EVALUATION OF TOGGLE PINNING TECHNIQUE FOR SURGICAL MANAGEMENT OF COXOFEMORAL DISLOCATION IN DOG

THESIS

Submitted
In partial fulfillment of requirements for the Degree of

MASTER OF VETERINARY SCIENCE
IN
VETERINARY SURGERY & RADIOLOGY
BY

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Enrolment No: V/17/197

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2025

DECLARATION OF STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled **"EVALUATION OF TOGGLE PINNING TECHNIQUE FOR SURGICAL MANAGEMENT OF COXOFEMORAL DISLOCATION IN DOG"** or part thereof has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis or publications of any University or scientific organization. The sources of materials used and all assistance received during the course of investigation have been duly acknowledged.

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Ms. MEHENDALE SHRUTI VIDYESH has satisfactorily prosecuted her course of research for a period of not less than one semester and that the thesis entitled, **“EVALUATION OF TOGGLE PINNING TECHNIQUE FOR SURGICAL MANAGEMENT OF COXOFEMORAL DISLOCATION IN DOG”** submitted by her is the result of research work is sufficient to warrant its presentation to the examination in the subject of **VETERINARY SURGERY & RADIOLOGY** for the award of **MASTER OF VETERINARY SCIENCE** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

We also certify that the thesis or part thereof has not been previously submitted by her for a degree of any other University.

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Dedicated to

My Family….

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Dr Shruti V. Mehendale

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ABBREVIATIONS

%	Per cent (percentage)
@	At the rate
<	Less than
>	Greater than
±	Plus or minus
µL	Micro litre
°F	Degree Fahrenheit
ACL	Anterior cruciate ligament
ALP	Alkaline phosphatase
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
ANOVA	Analysis of variance
BWT	Body weight
Ca	Calcium
CBC	Complete blood count
CCL	Cranial cruciate ligament
CF	Coxofemoral
CK	Creatine kinase
cm	Centimetres
CRI	Constant rate infusion
DJD	Degenerative joint disease
dL	Decilitre(s)
DLC	Differential leucocyte count
et *al*	and others (et alia)
FHO	Femoral head ostectomy
g/L	Gram per Litre
Hb	Haemoglobin
hr	Hour(s)
IM	Intramuscular
Inj.	Injection

IU	International unit(s)
K-D	Ketamine-Diazepam
Kg	Kilo gram
K-P	Ketamine-Propofol
kVp	Kilovoltage peak
L	Litre(s)
mAs	Milliampere seconds
mEq/L	Milliequivalents per litre
Mg	Milligram(s)
Min.	Minute(s)
ml	Millilitre
ND	Non-descript
No.	Number(s)
NS	Non- significant
NSAID	Non-steroidal anti-inflammatory drugs
P	Phosphorus
PCV	Packed cell volume
RBCs	Red blood cell(s)
RR	Respiration rate
RT	Rectal temperature
RTA	Road traffic accident
SC	Subcutaneous
SE	Standard error
TEC	Total erythrocyte count
TLC	Total leucocyte count
UHMWPE	Ultra-high molecular weight polyethylene
VCC	Veterinary clinical complex
WBCs	White blood cell(s)

Introduction

CHAPTER I

INTRODUCTION

Canine lameness is a common orthopaedic problem encountered in veterinary practice. Fractures, joint luxations, infections (osteomyelitis), tumours (osteosarcoma), nutrient deficiency and metabolic diseases are some of the conditions causing lameness in dogs.

A joint comprises of two or more bones articulating together and stabilized by a thick layer of fibrous capsule. In most joints, apart from this fibrous joint capsule, additional ligaments connected between the bones provide further stabilization and allow the joint mobility within the normal range. Trauma to the joint may damage these structures to a varying extent (Aithal *et al*., 2023).

A joint luxation or joint dislocation is described as the complete separation of bony ends that articulate to form the joint and is usually the result of severe trauma to the joint's supporting structures. In the coxofemoral joint, the joint capsule, the round ligament of the femoral head, and the dorsal rim of the acetabulum are the primary stabilising structures. Damage to two or more of these structures results in luxation of the joint (Aithal *et al*., 2023).

Among joint dislocations of the extremities in small animals, the coxofemoral joint luxations have been found to be the most common, followed by dislocation of the carpal, tarsal, elbow and shoulder joint (Kriegsheim, 2005). Coxofemoral luxations amount to almost 90% of all joint luxations in dogs (McLaughlin, 1995; Venzin and Montavon, 2007; Çetinkaya and Olcay, 2010).

Most coxofemoral luxations are traumatic in origin, which includes high magnitude trauma, such as automobile accident and low magnitude injury such as those occurring while running or playing. Vehicular trauma accounts for 59% to 83% of all coxofemoral luxations in dogs and cats (Bone *et al*., 1984; Harasen, 2005; Jha *et al*., 2012 and Mathews and Barnhart, 2020). In certain breeds like Labrador Retrievers and German shepherds, luxation may occur secondary to hip dysplasia. Rarely, spontaneous hip luxation, without trauma and in the absence of hip dysplasia, has also been observed.

Craniodorsal coxofemoral luxation is the most common type of hip luxation and this may be because of the force applied on the greater trochanter by the gluteal and iliopsoas muscles (Harasen, 2005; and Venzin and Montavon, 2007). Studies have found that in 78% of total affected dogs and 73% of cats, coxofemoral luxation was craniodorsal while caudoventral coxofemoral luxations were relatively rare and accounted for only 1.5% and 3.2% in dogs and cats, respectively (Fry, 1974; Bone *et al*., 1984; Piermattei *et al*., 2016).

Diagnosis of coxofemoral luxations is based on clinical signs and radiographs. In craniodorsal luxation, the limb is extended caudally and shows shortening as compared to the opposite limb. The limb is adducted with outward rotation of the stifle and inward rotation of the hock. On palpation, there is pain on manipulation or rotation of the hip, the greater trochanter is elevated compared with the normal side and the space between it and the tuber ischii is increased (Piermattei *et al*., 2016). Signs of caudoventral luxation include inability to bear weight on the affected limb and pain on palpation and manipulation of the hip joint. There is lengthening of the affected hind limb and the greater trochanter is difficult to palpate (Piermattei *et al*., 2016).

Conservative treatment without reduction has been attempted in cats wherein pseudoarthrosis develops between the dislocated femoral head and the caudal ilium and allows limited, pain-free movement of the hip. However, if weight bearing is not initiated within 4 to 5 days of the injury, joint reduction and stabilization is essential.

In contrast, in all dogs with coxofemoral luxation, reduction and stabilization of the joint are necessary, regardless of how much time has passed since the injury (Wardlaw and McLaughlin, 2018).

Numerous methods have been employed to stabilize the coxofemoral luxation in dogs and cats, which include open reduction and closed reduction. When there are no complicating factors, most simple luxations respond to external manipulation and closed reduction.

The most common complication after hip luxation repair is its recurrence.

Reluxation following closed reduction has been observed in cases complicated with severe surrounding tissue trauma, avulsion fractures of the ligament of the head of the femur or moderate to severe hip dysplasia.

In all luxations, a portion of the joint capsule and the round ligament of femoral head are torn. In more severe cases, one or more of the gluteal muscles may be partially or completely torn. Damage to the articular cartilage of the femoral head or acetabulum may be present. This makes closed reduction difficult and it has been found that closed reduction has a reported 47–65% failure rate for single attempts (Evers *et al*., 1997).

Comparatively, the success rate after open reduction and stabilization is significantly greater (≈85%) (Wardlaw and McLaughlin, 2018).

Open reduction of coxofemoral luxations enables direct access to the joint, allowing for the removal of any haematoma and soft tissue trapped within the acetabulum, as well as the application of internal stabilizers to secure the joint (Wardlaw and McLaughlin, 2018).

Surgical methods of coxofemoral luxation repair include capsulorrhaphy, trochanteric transposition, sacrotuberous ligament transposition, transarticular pinning, ischioilial pinning, deep gluteal muscle tenodesis, triple pelvic osteotomy and external skeletal fixation (Ash *et al.,* 2012).

Ischioilial pinning presents complications such as sciatic nerve injury, pin migration, reluxation, injury to the femoral head and development of draining sinus tracts. Potential complications of the extracapsular suture stabilization technique include damage to the articular cartilage by the suture, reluxation through the web and infection. Complications observed with the use of the flexible external fixator include drainage from the pin tracts, disruption of the bands and joint reluxation (Harasen 2005; Moores, 2006).

Toggle fixation for coxofemoral luxation was first described by Knowles *et al*. (1953) and involves replacement of the round ligament of femoral head with fascia or braided nylon, stainless steel wire, heavy plastic suture or skin, according to various modifications made over time (Denny and Butterworth, 2000). Recently, toggle pin implies to the use of material like titanium endobutton and polypropylene button while the suture material includes polyester and ultrahigh molecular weight polyethylene and their modifications such as fiber-tape and fiber-wire, which consist of braided polyester with a multifilamentous ultrahigh molecular weight polyethylene core. The anchorage provided by the synthetic suture material in the place of the torn round ligament essentially substitutes the ligament and further stabilises the coxofemoral joint (Ash *et al.*, 2012, Fossum, 2013; Karsli *et al*., 2022).

This technique may work well in cases of luxations presented with simultaneous multiple limb injuries, chronic luxations, mild hip dysplasia, etc. and allow early use of the limb after surgery, which is advantageous when injury to the opposite hindlimb or forelimbs is present (Wardlaw and McLaughlin,2018).

Monitoring parameters such as the period required for return of limb function after surgery, development of osteoarthritic changes in the joint, muscle atrophy and occurrence of reluxation can help evaluate the efficacy of an open reduction technique used for coxofemoral repair.

