then pulled together to push the femoral head firmly in to the acetabulum. The Toggle threads were then tied on the lateral side of proximal femur using a 2-hole finger plate in 4 cases and with another toggle pin in 1 case (case no.10).

Plate 4.32: Toggle pinning for internal fixation of CF luxation in dog	
	
Luxated femoral head (Yellow arrow) and Acetabulum (Black arrow)	Drilling of hole in acetabulum
	
Drilling of tunnel through femoral head	Polyester thread tied to toggle pin
	
Passing of toggle pin through the hole in acetabulum	Polyester thread being pulled through the tunnel in femoral head & neck

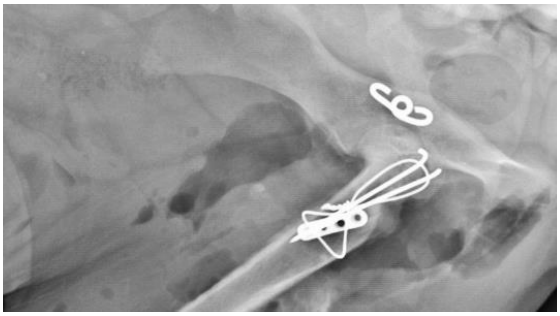
	
A double hole plate being placed at the level of third trochanter to secure the thread	

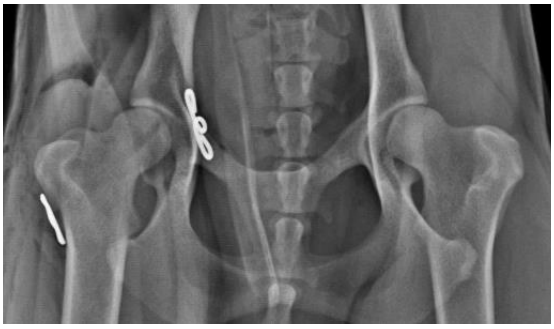
Intra-operative difficulties were observed in case no. 6. In this case, due to multiple concurrent injuries, repair of different fractures was planned in 2 phases. In first phase femoral diaphyseal and distal tibial fracture was repaired and toggle pinning was performed in second phase. Severe adhesions due to callus formation between femoral metaphysis of the luxated limb and ischium was observed as surgery was performed 15 days after the 1st phase of surgery. Severe adhesions made it difficult to locate the femoral head and reduce it into the acetabulum.

Plate 4.33: Intraoperative difficulties during Toggle pinning in Case-6	
	
Extensive callus formation at femoral metaphysis	

The immediate post-op radiographs showed adequate reduction of femoral head into the acetabulum in all the 5 cases.

Plate 4.34: Immediate post-op radiograph of CF luxations



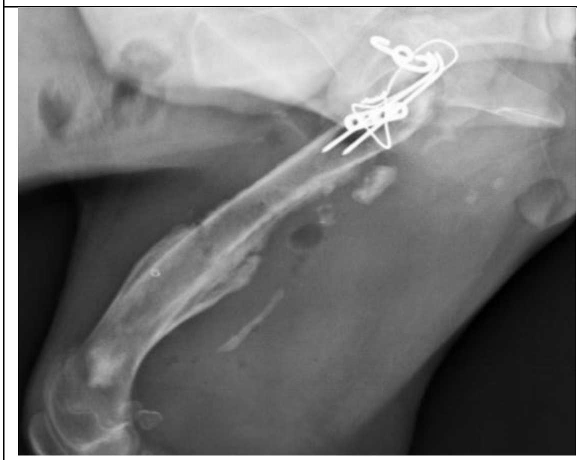


1. Case 2
2. Case 6
3. Case 8
4. Case 10
5. Case 11

Limb function improved gradually and 15 days PO radiographs revealed no re-luxation. Full weight bearing was observed in 3 cases (Case nos. 2, 8 and 10) at this interval. However, post-operative complications developed in two cases (Case 6 and 8).

In Case-6, non-weight bearing lameness was present at 15th PO Day. A clinical examination revealed moderate swelling in proximal femoral area and a sero-sanguinous discharge was oozing from the suture line. This was the case of chronic caudo-dorsal CF luxation in which severe adhesions were observed in between femoral neck and ischium and the surgical trauma was far greater than usual. On further enquiry, owner confirmed discontinuing post-op medications prematurely of his own. The radiological examination revealed generalized periosteal reaction in femoral shaft, a small bone sequestrum and multiple air opacities suggestive of chronic osteomyelitis. After change of antibiotics and re-institution of anti-inflammatory management improved the limb function gradually. A clinical appraisal of the case after 21 days revealed partial weight-bearing on the affected limb with disappearance of wound exudation. However, limb did not return to full function by the time of last appraisal after 3 months. A neurological deficit due to sciatic nerve injury was suspected in this case.

In case 8, the dog regained the limb function after Toggle pinning within 15 days however, it was presented again after 75 days with the history of pain and lameness in the operated limb for the last few days. The Orthopaedic examination revealed positive Ortolani's sign and the radiological examination confirmed the subluxation of the left CF joint along with a sagittal fracture of femoral head. Additionally, Osteosclerotic lesions were also detected around the femoral neck (Plate 4.35). On further enquiry, the owner of the dog accepted their failure in restricting the movements of the patient as much and as long as prescribed for the case. The case was then subjected to femoral head osteotomy. The implant was found intact during surgery but a significant joint laxity was present.