The current study was undertaken with an objective to evaluate the efficacy of toggle-pinning with respect to stabilization of the hip joint in dog.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The literature is summarized under the following headings:

2.1 Anatomy of hip joint
2.2 Incidence of coxofemoral luxation
2.3 Aetiology of coxofemoral luxation
2.4 Diagnosis of coxofemoral luxation
2.5 Classification of coxofemoral luxation
2.6 Anaesthesia
2.7 Surgical procedure
2.8 Implants
2.9 Post-operative care and evaluation
2.10 Complications

2.1: Anatomy of hip joint

The hip is a diarthrodial joint allowing a wide range of motion in extension and flexion and also abduction and adduction. The inherent stability of the 'ball-and-socket' configuration is augmented by the teres ligament (passing from the acetabular fossa to the fovea on the femoral head), the transacetabular ligament (on the ventral aspect of the joint), the joint capsule and the musculature originating on the pelvis and inserting on the femur **(Denny and Butterworth, 2000).**

The three major stabilizers of the coxofemoral joint are the ligament of the femoral head, the joint capsule and the dorsal acetabular rim. Functional loss of two or more of the major stabilizers results in luxation **(Slatter, 2003).**

2.2: Incidence of coxofemoral luxation

Bone *et al*. (1984) studied traumatic hip luxation in 171 dogs and found road traffic accident to be the most common cause (83%), followed by fall from height (8.3%), dog fights (4.5%), human inflicted trauma (2.3%) and catching of limb in fences (2.3%). They recorded the mean age of the patients to be around 4.4 years and only 14 (8.8%) dogs were less than 1 year of age. Mixed breed dogs with hip luxations represented 32.7% of the hip luxation cases.

Basher *et al*. (1986) observed that incidence was higher in adult animals and dogs below one year of age accounted for only 8.33% of the total number. 36% of the dogs affected were of mixed breed, followed by miniature Poodle (10.7%), Doberman Pinscher, German shepherd, and Labrador Retriever (each 6.0%). Incidence was higher in males than in females, with 56% of the dogs being intact males and 2.4% were neutered males. Automobile accident accounted for at least 5% of luxations, while 21.05% cases were of lesser intensity traumas of miscellaneous origin.

Martini *et al*. (2001) studied coxofemoral luxation in 14 dogs and observed the average age to be six years (range, 1 to 10 years).

Harasen (2005) stated that coxofemoral luxation is primarily an injury of skeletally mature animals. He further stated that before 9 to 10 months of age, a similiar trauma is more likely to produce a capital physeal fracture as the capital physis is yet to close.

Demko *et al*. (2006) studied use of toggle rod for hip joint luxation in 62 cases and found that the mean age of the affected dogs was 5.3 ± 3.4 years. Incidence was highest in mixed-breed dogs, followed by Labrador Retrievers, German shepherd dogs and Cocker Spaniels. 31% dogs were intact males, 34% were castrated males, 14% were intact females and 21% were spayed females.

Arun Prasad *et al*. (2012) recorded the incidence of coxofemoral joint affections in 575 dogs of different breed, age and sex during the period from 2007 to 2010. Amongst that, hip dysplasia accounted for 54%, osteoarthritis 28%

and fracture luxation 18%. Out of 106 cases, the incidence of luxation was highest in crossbred dogs (33%, 36), followed by Labrador retriever (23%, 24), Spitz (19%, 20) German shepherd (5%, 5), while Great Dane, Rottweiler, Doberman, Boxer, Pug, Dalmatian, bull dog and Cocker spaniel breeds contributed less than two per cent each. The age wise incidence at less than one year of age was 51% (54), 1 to 4 years of age 22% (23) and above four years of age 27% (29).

Kieves *et al*. (2014) studied stabilization of coxofemoral luxation by toggle pinning and recorded the mean age of dogs as 5.9 years.

Smitha (2014) recorded incidence of coxofemoral luxation to be most frequent in Labrador Retriever (44.44%), followed by German Shepherd (22.22%), and then equally in non-descript dogs, Beagle, and Rottweiler (each 11.11%). The author noted that dogs were between 6 and 8 years were most frequently affected (55.55%), followed by 2 to 4 years of age (22.2%), within 1 year of age (11.11%) and 13 years age and above (11.11%).

Singh *et al*. (2017) observed joint dislocations in 10 dogs. Out of these, coxo-femoral dislocation was observed in 7 cases (70%), lumbar dislocation in 2 cases (20%) and scapulo-humeral in 1 case (10%). In coxo-femoral dislocation (n=7), cranio-dorsal coxo-femoral luxation was observed in 71.43% (n= 5) and caudo-dorsal in 28.57% (n=2). Occurrence of coxo-femoral dislocation (cranio-dorsal dislocation) was higher than other dislocations.

Schlag *et al*. (2019) recorded hip dislocation in 92 dogs, 47 dogs were female and 44 were male. Sex was not recorded for 1 dog. Mixed-breed dogs were most commonly represented (n=15) followed by Labrador Retrievers (n=11), Yorkshire Terriers (7), German shepherd dogs (6), and Pomeranians (6). Median body weight was 18.1 kg. 12 dogs showed evidence of pre-existing coxofemoral abnormalities on pelvic radiographs, which included hip dysplasia (n=11) and a hip implant (1). 28 of 92 dogs were found to have polytrauma, 5 dogs had chip fractures of the acetabulum or femoral head of the luxated joint, 8 dogs had fractures involving the weight-bearing axis elsewhere in the pelvis and 5 dogs had a fracture along the pelvic weight-bearing axis on the side contralateral to the luxation.

De Los Santos *et al.* (2021) documented the mean age of dogs with coxofemoral luxation to be 3.54 years. While the average body weight was 10.59 kg. Mixed breed dogs were most presented and the odds of Pomeranians and Poodles being affected with coxofemoral luxation are 4.35 and 5.56 times, respectively. Unilateral craniodorsal luxation was the most prevalent type at 38.64%.

Patwa *et al*., (2024) studied 12 cases of hip dislocation and recorded the age, breed and body weight of each case. There were 6 male (50%) and 6 females (50%). Average age was 32.42 months and the average body weight was 26.25 kg. More number of hip dislocations were found in mix breed dogs (n=07), followed by Spitz (n=02) while one case each was recorded in German shepherd, Golden Retriever and Labrador.

2.3: Aetiology of coxofemoral luxation

Breure (1961) saw that in working dogs, sudden excessive tension on the hind leg, such as being caught in a fence when jumping, may cause hip dislocation. Another cause, seen in a large number of cases, was severe pressure on the limb, such as in a glancing blow from a fast-moving vehicle.

Seer and Hurov (1968) noted that dogs suffering from hip dysplasia were predisposed to hip dislocation.

Bone *et al*. (1984) found road traffic accident to be the most common cause (83%), followed by fall from height (8.3%), dog fights (4.5%), human inflicted trauma (2.3%) and catching of limb in fences (2.3%).

Basher *et al*. (1986) observed that 59% cases were struck by automobile accident, fall from height and falling over a short distance accounted for 3.15% each, dog fights, leg grabbing while jumping and playing with other dogs accounted for 2.1% each, twisting of leg while running, slipping on ice, mating and gunshot wounds each accounted for 1.05% while 21.5% were unknown.

Slocum and Devine (1990) found that severe hip dysplasia or Legg-Calve-Perth's disease resulted in hip luxation in dogs.

Kilic *et al*. (2002) studied coxofemoral luxation in 10 dogs. The authors found that out of 10 dogs, six were males and four were females. In seven dogs, road traffic accident was the cause while, in the remaining three animals, luxation was due to other traumatic causes like jumping, human inflicted trauma, etc.

Harasen (2005) observed that 59% to 83% of coxofemoral luxations are caused by vehicular trauma and at least half produce other major injuries as well.

Jha and Kowaleski, (2012) found 60% of coxofemoral luxations to be due to motor vehicle accidents.

Beteg (2018) observed that 85% cases of coxofemoral luxations were caused by vehicular trauma while severe hip dysplasia, spontaneous hip luxation and trauma of unknown origin were among the other, less common causes.

Schlag *et al*. (2019) found vehicular trauma (n = 46), jump or fall (n=21), owner-induced injury (n=4), dog fight injury (n=2), and leash injury (n=1) to be the most common causes of as of hip dislocation.

Mathews and Barnhart (2020) reported vehicular trauma to be the most common cause of coxofemoral luxations in dogs and accounting for 79%–83% of all luxation cases. Known high-impact traumatic events were the most common cause of hip luxation and occurred in 93 (72.7%) dogs, out of these, the most common was vehicular trauma in 75 (58.6%). For 12 (9.4%) dogs, unobserved vehicular trauma was suspected based on the presence of polytrauma. Other traumatic events occurred in 19 (14.8%) dogs, including being hit by a falling tree, hit by a falling gate, and an altercation with a cow. Known non-traumatic or low-impact events, including a small fall or jump, a misstep on a stair, slipping while running, altercation with another dog, or handling at a grooming facility, resulted in luxation in 20 (15.6%) dogs. The underlying etiology of luxation was unknown for 14 (10.9%) dogs.

2.4: Diagnosis of coxofemoral luxation

Basher *et al*. (1986) stated that the diagnosis of coxofemoral luxation is made by physical examination and is further confirmed using lateral and ventrodorsal pelvic radiographs. The researcher also stated that an accurate description of the direction of luxation is only possible with both a ventrodorsal and a lateral radiographic view of the pelvis. The authors suggested that the presence of an avulsion fragment in the acetabulum, signs of hip dysplasia or DJD, and concomitant femoral or pelvic fractures are the important points to note on radiographs.

Fossum *et al*. (2013) stated that diagnosis of hip luxation should be confirmed with ventrodorsal and lateral radiographs. Detection of lesions like dyplastic joint, concurrent pelvic or femoral fractures, avulsion of the fovea capitis in radiographs also influence the method of fixation to be selected.

According to **Denny and Butterworth (2000)**, lateral and ventrodorsal radiographs of the pelvis must be taken to determine the direction of luxation and also to detect any complicating fractures of the acetabulum, iliac shaft and greater trochanter or separation of the sacroiliac joint.

2.5: Classification of coxofemoral luxation

Fry (1974) studied coxofemoral luxation in 19 dogs and found that 94.7% dogs had a craniodorsal coxofemoral luxation while caudoventral luxation was seen in 5.3% of cases.

Based on a study by **Bone *et al*. (1984),** craniodorsal hip luxation was seen in 95.5% of cases, 3.4% cases were of cranioventral luxation, 0.6% were in caudoventral direction and 0.6% in caudodorsal direction.

McLaughlin (1995) noted that approximately 75% of coxofemoral luxations were in craniodorsal direction and opined that most hip luxations were craniodorsal owing to the force applied on the greater trochanter by the gluteal muscles.

Denny and Butterworth (2000) stated that the femoral head luxated in a craniodorsal direction in 85-90% of cases.

Haburjak *et al*. (2001) studied traumatic coxofemoral luxation in 19 dogs and recorded the position of femur head with respect to the acetabulum. The researchers found that the direction of luxation was most frequently (80-95%) in the dorsal or craniodorsal.

Harasen (2005) stated that craniodorsal luxations accounted for 73% to 90% of hip dislocations in dogs and were caused by the strong pull of the gluteal muscles on the greater trochanter of the femur.

Venzin *et al*. (2007) found that craniodorsal luxation of the femoral head occurs in 95.6% of cases. The authors suggested the likely cause to be the traction from the gluteal and iliopsoas muscles on the femur.

Mathews and Barnhart (2020) reported in their study that out of 128 cases, coxofemoral luxations were craniodorsal in 125 (97.7%) and caudoventral in three (2.3%) dogs.

Karsli *et al*. (2022) studied coxofemoral luxation in 11 dogs and all these patients showed craniodorsal luxation. The researchers stated the reason to be the trauma-induced forces and the gravitational traction created by the gluteal and iliopsoas muscles on the greater trochanter. They further stated that cranioventral, caudodorsal, and caudoventral luxations are rare and may be seen when avulsion fracture of the trochanter major occurs in addition to the luxation.

2.6: Anaesthesia

Raghavan *et al*. (1979) studied the influence of xylazine as a pre-anaesthetic drug in different dosage levels. At 1mg per kg body weight (b.w.t), it produced a considerable increase in the anaesthetic period.

Watkins *et al*. (1987) studied intravenous formulation of anaesthetic propofol in dogs and showed that induction of anaesthesia was smooth and it was possible to maintain anaesthesia by intermittent injection. The mean dose for induction of anaesthesia in unpremedicated dogs was 5.95 mg/kg body-weight and maintained by a total dose of approximately 0.806 mg/kg/minute. They also premedicated dogs with between 0.02 and 0.04 mg/kg body weight of acepromazine and it reduced the mean induction dose by about 30 per cent and the maintenance dose by more than 50 per cent. They concluded that 68 unpremedicated dogs given one dose, recovery was complete in a mean time of 18 minutes and after maintenance of anaesthesia by intermittent injection in 65 dogs the mean recovery time was 22 minutes from administration of the last dose.

Fieni *et al*. (1990) produced good quality of anaesthesia lasting for an hour in 35 dogs with repeated infusion of propofol 4 mg/kg body weight following premedication with atropine and acepromazine.

Rosin *et al.* (1993) demonstrated that antimicrobial should be given intravenously, at least 30 minutes prior to the surgical incision (but not later than 60 minutes) to achieve adequate tissue concentration at the time of surgery and that there is no effect if the antimicrobials are administered after the contamination has begun. Their recommendation was based on evidence that peak serum and surgical wound fluid concentrations take approximately 30 minutes to equilibrate and subsequently declines rapidly.

Paddleford (1996) observed that, analgesics are most effective when administered prior to the onset of pain as surgery or any noxious insult alters how the nervous system processes and responds to stimuli and accordingly, it affects the nervous system at end central levels. Peripherally, nociceptor afferent fibers display reduced threshold for stimulation.

Thurmon *et al*. (1996) stated that atropine was an anticholinergic (parasympatholytic) drug frequently used to reduce the secretion in the respiratory tract and salivary glands and also to inhibit the vagal stimulation of the cardiovascular and respiratory system.

Hellebrekers *et al*. (1998) compared the effect of propofol with ketamine in dogs premedicated with medetomidine and was observed in 89 % of dogs in the propofol group showed smooth recovery while in the ketamine group 63 % of dogs showed smooth recovery.

Bayan (2000) used propofol in dogs as the sole anaesthetic agent at the dose rate of 5.5 mg/kg body weight and observed that, use of propofol at this dose rate in unpremedicated dogs gave quick and smooth induction of general anaesthesia. Pharyngeal, laryngeal, palpebral and pedal reflexes were abolished. Adequate analgesia and muscle relaxation was observed. Rapid, complete and uneventful recovery was seen. There was no significant fall in body temperature.

Sooryadas *et al*. (2001) studied the use of propofol as an anaesthetic agent under atropine-xylazine premedication in both healthy and compromised dogs. After 15 minutes of preanaesthetic administration, propofol was administered intravenously @ 5mg/kg body weight for induction of anaesthesia. Maintenance of anaesthesia was done at the dose rate of 2.5 mg/kg body weight with propofol injected as an intermittent bolus.

Stegmann and Bester (2001) studied the clinical effects of midazolam premedication in propofol induced and isoflurane maintained anaesthesia in 8 dogs during ovariohysterectomy. In this study, anaesthesia was induced with propofol (4 mg/kg) after intravenous premedication with or without midazolam

(0.1 mg/kg). Midazolam administration induced acute behavioural changes, and increased reflex suppression after propofol induction. Compared to the control group, the dose required to obtain loss of the pedal reflex was significantly reduced by 37% and the end-tidal isoflurane concentration during maintenance, reduced by 23%.

Kulkarni *et al.* (2006) reported rapid and smooth induction of anaesthesia with propofol in dogs and found that anaesthesia could be safely for maintained by continuous infusion technique using propofol in these patients.

Muir *et al.* (2007) reported that atropine sulphate can be given at a dose rate of 0.02 to 0.04 mg/kg body weight in dog. Atropine sulphate (20 to 40 μg/kg body weight) or glycopyrrolate (10 μg/kg body weight) increased heart rate and dried secretions in small animals. The duration of action of atropine sulphate was 60 to 90 minutes.

Kinjavdekar *et al*. (2010) used medetomidine-butorphanol-propofol anaesthesia in dogs undergoing orthopaedic surgery and reported slight increase in creatinine level at the early stage of anaesthesia and which returned to base level at the end of the experiment.

Nesgash *et al*. (2016) evaluated the use of xylazine-ketamine combination with and without diazepam as general anaesthesia for ovariohysterectomy in bitches and stated that atropine-xylazine-ketamine-diazepam combination is useful anaesthetic protocol for excellent induction, adequate muscle relaxation, satisfactory duration of anaesthesia and smooth recovery for OHE in bitches.

Kelawala and Parsania (1997) used propofol in dogs and produced good anaesthesia along with smooth induction and good quality muscle relaxation when administered @ 3.5 mg/kg body weight i.v. in dogs premedicated with chlorpromazine hydrochloride @ 0.75 mg/kg body weight i.v.

Kushwaha *et al.* (2012) achieved general anaesthesia in dogs by using combination of midazolam and propofol and maintenance of anaesthesia by injecting incremental dose of same drugs and observed moderate to excellent muscle relaxation and analgesia, recovery was smooth and rapid.

Saikia (2016) administered atropine sulphate @ 0.04 mg/kg body wt. i.m. and xylazine HCl @ 0.5 mg/kg body wt. i.m. route as premedicants followed by administration of propfol @ 5 mg/kg body weight intravenously after 15 minutes for induction of general anaesthesia. The author found that induction with propofol was rapid, recovery was smooth and rapid, maintenance of anaesthesia was smooth and stable with good muscle relaxation but analgesia was poor and a brief period of apnoea was observed at the time of induction.

Garnier *et al*. (2023) studied surgical fixation of coxofemoral luxation in dogs. For their surgeries, they induced anaesthesia with midazolam at 0.2 mg/kg body weight and propofol at 2 to 4 mg/kg body weight intravenously.

2.7: Surgical procedure

2.7.1: Approach to the coxofemoral joint

Denny and Butterworth (2000) described a craniolateral approach to expose the joint. A skin incision is made just cranial to the greater trochanter if the hip has been reduced, or over it if not, extending halfway down the femur. The fascia lata is incised close to its attachment to the biceps femoris and the incision is extended proximally through the gluteal fascia. The middle gluteal muscle is elevated to expose the tendon of insertion of the deep gluteal muscle and the cranial half of this is incised. Dorsal retraction of the gluteals and caudal retraction of the vastus lateralis exposes the torn joint capsule and femoral head. The acetabulum is located ventrally and is most easily exposed by caudal retraction of the proximal femur.

Piermattei and Johnson (2004) stated that the hip joint is approached by taking a skin incision over the cranial border of the femoral shaft, centered at the level of the greater trochanter. It extends distally to cover one-third to one-half of the femur’s length, while proximally, it curves slightly cranially, stopping just short of the dorsal midline. Next, the superficial layer of the fascia lata is incised along the cranial border of the biceps femoris muscle. The biceps femoris is retracted caudally to allow further incision through the deep layer of the fascia lata, freeing the insertion of the tensor fasciae latae muscle. The incision is then extended proximally through the intermuscular septum between the cranial border of the superficial gluteal muscle and the tensor fasciae latae muscle. The fascia lata and attached tensor fasciae latae are retracted cranially, while the biceps femoris is pulled caudally. Using blunt dissection, a triangular space is separated along the femoral neck. This space is bordered dorsally by the middle and deep gluteal muscles, laterally by the vastus lateralis muscle, and medially by the rectus femoris muscle. The joint capsule is initially covered by areolar tissue, which must be cleared away using blunt dissection. An incision is then made in the joint capsule and extended laterally along the femoral neck, cutting through the origin of the vastus lateralis muscle on both the neck and lesser trochanter. To enhance exposure, a portion of the deep gluteal tendon can be carefully severed near the trochanter, ensuring that enough tendon remains attached to the bone for later suturing. The muscle is then split proximally, following the direction of its fibers, and the pedicle is allowed to retract naturally.

According to **Fossum (2013)**, the patient is positioned in lateral recumbency with the affected limb upwards. A craniolateral skin incision centered over the hip joint is taken. The biceps femoris muscle is retracted caudally and the tensor fasciae latae muscle cranially. The vastus lateralis muscle is incised and reflected ventrally. The joint capsule is incised to reach the femoral head.