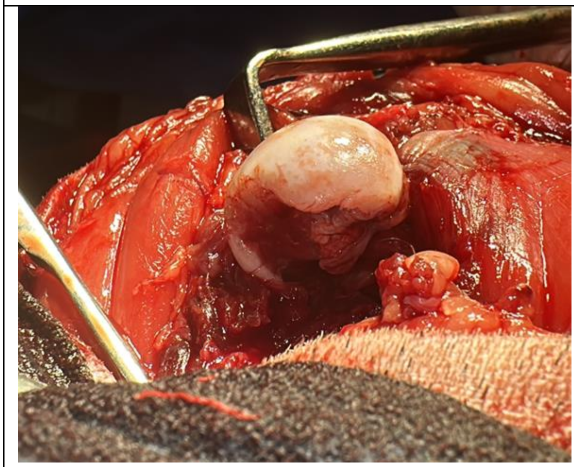
Plate 4.35: Complications after Toggle pinning	
	
Severe periosteal reaction throughout the length of femur in Case-6	Subluxation of femoral head after 75 days in Case-8

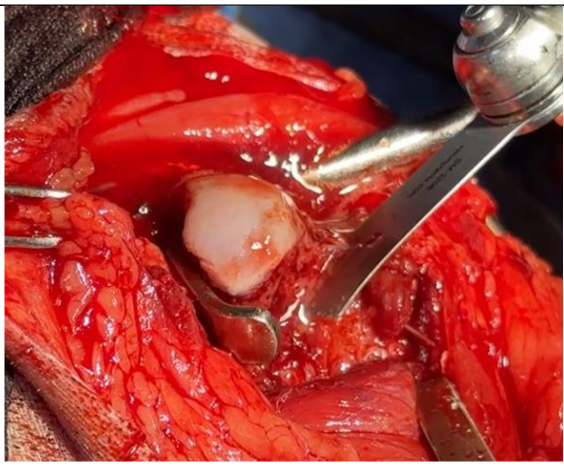
Toggle pin stabilization proved to an effective treatment for hip joint luxation in dogs and resulted in satisfactory outcome in 4 out of 5 cases. Similar outcomes were reported by Demko et al. (2006), who observed post-operative complication of reluxation in 7 out of 62 cases of hip luxation fixed with toggle pin.

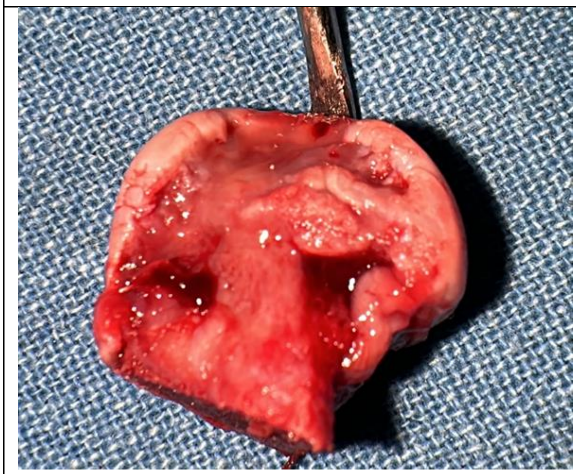
Brinker et al. (2006) reported that the prognosis for open reduction varied with the stability achieved after reduction and with the time interval between luxation and reduction. Although the prognosis of the case would be good if reduction was maintained for 3 weeks unless another trauma was introduced or if there was underlying hip laxity (CHD).

FHO was performed in two cases (Case 8 and 9). In case 8, FHO was performed due to femoral head fracture detected 75 days after employing toggle pining. Whereas, Case 9 was presented 25 days after the injury and radiographic examination revealed femoral head epiphyseal fracture along with luxation and deemed unfit for other fixation methods.

Plate 4.36: Femoral head osteotomy in dog







1. Damaged femoral head
2. Use of oscillating electric saw
3. Excised femoral head

The FHO was performed using a Cranio-lateral approach as described above. After exposing the femoral head, it was tilted outside by holding the stifle and bending the femur outside and abducting the joint. An oscillating electric saw was used to transect the femoral head. The sawing started from the medial aspect of greater trochanter and passed through the neck of the femur and ended at the proximal aspect of lesser trochanter as per the technique described by Rawson et al. 2005. The cut end of the femur was then palpated for any sharp edges and smoothened with rasp, if needed.

In Case-8, partial weight bearing was observed after 15 days of FHO. The next appraisal could be done after 75 days. Though there was no pain on palpation of affected joint, the thigh muscles appeared moderately atrophied and the patient showed slight limping during movement.

Case 9 was not presented thereafter for reappraisal but telephonic reappraisal after 35 days revealed partial weight bearing on the affected limb.

Plate 4.37: Immediate post-op radiographs after FHO in dogs	
	
Case 8	Case 9

Seddawy et al (2022) observed that all the 7 cases treated with FHO for different conditions of CF joint, started ground toe touching one week after FHO. After 3 weeks, they initiated weight-bearing with nonpainful lameness and after 5 weeks, mild nonpainful lameness with weight-bearing was noted. By the 12th week, no lameness was observed, although a slight abnormal gait persisted.

Table 4.11: Status of limb function after CF luxation repair in dogs				
Case no.	Surgical technique	FRD	Wt- bearing score at FRD	Limb function
Case 2	Toggle pin	30	10	Full
Case 4	Closed reduction with Slocum sling application	33	10	Full
Case 6	Toggle pin	60		Partial
Case 8	FHO	100	10	Full
Case 9	FHO	35	10	Partial
Case 10	Toggle pin	15	10	Full
Case 11	Toggle pin	15	10	Full

4.1.2.3 Management of Canine hip dysplasia

All the cases of canine hip dysplasia were managed conservatively as explained in 'Materials and Methods'.

Out of 33 cases, reappraisal or telephonic follow up could become possible in 18 cases only. Slight improvement in clinical signs were noted in all of them but the follow up radiographic examination revealed progression of secondary changes due to CHD.

NSAIDs, chondroprotective agents and physiotherapy are reported to help in alleviating the signs associated with canine hip dysplasia but their long-term utility is uncertain (Plante et al, 1997) as has been observed in the present study.

Smith et al. (2006) observed lifelong dietary restriction of 25% delayed the appearance of OA as well as the intensity of clinical signs in Labrador retrievers compared with feeding *ad libitum.*

Barr et al. (1987) studied 68 immature dogs with clinical and radiographic evidence of hip dysplasia and assessed the long-term efficacy of conservative management. Of these 19 dogs were re-examined clinically and radiographically and 17 showed either no gait abnormality or only a slight sway when moving.

Plate 4.38: Progression of CHD even after conservative management

VD view of pelvis on 1st day

VD view pelvis 150 days after conservative management

4.2 Ascertaining the regional occurrence of the coxofemoral joints conditions in dogs

During the study period spanning from August 2022 to September 2023 overall, 1989 clinical cases of dogs were presented to the Department of Veterinary Surgery and Radiology, DGCN College of Veterinary and Animal Sciences, CSKHPKV Palampur. Out of which, 384 dogs were found afflicted with orthopaedic conditions affecting the appendicular skeleton with an incidence rate of 19.3%. Among them, the coxofemoral joint (CF) conditions were identified in 61 dogs thus constituting 15.8% of total appendicular orthopaedic conditions. The overall incidence rate of CF conditions was calculated to be 3.07% (Table 4.12).

Table 4.12: Occurrence of orthopaedic and CF conditions in dogs				
Nos. of clinical cases	Overall orthopaedic conditions		Coxofemoral joint conditions	
	Number	Incidence	Number	Incidence
1989	384	19.3 %	61	3.07 %

The most common CF condition of dogs observed during the study was hip dysplasia (33) followed by CF luxation (14), fractures (13) and miscellaneous tumours (1). Their incidence and distribution rate are shown in table 4.13.

Table 4.13: The CF conditions in dogs				
Condition		Number	Distribution	Incidence
Other conditions	Hip dysplasia	33	54.09%	1.65%
	CF Luxation	14	22.95%	0.70%
	Miscellaneous tumours	1	1.63%	0.05%
	Total	48	78.68%	2.40%
Fractures	Femoral neck fracture	9	14.75%	0.45%
	Acetabular fracture	4	6.56%	0.20%
	Total	13	21.31%	0.65%

The fractures were further categorized as per their location viz acetabulum or femoral head and neck. It was found that femoral neck fractures were significantly more than standalone acetabular fractures (8 vs 4).

The incidence of orthopaedic conditions as reported by Maruthi et al. (2017) in 2418 cases of dogs was 30.02%. The fact that only the orthopaedic cases involving limbs are included in the present study, had contributed to the lower incidence of the orthopaedic cases.

The findings of the present study are in line with the similar study conducted in the same geographical area by Ankit (2020) who reported the incidence of CF conditions as 3.83% among 1461 clinical cases and hip dysplasia was found to be the most common condition with the distribution of 50% followed by coxofemoral luxation (21.43%), femoral head and neck fracture (16.07%), acetabular fracture (8.93%) and osteoarthritis (3.57%).

Prasad (2009) also reported that the incidence of hip dysplasia (54%) was highest among coxofemoral joint conditions followed by osteoarthritis (28%) and fracture and luxation (18%).

Sex, age and breed-wise incidence and distribution of coxofemoral joint cases

Predominant number of cases presented to department were males (1475 vs 514), the incidence of CF conditions among males was 2.98% and among females was 3.30%. The sex-wise distribution was 72.13% in males (44 cases) and 27.87% in females (17 cases). Though the overall incidence rate of coxofemoral joint conditions were slightly more in females (3.3%) as compared to that of males (2.98%), their overall distribution was significantly less i.e. 27.87% vs 72.13% in males.

Table 4.14: Sex-wise distribution and incidence CF conditions in dogs

	Nos. of clinical cases	CF conditions	Incidence	Distribution
Males	1475	44	2.98%	72.13%
Females	514	17	3.30%	27.87%
Total	1989	61		

The higher distribution of males was due to the preference of people to keep male dogs as pet than female dogs. Ankit (2020) also observed similar findings for sex-wise incidence and distribution in a study conducted on orthopaedic conditions of pelvic region. He reported the incidence as 2.08% in females and 1.83% in males and distribution of Pelvic region conditions was more in males (67.85%) than in females (32.14%). Prasad (2009) recorded the distribution of coxofemoral joint conditions as 61% in males and 39% in females.

The age-wise incidence was found to be highest in senile (4.44%) followed by juvenile (3.09%) and adult (44.26%) whereas highest number of cases presented belonged to adult (27) age-group followed by juvenile (18) and senile (16) (Table 4.15). Thus, it is clear that distribution alone is not the true measure of studying the prevalence of disease conditions in a particular category.

Table 4.15: Age-wise distribution and incidence of CF conditions in dogs				
Age-group	OPD cases	Number of cases	Distribution	Incidence
Juvenile (<1 year)	582	18	29.51%	3.09%
Adult (1-7 years)	1047	27	44.26%	2.57%
Senile (>7 years)	360	16	26.22%	4.44%
Total	1989	61		

Among the registered breeds of dogs, the highest distribution of 16.39% was observed for Labrador Retrievers followed by German Shepherd (13.11%, 8 cases), Golden Retriever (8.19%, 5 cases), Pug (6.55%, 4 cases), Spitz (6.55%, 4 cases), Rottweiler (3.29%, 2 cases), Shih Tzu (3.29%, 2 cases), St. Bernard (3.29%, 2 cases), Beagle (1.64%, 1 case), Boxer (1.64%, 1 case), Dachshund (1.64%, 1 case), French Mastiff (1.64%, 1 case), Bull Terrier (1.64%) and Husky (1.64%, 1 case).