2.7.2: Preparation of surgical site

Brown *et al.* (1997) determined post-operative wound infection rates in dogs and cats for various wound contamination categories and to identify factors that influence postoperative wound infection rates. Total population size studied was 1,574 wounds in 1,255 dogs and cats. Postoperative infection was evident in 86 of 1,574 (5.5%) wounds, including 54 of 1,146 (4.7%) and 13 of 259 (5.0%)

animals with clean and clean-contaminated wounds, respectively and 12 of 100 (12.0%) and 7 of 69 (10.1%) animals with contaminated and dirty wounds, respectively. Animals with clean wounds that received antibiotics other than as prescribed in preoperative protocol followed in the experiment had a higher infection rate than animals that did not receive antibiotics. Surgical sites clipped before anaesthetic induction were 3 times more likely to become infected than sites clipped after induction. Risk of wound infection increased with increasing duration of surgery. Wound contamination categories had too much variation to make them useful for predicting animals that would develop wound infections. Surgical sites should be clipped immediately prior to surgery, and intraoperative time should be kept to a minimum. Unless indicated for other current active infection, prolonged use of antibiotics after surgery should be avoided in animals with clean wounds.

2.7.3: Surgical Procedure

Karsli *et al*. (2022) performed a craniolateral approach involving external rotation and adduction of the extremity in reaching the hip joint. The acetabulum was cleared of debris, hematoma, fibrin, granulation tissues, and the remnants of the detached ligament capitis ossis femoris. Then a hole was drilled in the acetabular fossa with a 2.7 mm or 3.5 mm diameter drill depending on the size of the animals, and the toggle pin was pushed through the created hole into the canalis pelvis. Thus, when the thread was pulled back, the toggle pin rested against the medial wall of the acetabulum. Guidewire was used to tunnel from the fovea capitis to the third trochanter, and a 2.0 mm or 2.7 mm diameter drill was used depending on the animal's size. Under the guidance of a 0.80 mm Kirschner wire, the suture material attached to the toggle pin was fed through the tunnel. After joint reduction, a button made of Kirschner wire was used to secure the end of the monofilament nylon to the proximal lateral surface of the femur at the level of the third trochanter.

Aithal *et al*. (2023) stated that in the 'toggle' technique for coxofemoral luxation repair, a standard craniolateral approach is used to expose the joint and a hole is drilled in the acetabular wall at the site of attachment of the round ligament while a bone tunnel is drilled through the femoral neck from the subtrochanteric region of the lateral femur to the point of the fovea capitis of the femoral head. A strong suture material or an orthopaedic wire attached to a toggle pin is first threaded through the acetabular hole and tensioned to pull the toggle pin against the medial wall of the acetabulum tightly. The suture is then pulled or pushed through the femur bone tunnel to exit the lateral femur and tensioned while the femur head is replaced into the acetabulum. After verifying that the femur head is firmly seated in the acetabular socket, the suture ends are tied to a toggle pin on the femoral surface. Subsequently, the torn joint capsule is sutured as much as possible.

2.8: Implants

Flynn *et al*. (1994) found that conventional toggle pins made by twisting a Kirschner wire (K-wire) failed due to breaking of the K-wire at the eye. This mechanical study also showed that braided polyester suture materials have longer fatigue life in cyclic testing and are significantly stiffer and resistant to elongation compared to monofilament sutures.

Barrett *et al.* (1995) studied the surgical technique of endobutton fixation for anterior cruciate ligament (ACL) reconstruction and stated that it is adaptable to be used with a variety of graft materials and showed promise in ligament reconstruction procedures.

Ahmad *et al*. (2004) compared fixation devices for anterior cruciate ligament reconstruction, including interference screw, Endobutton, Rigidfix cross-pin, and Bio-Transfix cross-pin methods and found endobutton to be more superior as a suture anchor than the other devices.

Benjamin *et al*. (2004) state that in human anterior cruciate ligament (ACL) tears, EndoButton screw-post fixation has been a reliable fixation for quadruple hamstring graft for ACL reconstruction

Fitzpatrick (2008) stated that Fiberwire, which is a braided combination of ultrahigh molecular weight polyethylene (UHMWPE) and a polyester material, with a UHMWPE multifilament core has become popular for ligament repair in animals. The researchers found that this suture material shows adequate mechanical strength to prevent premature breakage before the supporting peri-articular structures are adequately recovered.

Burgess *et al*. (2010) conducted an in-vitro study to compare the mechanical strength of sutures used in ligament repair and noted that multifilament polyethylene sutures were stronger and stiffer than monofilament sutures

Çetinkaya and Olcay (2010) used a toggle pin formed from Kirschner wire with a central wire loop for suture attachment and two wings to allow the pin to anchor on the medial aspect of the acetabulum.

Jha and Kowaleski (2012) studied the use of original Piermattei toggle fashioned from a 3/32" Steinmann pin, modified Piermattei toggle made from 0.045" Kirschner wire and commercially available 1/8" Securos toggle rod for stabilization of coxofemoral luxations.

Ash *et al*. (2012) implemented commercially manufactured toggles, including metal rods and polypropylene buttons for coxofemoral repair. The researchers used FiberWire which is a multi-stranded, long-chain, ultra-high molecular weight polyethylene core with a polyester braided jacket and found that this suture material proved favourable in terms of stiffness and load to failure.

Azeez *et al*. (2018) compared the use of titanium interference screws and endobuttons for repair of anterior cruciate ligament tears in humans and found that endobuttons provided better stability.

Titanium endobuttons have been used for ACL reconstruction, repair of clavicular fractures and acromioclavicular joint in humans **(Struhl *et al*., 2016; Plaweski *et al*., 2009).**

Titanium endobuttons have been used for CCL reconstruction in ovine and porcine models **(Field *et al*., 2001).**

2.9: Post operative care and evaluation

2.9.1: Post operative coaptation

Denny and Butterworth (2000) stated that an Ehmer sling should be applied for 5 days and exercise restricted for 1 month.

Özaydin *et al*. (2003) stated that they avoided bandaging the hip because a bandage such as an Ehmer sling may increase risk of separation of the ligament from the bone because of tension associated with limb flexion. This approach may also have decreased the severity of muscle atrophy in their study.

Hõim *et al*. (2003) reported that they used no external support postoperatively and exercise was restricted for 2–4 weeks.

Moores (2006) recommended that postoperative sling support is not required as long as the patient's activity is suitably restricted.

Çetinkaya and Olcay (2010) stated that bandage was not applied in either animal in their study, and exercise was restricted to cage rest for 10 days.

Fossum (2013) stated that patients may be placed in an Ehmer bandage to assist hip reduction in the early postoperative period. The bandage is removed 4 to 7 days after reduction.

According to **Piermattei *et al*. (2016)**, following all CF reduction techniques, the limb is usually supported in an Ehmer sling for 10 to 14 days unless otherwise noted.

Mathews and Barnhart (2020) stated that no external coaptation was placed postoperatively in any dog for the coxofemoral luxation. All dogs were allowed to bear weight on the limb after surgery and 6 weeks of restricted activity was ensured.

2.9.2: Clinical Evaluation

Lawson *et al.* (1965) performed toggle pinning for recurrent hip luxation in dog and in their study, they did not apply external support to the hip. The researchers permitted normal walking exercise immediately after surgery and found that limb function is completely recovered within a period of three days of operation.

Beckham *et al*. (1996) performed thorough clinical evaluation including pain, crepitation, joint laxity and lameness and recorded the average period required for weight-bearing was 3 days post-surgery. On comparing the limb circumference of the operated limb and the contralateral limb, no significant difference was present.

Hoim *et al*. (2003) stated that during the follow-up period early return of function in the affected limb and a quick return to normal gait was observed. Reluxation did not occur and no complications associated with the surgical technique were encountered.

Demko *et al*. (2006) recorded that out of 51 dogs operated, 33 (65%) were toe touching or bearing weight 24 hours after surgery, and 45 (88%) were toe touching or bearing weight at the time of discharge. All dogs that were bearing weight on the affected limb 24 hours after surgery were also bearing weight on the limb at the time of discharge

Muller *et al.* (2023) used toggle pinning for repair of hip luxation in a Shetland pony and noted that the pony was bearing full weight on the left hindlimb immediately after surgery. There was no evidence of wound swelling or exudation and the skin sutures were removed 14 days after surgery. Postoperative radiographic examination confirmed that the femoral head had remained in the acetabulum and the stainless-steel implants were in place.

2.9.3: Haematological and Biochemical Evaluation

Tembhurne *et al.* (2010) reported that the hematological parameter viz Hb%, TEC, TLC, PCV, eosinophils, monocytes and basophils were within normal physiological range. There was constant and increasing trend of neutrophil and the values were not statistically significant. The rise in neutrophil percentage might be due to the response to inflammatory condition during healing of surgical wound and stress during post-operative period.

Smitha (2014) analyzed hematological and biochemical parameters and observed decreased hemoglobin, packed cell volume and total erythrocyte count and increased value of total leucocyte count, Serum ALT and AST on 1st, 3rd, and 5th postoperative day, which receded thereafter to normal by the 15th postoperative day. Serum creatinine level increased on 7th postoperative day. The variations were minimal and statistically nonsignificant.

Polat *et al*. (2021) stated that diseases that cause deformities in the skeletal system, such as hip dysplasia, cause changes in the levels of some serum enzymes (ALP and CK) and elements (Ca, P). They determined that in patients with hip dysplasia, which causes inflammatory reactions in the hip joint, serum ALP and serum CK levels are affected with oxidative stress factors. Therefore, especially in young dogs, information about the presence of hip dysplasia cases and the severity of the inflammation can be obtained by examining the levels of these oxidative stress factors and serum ALP and serum CK levels. On the other hand, this study found that serum Ca and serum P levels were not statistically significantly affected by hip dysplasia.

Budhwar *et al*. (2021) in their study on serum ALP, Ca and P in coxofemoral disorders in dogs found decreasing order of ALP values from day 0 to day 30 post-surgery. This could be due to increase in osteoblastic activity immediately after the surgery to compensate with process of bone healing initially but gradually decreasing when healing process could have completed before 30th day. Decreasing trend of calcium values could be seen by day 30. This could be due to cessation of calcium supplements 20-30 days post-surgically and the normal body compensation of calcium level during the healing process. Mild decreasing order of phosphorus on day 30 was seen. This could be in accordance to the serum calcium level of the body and compensation of the body phosphorus levels during the healing process.

Qiao *et al*. (2022) in their research on recurrent patellar luxations found that serum calcium level was an influential factor associated with postoperative knee function. The patients with poor postoperative recovery had a lower preoperative calcium value than their counterparts in the study.

2.9.4: Radiolographic Evaluation

Hoim *et al*. (2003) noted that out of 2 cases operated, 1 dog showed good hip reduction with no evidence of DJD, while 1 dog showed an osteophyte (approx. 3 mm) on radiography, at the insertion of the joint capsule cranially, which indicates moderate DJD. During the follow-up period there was no progression of DJD radiographically.

According to **Ash *et al*. (2012)** in the dogs undergoing toggle pinning, radiographic images taken both immediately postoperatively and six weeks postoperatively confirmed consistent and unchanged quality of hip reduction, toggle position and absence of periarticular osteophytosis or coxofemoral remodelling.

2.10: Complications

Karsli *et al*. (2022) recorded that out of 11 dogs operated, lameness was observed in 2 dogs, four and five days after the operation, and reluxation was detected in the radiographic examination. Caput femoris degenerations were discovered during the reoperation on these two patients, and excision arthroplasty was performed.

Mathews and Barnhart (2020) noted that potential causes of reluxation included toggle rod pulling through the acetabulum, suture breaking and wearing of the dorsal acetabular rim.

Materials & Methods

CHAPTER III

MATERIALS AND METHODS

3.1 Case selection

The current study was undertaken in cases of coxofemoral luxation at the Veterinary Clinical Complex, Krantisinh Nana Patil College of Veterinary Science, Shirwal and the District Veterinary Polyclinic, Aundh, Pune from June 2024 to February 2025. Dogs presented with hindlimb lameness were subjected to clinical and radiographic examination. Out of these, dogs with coxofemoral luxation were selected for studying the efficacy of toggle pinning for hip joint stabilization.

3.2 Signalment of selected cases

Coxofemoral luxations found appropriate for open reduction were selected for surgical repair using toggle pinning and their clinical, hemato-biochemical and radiological parameters were recorded. The signalment of selected cases is detailed in table 3.1

Table 3.1: Signalment of selected cases

Case No.	Species	Breed	Age (yr)	Sex (M/F)	Body weight (kg)
C1	Canine	Indian Spitz	4 yr	F	16
C2	Canine	Caravan Hound	2 yr	M	25
C3	Canine	Lhasa Apso	3 yr	M	15
C4	Canine	Non-descript	3 yr	M	30
C5	Canine	Indian Spitz	14 yr	M	11
C6	Canine	Golden	1 yr	F	22

		Retriever			
C7	Canine	Non-descript	1 yr	M	9
C8	Canine	Non-descript	1.5 yr	M	22

3.3 Anamnesis

For the selected cases, patient details which were recorded included age, sex, breed, chief complaint, duration of injury, history of other illnesses, etiology of the chief complaint, duration of signs and any past treatments undertaken for the chief complaint.

3.4 Clinical examination

For each case clinical, radiographic and haemato-biochemical parameters were recorded pre-operatively (i.e. day 0) and post-operatively on day 15, 30 and 60.

Intra-operative observations regarding extent of tear of the round ligament and joint capsule, damage to surrounding muscles, integrity of the bone surfaces, congruency of articulating surfaces and ease of joint reduction were noted for each case.

3.4.1 Pre-operative examination

Dogs selected for the study further underwent orthopaedic examination. Assessment included loss of function, abnormal gait, limb deformity, shortening or lengthening of affected limb, angulation changes of the limb, pain on manipulation or rotation of the hip joint. Clinical signs like swelling, infection, and indications of concomitant fractures, joint incongruence or osteoarthritis were also noted.

3.4.2 Evaluation of lameness

The degree of lameness was recorded preoperatively and at regular intervals i.e. on the day of surgery and on 15th, 30th and 60th postoperative days and scored as described by Bone *et al*. (1984). (Table 3.2)

Table 3.2: Lameness grading score (Bone *et al*., 1984)

Grade	Lameness	Radiographic interpretation
0 (normal)	Normal gait	No degenerative changes
I (mild)	Weightbearing but mild or occasional limp	Mild osteoarthrosis
II (moderate)	Intermittent weightbearing, persistent limp	Moderate osteoarthrosis
Ill (severe)	Non-weightbearing, carries limb	Severe osteoarthrosis

3.4.3 Muscle atrophy

The mid-thigh limb circumference was recorded on day 0 i.e. preoperatively, and on 15th, 30th and 60th day postoperatively to detect muscle atrophy as described by Beckham *et al*., (1996) and McCarthy *et al.*, (2018)

3.4.4 Haematological examination

5 ml of blood was drawn either from the cephalic vein or the saphenous vein and collected in the EDTA vial for estimation of hematological parameters on day 0 i.e. preoperatively, and on 15th, 30th and 60th day postoperatively, as listed below:

1. Haemoglobin (Hb) in g/dL,
2. Packed Cell Volume (PCV) in %
3. Total Erythrocyte Count (TEC) in N×10^{6} /µL,
4. Total Leukocyte Count (TLC) in N×10^{3} /mm^{3}
5. Platelets in Lacs/µL

6. Differential Leukocyte Count (DLC) in %

An automated haematological analyser (Abacus *Jr* Vet 5, Diatron, Hungary) was used for estimation of above mentioned parameters.

3.4.5 Biochemical examination

5 ml of blood was drawn either from the cephalic vein or the saphenous vein and collected in the clot activator vial. The blood was centrifuged at 3000 rpm for 10 minutes and serum was separated for estimation, which was done using a semi-automatic biochemistry analyzer (ERBA CHEM 7 model, Transasia Biomedicals, India). The standard Diagnostic kits[1] were used for estimation of the biochemical parameters mentioned below:

1. Alkaline phosphatase (IU/L)- Serum alkaline phosphatase was estimated by International Federation of Clinical Chemistry (IFCC) kinetic assay method.
2. Serum Calcium (mg/dL)
3. Serum Phosphorus (mg/dL)

3.4.6 Radiographic examination of affected limb

Multix Fusion (Siemens Healthcare Private Limited Mumbai –54 400 079, India) machine and AGFA CR system was used for radiographic examination and orthogonal views i.e., mediolateral and ventrodorsal of the pelvis were taken. The exposure parameters were set within a range of 12–18 mAs and 50–65 kVp, while the focal film distance was maintained between 90 and 100 cm.

Radiographic examination was done:

1. Preoperatively i.e., day 0 to locate the direction of luxation as well as to detect concurrent bone injuries and osteoarthritis.
2. Immediate post-operative radiographs were taken to determine the joint alignment and implant position.

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1. Meril diagnostics- Obeliss.a, Bd General Wahis 53, 1030 Brussels, Belgium.

3. Follow-up radiographs were taken on 15th, 30th and 60th day post-operatively to note the alignment of the implants and detect any signs of osteoarthritic changes, using the score described by Bone *et al*., (1984). (Table 3.2)

3.5 Preoperative preparation and anaesthesia

3.5.1 Preoperative preparation

The patient was kept on fasting for 8-12 hours and water was withdrawn upto 2-4 hours prior to surgery. Preemptive analgesic meloxicam[2] at 0.5 mg/kg body weight subcutaneously (SC), and broad-spectrum antibiotic amoxicillin-sulbactam[3] at 12.5 mg/kg body weight intravenously (IV), were administered 0.5-1 hour before the surgical procedure. The affected hip was shaved from pelvis upto the stifle joint followed by scrubbing of site with diluted betadine scrub[4] and painted with 5% betadine solution[5].

3.5.2 Premedication and Anaesthesia

The patients were premedicated with anticholinergic drug atropine sulphate[6] at 0.04 mg/kg body weight SC and xylazine hydrochloride[7] at 1 mg/kg body weight was administered intramuscularly (IM) 10 minutes later. Once in lateral recumbency, anaesthesia was induced using propofol[8] at 5 mg/kg body weight IV. Diazepam[9] was administered at 0.2 mg/kg body weight IV. Endotracheal tube of appropriate size was placed after induction of general anaesthesia intravenous Ringer's lactate drip was connected. Anaesthesia was maintained using propofol at 2.5mg/kg IV given as intermittent bolus injections.

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2 .Melonex; Intas Pharmaceutical Pvt. Ltd., Ahmadabad, India

3. Amoxirum Forte; virbac india Pvt. Ltd., Mumbai, India

4. 7.5% w/v povidine iodine cleansing solution- WIN-MEDICARE PVT. LTD, Delhi, India.

5. 5% povidone iodine- WIN-MEDICARE PVT. LTD, Delhi, India.

6. 0.6 mg/ml; Tropine; Neon Laboratories Ltd., Thane, Maharashtra, India

7. 20 mg/ml; Xylaxin; Indian Immunologicals Ltd., Hyderabad, Andhra Pradesh, India.

8. 10 mg/ml; Zyfol; Themis Medicare Limited., Haridwar, Uttarakhand, India.

9. 5 mg/ml; Lori, Neon Laboratories Maharashtra, India

3.5.3 Positioning of the animal

For all cases, the dogs were placed in lateral recumbency with the affected hip upward. The limb was covered using sterile gauze bandage from the stifle upto the distal extremity of the limb. The prepared site was re-painted with 5% povidone-iodine solution and sterile drape was placed.