Table 4.16: Breed-wise distribution of CF conditions in dogs						
Breeds	CHD	CF fractures	CF Luxation	CF tumors	Grand Total	Distribution
Labrador Retriever	9	-	1	-	10	16.39%
German Shepherd	5	-	3	-	8	13.11%
Golden Retriever	5	-	-	-	5	8.19%
Pug	2	1	1	-	4	6.55%
Spitz	3	-	1	-	4	6.55%
Rottweiler	2	-	-	-	2	3.29%
Shih Tzu	1	1	-	-	2	3.29%
St. Bernard	2	-	-	-	2	3.29%
Beagle		1	-	-	1	1.64%
Boxer	1	-	-	-	1	1.64%
Dachshund	1	-	-	-	1	1.64%
French Mastiff	1	-	-	-	1	1.64%
Bull Terrier	1	-	-	-	1	1.64%
Husky	-	-	1	-	1	1.64%
Mixed Breed	-	10	7	1	18	29.50%
Total	33	13	14	1	61	

A significant number of non-descript dogs were also presented with CF conditions with the distribution of 29.50%. Thus, from the data it is clear that CF conditions were found distributed from small to large breed dogs.

Prasad (2009) reported higher incidence of coxofemoral joint conditions in larger breeds such as German Shepherd Dog (23%) and Labrador Retriever (34%) followed by Spitz (11%), Great Dane (6%), Rottweiler (4%) and non-descriptive (8%) in a study conducted on 575 cases of CF joint conditions. The higher prevalence of coxofemoral joint conditions among mixed breed dogs in present study was due to geographical differences and higher population of mixed breed dogs in the area.

Chapter 5

SUMMARY AND CONCLUSIONS

The study was performed on the clinical cases of dogs presented to the Department of Veterinary surgery and Radiology, DGCN College of Veterinary and Animal Sciences, CSKHPKV Palampur from August 2022 to September 2023. The objectives of the study were to diagnose and manage the conditions of coxofemoral (CF) joints in dogs and to record their regional occurrence.

For diagnosis and management of CF joint conditions, all the patients presented with the hind limb lameness or in non-ambulatory state were systematically examined. They were subjected to detailed clinical, orthopaedic, neurological, radiological and laboratory examinations to ascertain the involvement of coxofemoral joint, associated injuries and the overall status of the patients. All the subjective and objective relevant case details were recorded in the proforma in a systemic manner so that the prognosis of the cases could be assessed to plan the management. These case records were also used to ascertain the regional occurrence of CF joint conditions later on.

After performing the preliminary clinical examination, the neurological status of the patient was assessed. Later, in ambulatory patients, an orthopaedic examination was done in which the gait was assessed in standing and walking phases. A specific weight-bearing score was assigned based on different manifestations of lameness. The relationship among iliac wing, ischial tuberosity and the greater trochanter of the femur was visually inspected and the abnormalities, if any were recorded. The patient was then subjected to the palpation of the whole limb to pin-point the seat of lameness and to assess the degree of pain and inflammation at the fracture site. In suspected cases of CHD and CF luxations, Ortolani’s test was performed.

Radiographic examination of the patient was done to determine the type and location of injuries and to know the status of joint. Radiographs were achieved in extended hip ventro-dorsal and lateral position. The radiographs so obtained were evaluated critically and the diagnosis was ascertained.

Upon diagnosis, the conditions associated with the coxofemoral joint were first broadly categorised into ‘Fractures’ and the ‘Other conditions’. The CF fractures were further subcategorized on the basis of anatomical location into femoral head, neck and acetabular fractures. In ‘Other conditions’ category, the CF luxations, Canine Hip Dysplasia (CHD) and CF tumours were included. The CF luxations were further classified on the basis of position of femoral head relative to acetabulum into “Cranio-dorsal” or “Caudo-dorsal” luxations. The extended hip ventro-dorsal radiographs of the dogs above 1 year of age diagnosed with CHD were subjected to scoring as per the guidelines of British Veterinary Association/Kennel club (BVA/KC). Following diagnosis, the course of management of coxofemoral joint conditions were decided on the basis of the prognosis of case and owner’s willingness.

Among the 1989 clinical cases of dogs presented to the department during the study period, 61 dogs were diagnosed with the conditions of CF joint comprising 13 fractures, 14 CF luxations, 33 CHD and 1 CF tumour.

Among the CF fractures, the standalone involvement of femoral head and neck was observed in 8, acetabulum in 4 and simultaneous femoral neck and acetabulum in 1 dog. The vehicular trauma was the aetiology in 10 cases whereas, in remaining 3 dogs, it was uncertain. Concurrent fractures involving other bones of pelvis, appendicular or axial skeleton was observed in 8 dogs following vehicular trauma.

The majority of dogs (10) presented with CF fractures were juvenile (below 1 year of age); the remaining 3 were adult. The sex-wise distribution of CF fractures was 53.84% (7 dogs) for males and 46.16% (6 dogs) for females. The maximum number of dogs belonged to mixed breed category (10 dogs) followed by Shih Tzu, Pug, and Beagle (1 each).

Among ‘Other Conditions’, CF luxation was diagnosed in 14 dogs. The aetiology of luxation was vehicular trauma (n= 8) and fall from the height (n= 1) whereas, in remaining cases (5), it remained unknown. All the dogs were presented with the history of either variable degree of lameness (7) or complaint of not getting up (7) from the past 1 to 60 days. Recumbency was attributed to multiple concurrent injuries, vertebral compression, paralysis and systemic reasons in 7 cases of CF luxation.

The CF luxations were predominantly observed in male dogs (71.43% in males vs 28.57% in females). Age-wise CF luxations were more commonly observed in adults (71.43%) followed by juvenile (21.43%) and senile (7.14%) dogs. The majority of the dogs belonged to mixed-breed category (7) whereas, among the well-established breeds, the maximum number of cases were observed in German Shepherds (3), followed by Spitz, Pug, Labrador Retriever and Siberian Husky (1 each).