3.6 Materials used

3.6.1 Orthopaedic instruments

After appropriate sterilization by autoclaving, a set of general surgical instruments and the required orthopaedic instruments were used. (Plate 3.1 and 3.2) Orthopaedic instruments included:

1. Gelpi retractors
2. Hohmann's retractors
3. Lagenbeck retractors
4. Drill bit
5. Low speed high torque electric drill machine
6. Guidewire

3.6.2 Implants

For each surgery, a sterile Fiberwire suture[10] was used and 2 titanium endobuttons[11] of dimensions 4mm x 2mm were used as suture anchors. The endobuttons were sterilized by autoclaving prior to use. (Plate 3.1)

10. Fiber Wire; Medix Orthopedic Private Limited,Vadodara, Gujrat, India

11. Endo-Button Medix Orthopedic Private Limited,Vadodara, Gujrat, India

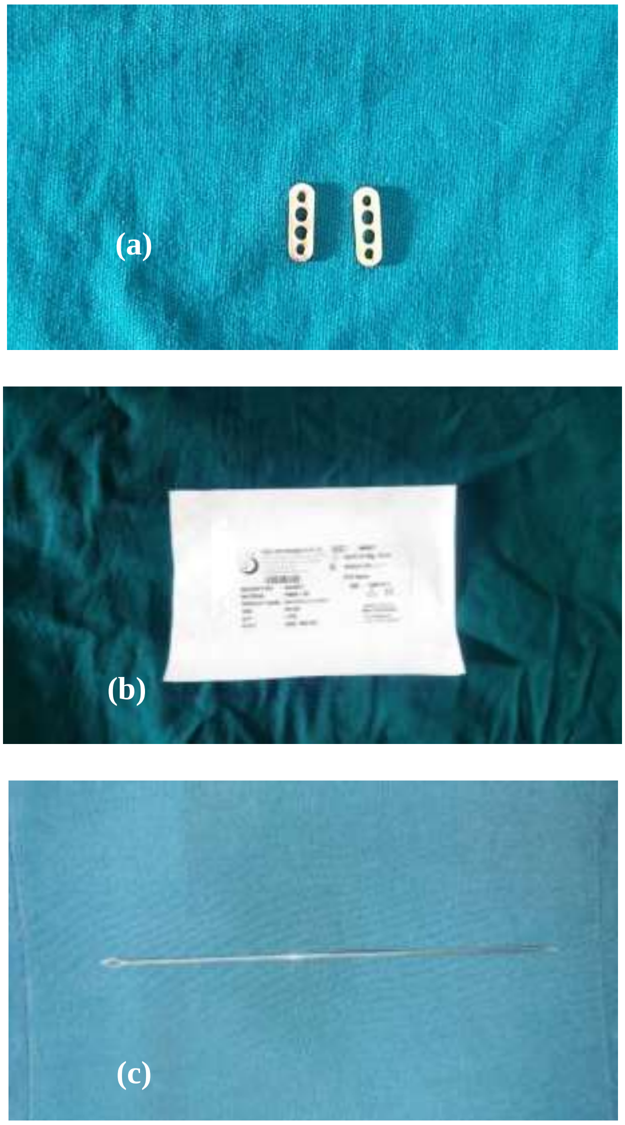

Plate 3.1 Implants and orthopaedic instruments (a) Titanium endobuttons size 4mm x 2mm (b) FiberWire suture size 0 (c) Guidewire

Plate 3.2 General and orthopaedic instruments (a) General surgical instruments (b) Orthopedic drill (c) Langenbeck retractor (d) Gelpi retractor (e) Hohmann retractor (f) Drillbit size 3.5mm and 2.7mm

3.7 Surgical approach to hip joint

A craniolateral skin incision was made starting from just cranial to the greater trochanter and extending halfway down the femur. The attachment between the fascia lata and biceps femoris was incised and muscles were separated to reach the vastus lateralis muscle. The superficial and middle gluteal muscles were elevated to expose the tendon of the deep gluteal muscle and a partial tenotomy of this tendon was done. The gluteal muscles were retracted dorsally and the vastus lateralis was retracted caudally to expose the dislocated femur head and the acetabulum.

3.8 Surgical procedure for toggle pinning

After exposing the hip joint, the acetabulum was cleared of debris, haematoma, or fibrin. Exposure to acetabular fossa was improved by outward rotation and adduction of the limb and a hole was drilled in the acetabular fossa with a 3.5 mm diameter drill bit. The toggle pin i.e. endobutton with suture strand looped through it was pushed through the drilled hole to rest against the medial surface of the acetabulum, within the pelvic cavity. The remnants of the detached round ligament were cleared from the fovea capitis and a tunnel was created from the fovea capitis to the greater trochanter using a 2.7mm drill bit. Using a guidewire, the suture strands attached to the toggle pin was fed through the tunnel. After reducing the joint, the ends of the suture strands were secured over the lateral surface of the femur, just below the greater trochanter using a 2nd titanium endobutton.

Joint capsule was sutured using No. 2-0 polyglactin 910. The partially incised tendon of the deep gluteal muscle was sutured with simple interrupted sutures using No. 2-0 polyglactin 910. The incision on the tensor fascia latae was closed in a simple continuous pattern using No. 0 polyglactin 910 followed by closure of the subcutaneous tissue with a simple continuous subcutaneous sutures of No. 2-0 polyglactin 910. The skin incision was closed by simple interrupted sutures using No. 2-0 polyamide.

3.9 Postoperative care and management

A thin strip of sterile gauze bandage soaked in 5% povidone iodine solution was kept over the suture line followed by covering with elastic adhesive bandage. Dressing of the surgical wound was done on every alternate day and was assessed for the presence of swelling, exudation and integrity of suture line. On the 12^{th} post-operative day, the sutures were removed. Post-operative antibiotic amoxicillin-sulbactam was administered orally at 12.5 mg/kg body weight twice daily, post-operatively for 7 days. NSAID carprofen[12] was administered at 4 mg/kg orally once a day for 3 days. Movement was restricted for the first 4-5 days after surgery followed by leash walking for the next week and gradual increase in movement was allowed by the 2^{nd} week post-operatively.

The postoperative day on which the dog started bearing weight was recorded and graded according to the score described by Bone *et al*. (1984). The mid-thigh circumference was recorded at on days 0, 15, 30 and 60 to detect any muscle atrophy.

3.10 Statistical analysis

Clinical, radiological and haemato-biochemical parameters recorded were compiled using Microsoft Excel and analysed using the (SPSS) Statistic Software for Windows, Version 26 developed by IBM Company, USA. Statistical analysis using One Way ANOVA was performed and results with $P < 0.05$ were considered to be statistically significant

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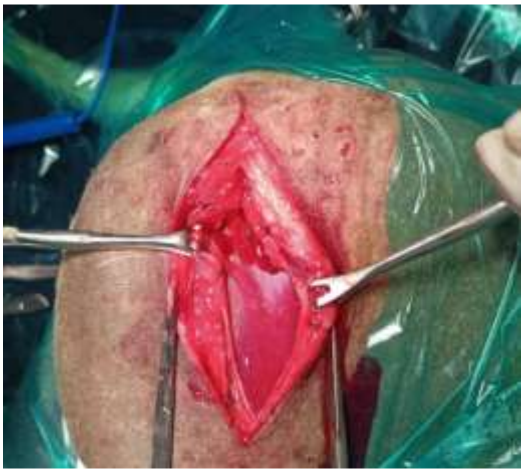
12. Carodyl; SAVA HEALTHCARE LIMITED; Surendranagar, Gujarat, India

Preparation of surgical site

Skin incision



Blunt separation of muscles

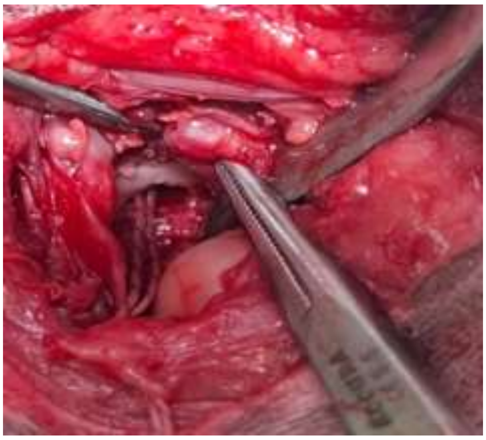
Incision of vastus lateralis

Exposure of joint/acetabulum

Drilling of acetabulum canal using 3.5 mm drill bit

Plate 3.3 Surgical procedure of toggle pinning

Suture looped through 1st endobutton



Passing endobutton and suture through acetabular canal

Drilling of femoral canal using 2.7mm drill bit

Tightening of suture knot over 2nd endobutton

Suturing of incised muscle

Closure of skin incision

Plate 3.4 Surgical procedure of toggle pinning

Results & Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The current study entitled "**Evaluation of Toggle Pinning Technique for Surgical Management of Coxofemoral Dislocation in Dog.**" was conducted to evaluate the efficacy of toggle pinning with respect to stabilization of the luxated hip joint in dog. The research was conducted in 8 clinical cases of dogs presented with coxofemoral luxation at the Veterinary Clinical Complex, of Krantisinh Nana Patil College of Veterinary Science, Shirwal and the District Veterinary Polyclinic, Pune from June 2024 to February 2025. The results and discussion of this study using different parameters are given below.

4.1 Selection of animals

Total 140 cases of hindlimb lameness were screened during the given time period, out of which 30 cases were of various joint disorders and 14 were the cases of coxofemoral luxation. 8 dogs irrespective of age, breed and sex presented with coxofemoral luxation were included in the study.

4.1.1 Signalment of selected cases

The data showing signalment of the selected cases is presented below in table 4.1

Table 4.1 Signalment of the selected cases

Sr. No.	Side affected	Aetiology	Breed	Sex	Age (yrs)	Weight (kg)	Direction of luxation
1	Right	Slipping during mating	Indian Spitz	Female	4	16	Craniodorsal
2	Bilateral	RTA	Caravan hound	Male	4	25	Craniodorsal
3	Right	RTA	Lhasa	Male	3	15	Craniodorsal

			Apso				
4	Right	RTA	Non-descript	Male	3	30	Craniodorsal
5	Right	RTA	Indian Spitz	Male	14	11	Craniodorsal
6	Left	Slipping during play	Golden Retriever	Female	1	22	Craniodorsal
7	Right	RTA	Non-descript	Male	1	9	Craniodorsal
8	Right	RTA	Non-descript	Male	5	20	Craniodorsal

4.1.2 Joint wise distribution of luxations

Table 4.2 and figure 4.1 show the data depicting the occurrence of different joint luxations.

Table 4.2 Joint wise distribution of luxations in the dogs

Sr. No.	Joint	No. of animals	Percentage (%)
1.	Coxofemoral	14	58.33
2.	Stifle-Patella	5	20.83
3.	Elbow	2	8.33
4.	Carpal	2	8.33
5.	Tarsal	1	4.16

In the present study, it was observed that coxofemoral (hip) luxations were most common (58.33%), followed by patellar luxations (20.83%), luxation of elbow joint (8.33%), carpal joint (8.33%) and tarsal joint (4.16%).

Similar findings were noted by Leonard (1960), Fry (1974), Johnson (1994) and Singh *et al.* (2017).

4.1.3 Breed wise occurrence of coxofemoral luxation in the dogs

The record of breed wise occurrence of coxofemoral luxation, during the current study, is presented in table 4.3 and figure 4.2.

Table 4.3 Breed wise occurrence of coxofemoral luxation in the dogs

Sr. No.	Breed	Number of animals	Percentage (%)
1.	Non- descript	4	28.57
2.	Indian Spitz	2	14.2
3.	Siberian Husky	2	14.2
4.	Golden Retriever	2	14.2
5.	German shepherd	1	7.14
6.	Caravan Hound	1	7.14
7.	Lhasa Apso	1	7.14
8.	Labrador Retriever	1	7.14

The occurrence of coxofemoral luxation was highest in non-descript breed (28.57%), followed by Indian Spitz, Siberian Husky and Golden Retriever each of which represented 14.2% of affected cases, followed by German shepherd, Caravan Hound, Lhasa Apso and Labrador Retriever which accounted for 7.14% of the total cases.

Occurrence was higher in non-descript breeds as compared to pedigreed dogs. The high population of non-descript dogs in the region and their free-roaming behavior may account for the higher incidence of luxation in these dogs.

Similar pattern was recorded by Basher *et al.* (1986), Smitha (2014), Shivakumar (2015), Shlag *et al.* (2019), Mathews and Barnhart (2021), Patwa *et al.* (2024) and Sharma *et al.* (2024)

4.1.4 Sex-wise occurrence of coxofemoral luxation in the dogs

The data representing sex wise occurrence of coxofemoral luxations during the study is shown below in table 4.4 and figure 4.3.

Table 4.4 Sex wise distribution of cases of coxofemoral luxation in the dogs

Sl. No.	Sex	Number of animals	Percentage (%)
1.	Male	10	71.42
2.	Female	4	28.58

The present study found that occurrence of coxofemoral luxations was higher in male dogs (71.42%) than in females (28.58%). The higher incidence in male dogs may be due to the higher population of male dogs and majority of owners preferring male dogs as pets. Moreover, male dogs tend to show more territorial behavior and are more likely to stray (Kolata *et al.,* 1974).

Similar findings were observed by Basher *et al.* (1986), Belge *et al.* (2014), Smitha (2014), Amith (2016) and Sharma *et al.* (2024).

4.1.5 Age-wise occurrence of coxofemoral luxation in the dogs

The data regarding age wise occurrence of coxofemoral luxations during the current study period is presented in table 4.5 and figure 4.4.

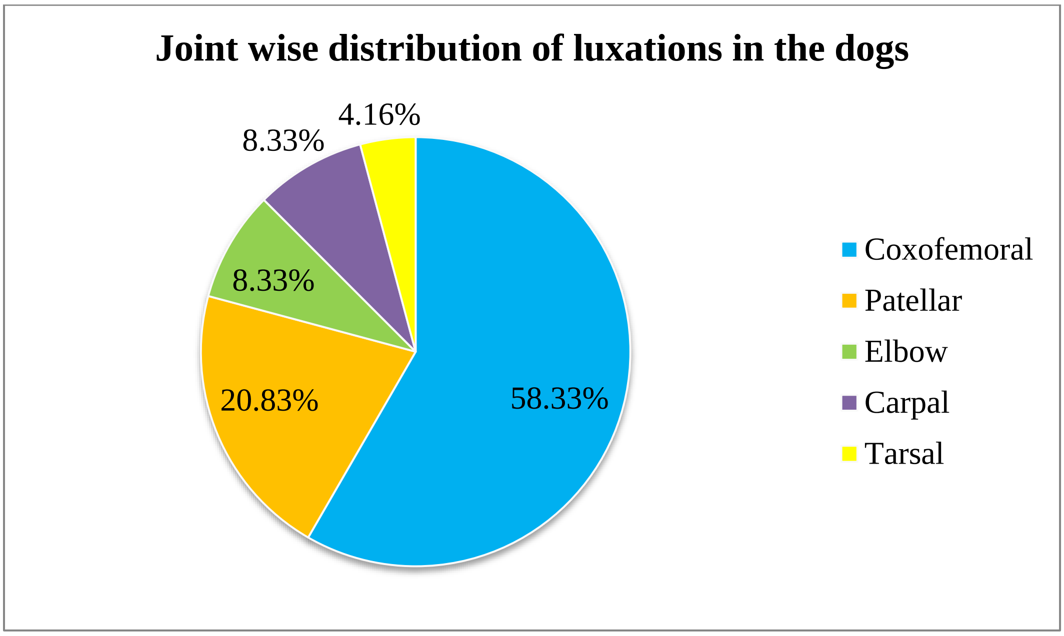


Fig. 4.1: Joint wise distribution of luxations in the dogs

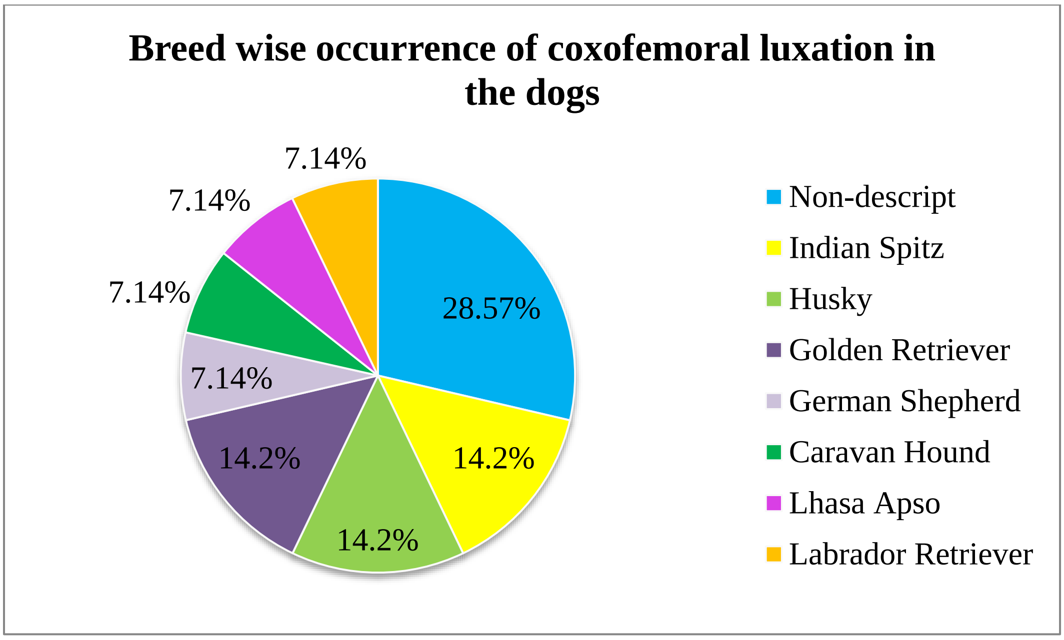


Fig. 4.2: Breed wise occurence of coxofemoral luxation in the dogs

Table 4.5 Age wise distribution of cases of coxofemoral luxation in the dogs

Sr. No.	Age Group (yrs)	No. of animals	Percentage (%)
1.	<1	2	14.2
2.	1-2	2	14.2
3.	2-3	3	21.4
4.	>3	7	50

The occurrence of coxofemoral luxation was found to be highest in dogs above 3 years of age (50%), followed by dogs in the age group of 2-3 years (21.4%), 1-2 years (14.2%) and less than 1 year of age (14.2%). Occurrence of luxation being higher in adult dogs as compared to young ones may be because, heavy trauma to the hindlimb usually results in capital physeal fracture in skeletally immature animals where the capital physis is yet to close. Similar observations were noted by Basher *et al.* (1986), Fox (1991), Evers *et al.* (1997), Harasen (2005), Garnier *et al.* (2023) and Sharma *et al.* (2024).

4.1.6 Weight wise occurrence of coxofemoral luxation in the dogs

The data representing weight wise occurrence of luxation during present study is depicted in table 4.6 and figure 4.5.

Table 4.6 Weight wise distribution of cases of coxofemoral luxation in the dogs.

Sr. No.	Body weight (kg)	No. of animals	Percentage (%)
1.	<10	1	6.25
2.	10-20	8	57.14
3.	20-30	5	35.71

Occurrence of coxofemoral luxation was highest in dogs weighing between 10-20kg (57.14%), followed by 20-30kg (35.71%) and <10kg (6.25%).

Similarly Basher *et al.* (1986), Evers *et al.* (1997), Haburjak *et al.* (2001), Kieves *et al.* (2014), Mathews and Barnhart (2021) also recorded highest number of cases in dogs between 10-20kg body weight. Sharma *et al.* (2024) reported most cases in dogs weighing between 20-30kg.

4.1.7 Etiology of coxofemoral luxation in dogs

Table 4.7 and figure 4.6 summarize the different etiologies of coxofemoral luxations recorded during the present study.

Table 4.7 Etiology of coxofemoral luxation in dogs

Sr. No.	Aetiology	No. of animals	Percentage (%)
1.	Road traffic accident	10	71.42
2.	Slipping while playing	2	14.28
3.	Slipping during mating	1	7.14
4.	Spontaneous luxation	1	7.14

The most common cause of coxofemoral luxation was road traffic accidents (71.42%), followed by slipping while playing (14.28%), slipping during mating (7.14%) and spontaneous luxations (7.14%). Basher *et al.* (1986) and Demko *et al.* (2006) reported vehicular trauma as the most common cause of coxofemoral luxations, while slipping or falling from height was one of the less common causes. Similar observations were made by Sharma *et al.* (2024).