Thirty-three dogs were diagnosed with different severity of Canine Hip Dysplasia (CHD). These included the dogs presented with clinical manifestations of hip dysplasia (22) as well as those without any overt signs and were screened randomly (11). Most common clinical signs were difficulty in rising up from rest (30), waddling gait (8), reluctant to climb stairs and run (22), exercise intolerance (15), atrophy of pelvic musculature (12) and bunny hopping gait (5) ranging from previous 6 to 30 days. Overall, 30 dogs showed almost similar radiographic changes on both CF joints whereas, 3 dogs showed more severe changes on one side.

A majority of cases of CHD were observed in male dogs (26) as compared to females (7). Hip dysplasia was not diagnosed in dogs less than 3 months of age; only 2 cases was found to be in the age-group of 3 to 6 months (6.06%); 7 in 6 to 24 months (21.21%) and remaining 24 in the age-group of above 2 years (72.72%). Most commonly affected breed was Labrador Retriever (27.27%), followed by German Shepherd and Golden Retriever (15.15% each), Spitz (9.09%), Pug, Rottweiler and St. Bernard (6.06% each), Shih Tzu, Boxer, Dachshund, French Mastiff and Bull-Terrier (3.03% each).

The properly positioned radiographs of dogs above 1 year of age diagnosed with CHD were subjected to hip scoring as per BVA/KC. Eight out of the 33 hip dysplastic dogs did not meet these requirements because 4 dogs were younger than 1 year of age and proper positioning could not be attained in other 4 dogs. Maximum distribution (44%) of total hip scores in dogs was in the range of 21 to 50, whose approximate interpretation as per BVA/KC classification was- ‘Moderate to marked hip dysplasia with osteoarthritis or severe hip dysplasia without osteoarthritis'. Substantial number of cases (10) were also found with hip score above 50 interpreted as 'severe to very severe osteoarthritis secondary to hip dysplasia' whereas, 4 dogs were found with hip score in between 11-20 corresponding to "mild changes in the hip that may worsen into DJD".

Management of coxofemoral joint conditions was done either surgically or conservatively. Surgical correction of femoral head and neck fracture was done in 7 CF joints of 5 dogs. Triple pinning was performed in 4 instances and excision of femoral head and neck in 3. Though the inter-fragmentary compression could not be achieved optimally in 2 Triple pinning surgeries but the healing of fracture occurred uneventfully. Hence, this technique was considered an acceptable method of fixation of femoral neck fractures as observed by many others. The long term follow-up revealed full limb function in 3 out of 4 cases repaired with triple pinning.

The salvage procedure like femoral head and neck excision were recommended in cases of pre-existing hip dysplasia, highly comminuted fractures and chronic cases. It yields satisfactory results in 1 case and no follow-up was attained in other 2.

The conservative management of CF luxations with closed reduction and external coaptation was attempted in two cases. In one case, it was successful whereas, it failed in another within two days. In latter as well as in 4 other cases, the CF luxations were surgically reduced and fixed using Toggle pinning technique. The immediate post-operative radiographs revealed adequate reduction of femoral head into the acetabulum in all the 5 cases. Long-term follow-up revealed restoration of full limb function in 3 dogs. In 1 dog the unrelated complication of sciatic nerve deficit and in another, femoral head fracture 2 months after the surgery was the reason of compromised recovery. In former case, extensive concurrent injuries in the patient and the non-compliance of owner to observe postoperative protocol was considered to be the reason of unsatisfactory limb function.

Femoral head osteotomy (FHO) was done 2 cases which included a case where subluxation and femoral head fracture occurred 2 months after Toggle-pinning and a case where, the femoral head was damaged beyond repair at the time of first presentation itself. In former case, the failure of the owners to restrict the activity to the suggested level in this hyper-active patient was considered to be the cause of complication.

All the cases of CHD were managed conservatively by using non-steroidal anti-inflammatory drugs (NSAIDs), joint supplements, weight management and restricting the activity of dogs to leash walking. Such treatment though reduced pain and lead to improvement in clinical signs to some extent but it did not halt the progression of disease.

Out of 1989 dogs, 384 were found afflicted with orthopaedic conditions affecting the appendicular skeleton with an incidence rate of 19.3%. Among them, the coxofemoral joint (CF) conditions were identified in 61 dogs thus constituting 15.8% of total appendicular orthopaedic conditions. The overall incidence rate of CF conditions was calculated to be 3.07%. The most common CF condition of dogs was hip dysplasia (33) followed by luxation (14), fractures (13) and miscellaneous tumours (1).

The incidence of CF conditions was 2.98% in male and 3.30% in fenale dogs. The sex-wise distribution was 72.13% in males (44 cases) and 27.87% in females (17 cases). Though the overall incidence rate of coxofemoral joint conditions were slightly more in females (3.3%) as compared to that of males (2.98%), their overall distribution was significantly less.

The age-wise incidence was found to be highest in senile (4.44%) followed by juvenile (3.09%) and adult (44.26%) whereas highest number of cases presented belonged to adult (27) age-group followed by juvenile (18) and senile (16).

Among the well-recognized breeds of dogs, the highest distribution of CF conditions was in Labrador Retrievers (16.39%) followed by German Shepherd (13.11%), Golden Retriever (8.19%), Pug (6.55%), Spitz (6.55%), Rottweiler (3.29%), Shih Tzu (3.29%), St. Bernard (3.29%), Beagle (1.64%), Boxer (1.64%), Dachshund (1.64%), French Mastiff (1.64%) and Husky (1.64%). A significant number of non-descript dogs were also presented with CF conditions with the distribution of 31.15%.

Based on above study, the following conclusions were drawn-

- The regional incidence of CF joint conditions in dogs is 3.07% with hip dysplasia (1.65%) having higher incidence than luxation (0.70%) and CF fracture (0.60%).
- The majority of hip dysplasia cases are detected in dogs above 2 year of age (72.72%) followed by 6-24-month age group (21.21%).
- For fixation of femoral head and neck fractures in dogs, though the placement of triple pins in divergent manner is technically quite demanding yet it is an effective method in providing adequate fixation at site to bring about fracture healing.
- Conservative management of CF luxation in dogs by closed reduction and fixation by using Slocum sling is useful only when the procedure is performed within short period of occurrence of the condition in a cooperative patient.
- Open reduction of CF luxation in dogs can be accomplished even after passage of many weeks and its surgical fixation using toggle pin is an effective method though it is technically demanding.
- Conservative management of clinically apparent cases of Canine Hip Dysplasia can ameliorate the signs of discomfort to certain extent but do not provide a long-term solution.
- The BVA/KC scoring of hips is a precise and an effective method for diagnosing Canine Hip Dysplasia in a comprehensive manner as it takes in to account the changes on 9 different anatomical landmarks rather than basing its conclusions on any one or two radiographic features.

LITERATURE CITED

Anderson GM, Cross AR, Lewis DD, Lanz OI. 2002. The effect of plate luting on reduction accuracy and biomechanics of acetabular osteotomies stabilized with 2.7-mm reconstruction plates. *Veterinary Surgery*. 31(1):3-9.

Armbrust L. 2009. Tips & techniques for pelvic radiography. *Clinician's Brief.* 51-4.

Adamiak Z. (2012). Treatment of bilateral hip luxation in dogs with the Shani-Johnston-Shahar technique: case report. *Revue Méd. Vét*. *163*(2): 76-78.

Ash K, Rosselli D, Danielski A, Farrell M, Hamilton M and Fitzpatrick N. 2012. Correction of craniodorsal coxofemoral luxation in cats and small breed dogs using a modified Knowles technique with the braided polyblend TightRope™ systems. *Veterinary and Comparative Orthopaedics and Traumatology*. *25*(01): 54-60.

Amort K, Sadan MA and Kramer M. 2015. Imaging of acetabular fractures in 14 dogs: A comparison of plain radiography and computed tomography (CT) scan. Indian Journal of Veterinary Surgery. 36(1): 37-40.

Ankit. 2020. Investigation on the orthopaedic conditions of pelvic region in dog. M.V.Sc. Thesis submitted to Department of Veterinary Surgery and Radiology, DCGN College of Veterinary and Animal Sciences, CSKHPKV, Palampur.

Basher AW, Walter MC, Newton CD. 1986. Coxofemoral luxation in the dog and cat. *Veterinary surgery*.15(5):356-62.

Barr ARS, Denny HR and Gibbs C. 1987. Clinical hip dysplasia in growing dogs: the long-term results of conservative management. *Journal of small animal practice.* 28(4): 243–252.

Boswell KA, Boone Jr EG and Boudrieau RJ. 2001. Reduction and temporary stabilization of acetabular fractures using ASIF mandibular reduction forceps: Technique and results using plate fixation in 25 dogs. *Veterinary Surgery*. *30*(1): 1-10.

Brinker, Piermattei DL, Flo G and DeCamp C. 2006. The hip joint. In; Brinker, Piermattei and Flo's Handbook of Small Animal Orthopedics and Fracture Repair, fifth edition. Saunders Elsevier, Missouri, USA. ISBN: 978-1-4377-2364-9. P 479-480.

Boiocchi S, Vezzoni L, Vezzoni A, Bronzo V and Rossi F. 2013. Radiographic changes of the pelvis in Labrador and Golden Retrievers after juvenile pubic symphysiodesis. *Veterinary and Comparative Orthopaedics and Traumatology*. *26*(03): 218-225.

Belge A, Bozkan Z, Sarierler M and YAYGINGÜL R. 2014. The treatment of coxofemoral luxation by modified synthetic capsule technique in dogs: 6 cases. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*. 20 (3): 337-343.

Blakely JA, Butler JR, Priddy LB, McCabe EM, Avendaño JN, Elder SH and Wills R. 2019. Ex vivo biomechanical comparison of 2.7 mm string-of-pearl plate versus screw/wire/Polymethylmethacrylate composite fixation and 2.7 mm veterinary acetabular plate for repair of simulated canine acetabular fractures. *BMC veterinary research*. *15*(1): 1-9.

Bozkan Z, Bulut B and Bellek CG. 2020. Treatment of Ventral Hip Luxation in a Puppy. *Journal of the Hellenic Veterinary Medical Society*.71(4):77-82.

Balima NS and Rajasekaran R. 2020. Conservative management of hip dysplasia in a dog. *Journal of entomology and zoology studies*. 8(2):294-296

Coughlan A. 1996. Decision making in the managemnent of canine hip dysplasia. *In Practice*. *18*(1): 2-8.

Citi S, Vignoli M, Modenato M, Rossi F, and Morgan JP. 2005. A radiological study of the incidence of unilateral canine hip dysplasia. *Schweizer Archiv für Tierheilkunde*. *147*(4): 173-178.

Cetinkaya MA and Olcay B. 2010. Modified Knowles toggle pin technique with nylon monofilament suture material for treatment of two caudoventral hip luxation cases. *Veterinary and Comparative Orthopaedics and Traumatology*. *23*(02): 114-118.

Comhaire FH and Schoonians FA. 2011. Canine hip dyslasia: the significance of the Norberg angle for healthy breeding. *Journal of Small Animal Practice*. 52: 536–542.

Daly WR. 1978. Femoral head and neck fractures in the dog and cat: a review of 115 cases. *Veterinary Surgery*. *7*(2): 29-38.

Dyce J, Houlton JE.1993. Use of reconstruction plates for repair of acetabular fractures in 16 dogs. *Journal of Small Animal Practice*. 34(11):547-53.

Demko JL, Sidaway BK, Thieman KM, Fox DB, Boyle CR and McLaughlin RM. 2006. Toggle rod stabilization for treatment of hip joint luxation in dogs: 62 cases (2000–2005). *Journal of the American Veterinary Medical Association*. *229*(6): 984-989.

Dueland RT, Patricelli AJ, Adams W M, Linn KA and Crump PM. 2010. Canine hip dysplasia treated by juvenile pubic symphysiodesis. *Veterinary and Comparative Orthopaedics and Traumatology*. *23*(05): 318-325.

Dennis R. 2012. Interpretation and use of BVA/KC hip scores in dogs. *In Practice*. *34*(4):178-194.

Engstig M, Vesterinen S, Morelius, Junnila J and Hyytiäinen HK. 2022. Effect of Femoral Head and Neck Osteotomy on Canines' Functional Pelvic Position and Locomotion. *Animals*. *12*(13): 1631.

El-Seddawy FD, El-Mezayen A, Tantawy MF and Gomaa M. 2022. Femoral Head and Neck Ostectomy (FHO) for Treatment of Different Hip Joint Disorders in Dogs. *Journal of Advanced Veterinary Research*. *12*(4): 422-425.

Fluckiger MA, Friedrich GA and Binder H. 1999. A radiographic stress technique for evaluation of coxo-femoral joint laxity in dogs. *Veterinary Surgery*. 28:1-9.

Fox DB. 2007. Orthopaedic Examination of the Rear Limb in the Dog. *NAVC Clinician's Brief*. 63-66.

Fisher SC, McLaughlin RM and Elder SH. 2012. In vitro biomechanical comparison of three methods for internal fixation of femoral neck fractures in dogs. *Veterinary and Comparative Orthopaedics and Traumatology*. *25*(01): 36-41.

Fossum TW. 2018. Diseases of the joints. In: Small Animal Surgery. 5th edition., St. Louis, Missouri, USA: Mosby Elsevier

Franco-Gonçalo P, Pereira AI, Loureiro C, Alves-Pimenta S, Filipe V, Gonçalves L and Ginja M. 2023. Femoral Neck Thickness Index as an Indicator of Proximal Femur Bone Modeling. *Veterinary Sciences*. *10*(6): 371.

Genevois JP, Remy D, Viguier E, Carozzo C, Collard F, Cachon T and Fau D. 2008. Prevalence of hip dysplasia according to official radiographic screening, among 31 breeds of dogs in France. *Veterinary and Comparative Orthopaedics and Traumatology*. *21*(01): 21-24.

Ginja MMD, Silvestre AM, Gonzalo-Orden JM and Ferreira AJA. 2010. Diagnosis, genetic control and preventive management of canine hip dysplasia: a review. *The Veterinary Journal*. *184*(3): 269-276.

Guilliard M. 2014. The Penn hip method of predicting canine hip dysplasia. *In Practice*. 36: 66-74.

Gomaa M, Elmezayen AF and Tantawy M F. 2023. Comparison of Three Different Suture Materials for Toggle Pin (TP) Technique in Induced Hip luxation in Dogs. *Zagazig Veterinary Journal*. *51*(2): 129-138.

Heo S, Lee H, Roh Y and Jeong J. 2023. Biomechanical Comparison between Inverted Triangle and Vertical Configurations of Three Kirschner Wires for Femoral Neck Fracture Fixation in Dogs: A Cadaveric Study. *Veterinary Sciences*. *10*(4): 285.

Johnston SA, Tobias KM. 2017. Veterinary Surgery: Small Animal Expert Consult-E-Book: 2-Volume Set. Elsevier Health Sciences.

Kolady. 2005. Hip Scoring in Dogs. M.V.Sc. Thesis submitted to Department of Veterinary Surgery and Radiology, Veterinary College Bangalore, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar.

Kapatkin AS, Gregor TP, Hearon K, Richardson R W, McKelvie PJ, Fordyce HH and Smith GK. 2004. Comparison of two radiographic techniques for evaluation of hip joint laxity in 10 breeds of dogs. *Journal of the American Veterinary Medical Association*. *224*(4): 542-546.

Kumar H. 2016. Comparative evaluation of different fixation techniques for fixation of femoral fractures in dogs. M.V.Sc Thesis, Department of Veterinary Surgery & Radiology, DCGN College of Veterinary and Animal Sciences, CSKHPKV, Palampur.

Lust G, Todhunter RJ, Erb HN, Dykes NL, Williams AJ, Wurster NIB and Farese JP. 2001. Comparison of three radiographic methods for diagnosis of hip dysplasia in eight-month-old dogs. *Journal of the American Veterinary Medical Association*. 219(9): 1242-1246

McLaughlin RM. 1995. Traumatic joint luxations in small animals. *Veterinary Clinics of North America: Small Animal Practice*. *25*(5): 1175-1196.

McDonnell JJ, Piatt SR and Clayton LA. 2001. Neurologic conditions causing lameness in companion animals. *Veterinary Clinics of North America: Small Animal Practice*. *31*(1): 17-38.

Martini F M, Simonazzi B and Del Bue M. 2001. Extra-articular absorbable suture stabilization of coxofemoral luxation in dogs. *Veterinary Surgery*. *30*(5): 468-475.

Moores A. 2006. Decision making in the management of hip luxations in dogs and cats. *In Practice*. *28*(10): 570-576.

Maruthi ST, Chandy G, Venugopal SK, Sooryadas S, Lucy KM and Sunanda C. 2017. Occurrence of hip dysplasia in dogs: A retrospective study. *Indian Journal of Canine practice.* 9(1): 67-69.

Piermattei DL and Johnson DA. 2004. The pelvis and hip joint. In; An atlas of surgical approaches to the bones and joints of dog and cat. Saunders Elsevier, Missouri, USA. ISBN 0-7216-8707-5. P 277-327

Powers MY, Biery DN, Lawler DF, Evans RH, Shofer FS, Mayhew P and Smith GK. 2004. Use of the caudolateral curvilinear osteophyte as an early marker for future development of osteoarthritis associated with hip dysplasia in dogs. *Journal of the American Veterinary Medical Association*. *225*(2): 233-237.

Prasad. 2009. Surgical management of coxofemoral joint diseases in dogs. M.V.Sc. Thesis submitted to Department of Veterinary Surgery and Radiology, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai.

Prasad AA, Shafiuzama M, Ayyappan S, Sureshkumar R and Jayaprakash R. 2012. Incidence of Coxofemoral Joint Affections in Dogs-A Clinical Study of 575 patients. *Intas Polivet*. 13(2): 281-283.

Prasad A, Shafiuzama MD, Jayaprakash, Ayyapana S, Ganesh TN and Thilagar S. 2015. Cemented total hip arthroplasty in dogs. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*. 8(2):36-42.

Riser WH and Shirer JF. 1969. Correlation between canine hip dysplasia and pelvic muscle mass: A study of 95 dogs. *Journal of Veterinary Medical Association*. 124: 769-777.

Rawson EA, Aronsohn MG and Burk L. 2005. Simultaneous bilateral femoral head and neck ostectomy for the treatment of canine hip dysplasia. *Journal of the American Animal Hospital Association*. 41(3): 166-170.

Slocum B & Slocum TD. 1992. Pelvic osteotomy for axial rotation of the acetabular segment in dogs with hip dysplasia. *Veterinary Clinics of North America: Small Animal Practice*. 22(3): 645-682.

Smith GK, Paster ER, Powers MY, Lawler DF, Biery DN, Shofer FS and Kealy RD. 2006. Lifelong diet restriction and radiographic evidence of osteoarthritis of the hip joint in dogs. *Journal of the American Veterinary Medical Association*. 229(5): 690-693.

Shiju Simon M, Ganesh R, Ayyappan S, Rao GD, Suresh Kumar R, Manonmani M, Das BC. 2010. Incidence of Canine Hip Dysplasia: A Survey of 272 Cases. *Veterinary World*. 3(5).

Stanin D, Pavlak M, Vrbanac Z, Potočnjak D.2011. Prevalence of hip dysplasia in dogs according to official radiographic screening in Croatia. *Veterinarski arhiv*. 81(2):235-48.

Sadan MA, Amort and Kramer M. 2015. Imaging of acetabular fractures in 14 dogs: a comparison of plain radiography and CT scan. *Indian Journal of Veterinary Surgery.* 36(1): 37-40.

Schachner ER and Lopez MJ. 2015. Diagnosis, prevention, and management of canine hip dysplasia: a review. *Veterinary Medicine: Research and Reports.* 181-192.

Schlag AN, Hayes GM, Taylor A Q, Kerwin SC, Dugat DR, Vitt MA and Duffy DJ. 2019. Analysis of outcomes following treatment of craniodorsal hip luxation with closed reduction and Ehmer sling application in dogs. *Journal of the American Veterinary Medical Association*. *254*(12): 1436-1440.

El-Seddawy FD, El-Mezayen AF, Tantawy MF, Gomaa M. 2022. Femoral Head and Neck Ostectomy (FHO) for Treatment of Different Hip Joint Disorders in Dogs. *Journal of Advanced Veterinary Research.*12(4):422-5.

Trostel CD, Peck JN, deHaan JJ. 2000. Spontaneous bilateral coxofemoral luxation in four dogs. *Journal of the American Animal Hospital Association*. 36(3):268-76.

Trostel CT and Fox DB. 2020. Coxofemoral joint luxation in dogs treated with toggle rod stabilization: a multi-institutional retrospective review with client survey. *Journal of the American Animal Hospital Association*. *56*(2): 83-91.

Verhoeven G, Fortrie R, Van Ryssen B and Coopman F. 2012. Worldwide screening for canine hip dysplasia: where are we now?. *Veterinary surgery*. *41*(1): 10-19.

Virag Y, Gumpenberger M, Tichy A, Lutonsky C, Peham C & Bockstahler B. 2022. Center of pressure and ground reaction forces in Labrador and Golden Retrievers with and without hip dysplasia at 4, 8, and 12 months of age. *Frontiers in Veterinary Science*. 9:1087693.

Vezzoni A, Boiocchi S, Vezzoni L, Vanelli AB and Bronzo V. 2010. Double pelvic osteotomy for the treatment of hip dysplasia in young dogs. *Veterinary and Comparative Orthopaedics and Traumatology*. *23*(06): 444-452.

Brief Bio-data of the Student

Name : Dr. Mridula Sharma

Father's Name : Sh. Moti Lal Sharma

Mother's Name : Smt. Sunita

Date of Birth : 07/08/1997

Permanent Address : V.P.O. Takka Tehsil and District Una (H.P.) 174303

Academic Qualifications:

Qualifi-cation	Month, Year	School	Board/ University	Marks (%/ OGPA)	Division
10th	2013	DAV Cent. Public School Una (HP)	CBSE	9.4	1st
12th	2015	DAV Cent. Public School Una (HP)	CBSE	81.4%	1st
B.V.Sc. & A.H.	2022	DGCN COVAS, CSKHPKV, Palampur (HP)	CSK HPKV	7.23	1st
M.V.Sc.	2024	DGCN COVAS, CSKHPKV, Palampur (HP)	CSK HPKV	8.16	1st