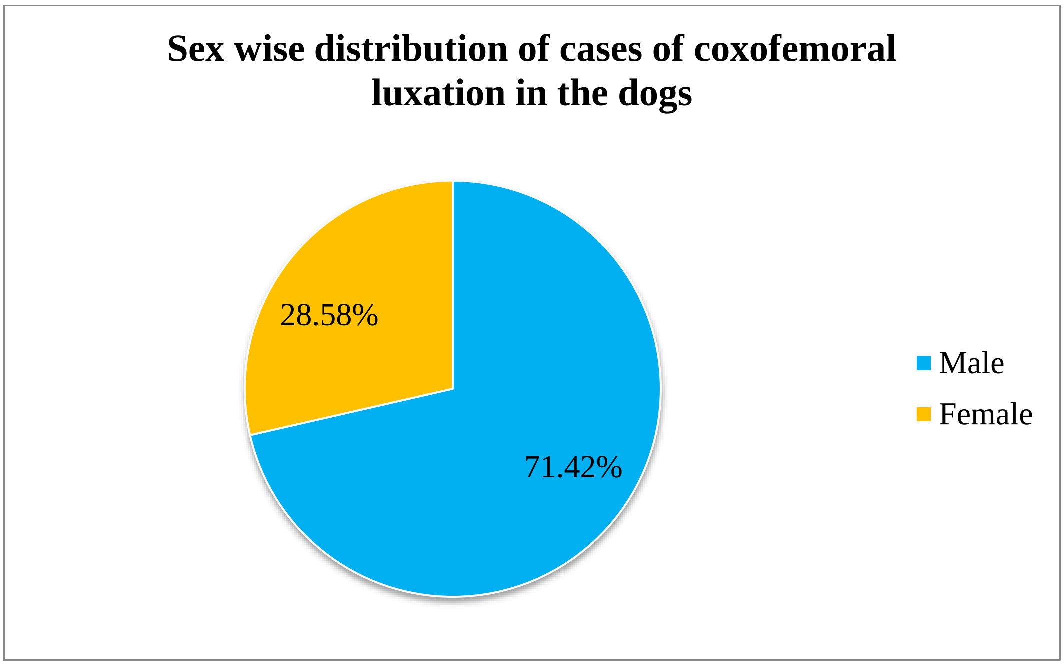


Fig. 4.3: Sex wise distribution of cases of coxofemoral luxation in the dogs

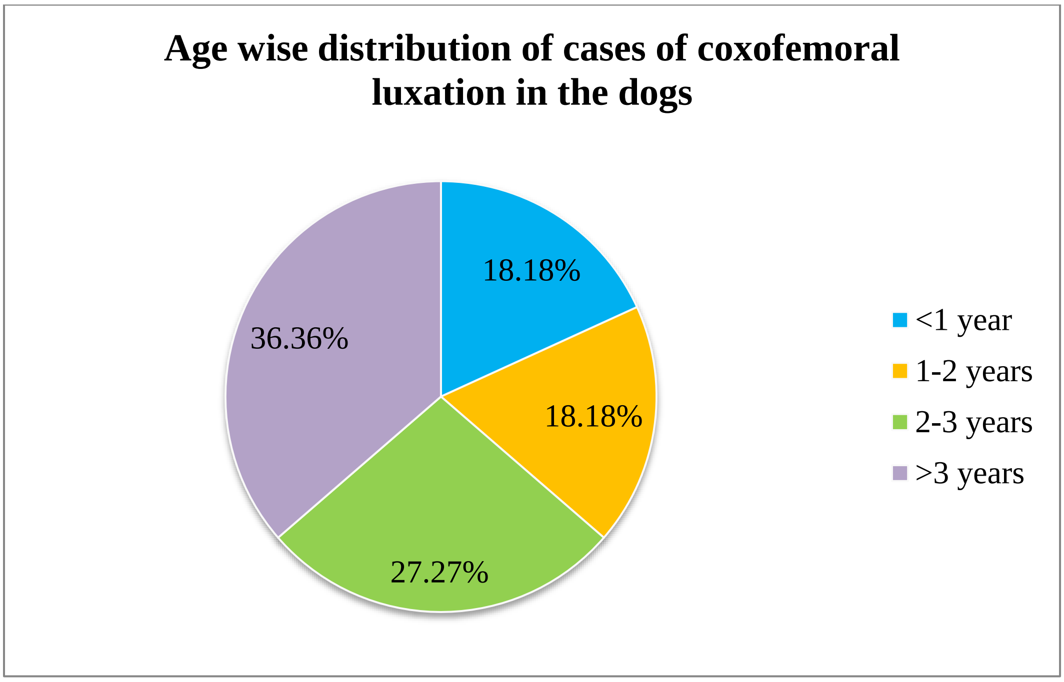


Fig. 4.4: Age wise distribution of cases of coxofemoral luxation in the dogs

4.2 Pre-operative observations

4.2.1 Pre-operative clinical observations

All the dogs presented with coxofemoral luxation showed non weight-bearing lameness in the affected limb. One dog with bilateral coxofemoral luxation and one dog with concurrent pelvic fracture showed inability to bear weight in both hindlimbs and were presented in sternal recumbency. In the dogs which were bearing weight in the other three limbs, the affected limb showed outward rotation of the stifle and inward rotation of the hock. In all cases, physical examination showed swelling, pain and crepitation on palpation of the affected hip. Similar signs were recorded by Harasen (2005), Moores (2006) and Aithal *et al.* (2023).

In addition to coxofemoral luxation, 3 cases with etiology of RTA showed concurrent fractures of the pelvis (Case no. 5) and long bones of the hindlimb (Case no. 3, Case no. 7). Mclaughlin (1995) noted that severe traumatic force is required to cause joint luxation and usually results in polytrauma.

Table 4.8 Data depicting direction of luxation, presence of concurrent bone injuries and surgeries performed.

Sr. No.	Direction of luxation	Side	Presence of concurrent conditions	Surgeries performed
1	Craniodorsal	Right	-	Toggle pinning for hip stabilization
2	Craniodorsal	Bilateral	-	Toggle pinning for hip stabilization
3	Craniodorsal	Right	Closed, proximal diaphyseal fracture of right femur and closed, mid-diaphyseal fracture	Toggle pinning for hip stabilization

			of right tibia	Intramedullary pinning for femoral fracture stabilization Intramedullary pinning for tibial fracture stabilization
4	Craniodorsal	Right	-	Toggle pinning for hip stabilization
5	Craniodorsal	Right	Multiple pelvic fractures	Toggle pinning for hip stabilization
6	Craniodorsal	Left	Dysplasia in right hip	Toggle pinning for hip stabilization
7	Craniodorsal	Right	Supracondylar fracture of right femur	Toggle pinning for hip stabilization Cross IM pinning for supracondylar fracture fixation
8	Craniodorsal	Right	-	Toggle pinning for hip stabilization

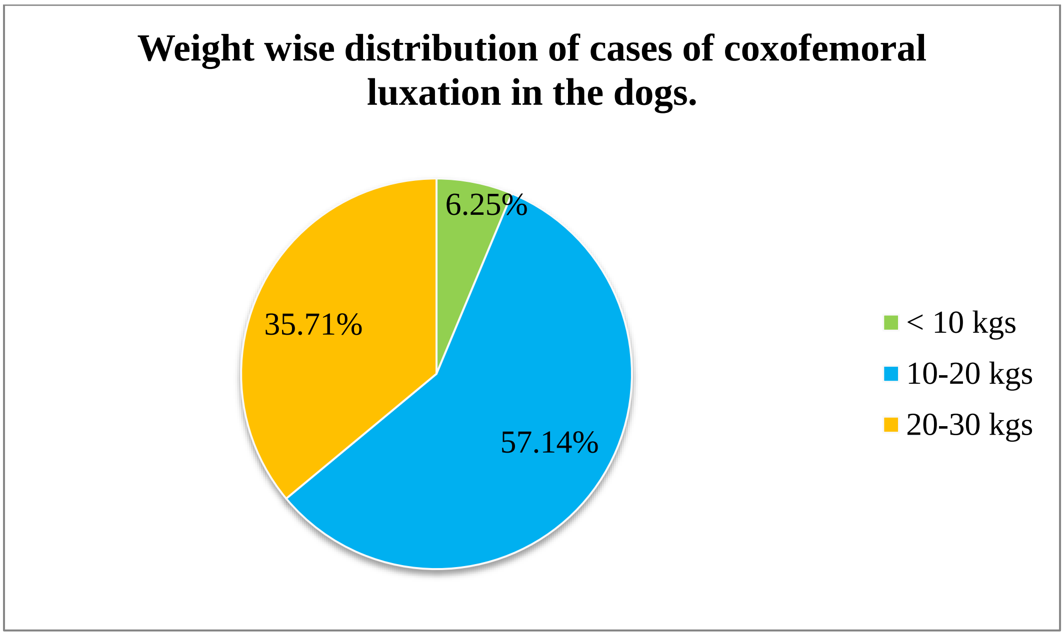


Fig. 4.5: Weight wise distribution of cases of coxofemoral luxation in the dogs

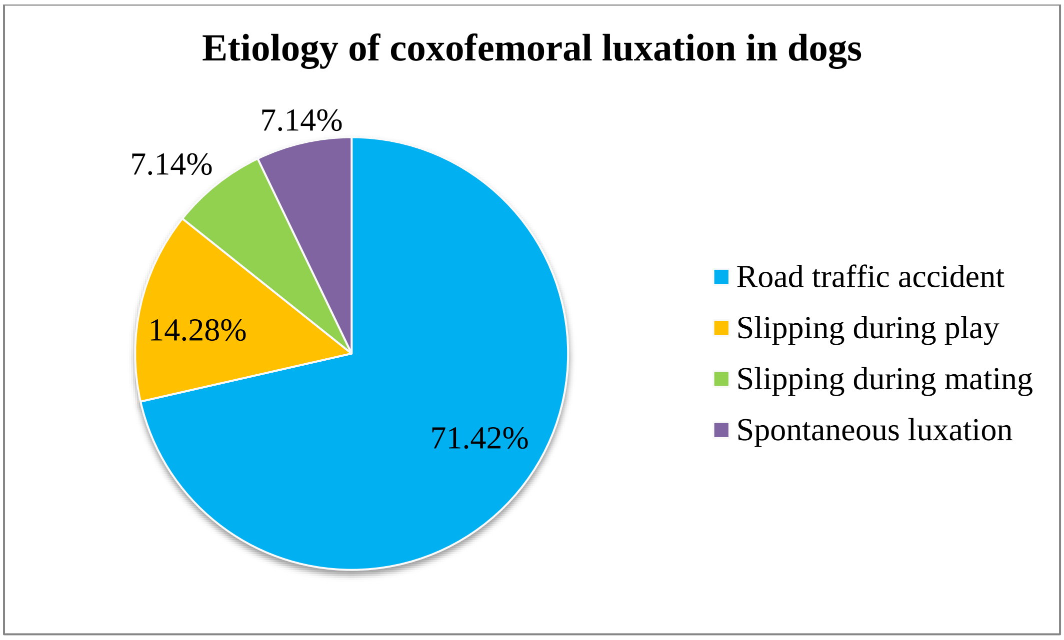


Fig. 4.6: Etiology of coxofemoral luxation in dogs

4.2.2 Preoperative radiographic observations

Two orthogonal radiographic views (ventrodorsal and mediolateral) were taken to confirm coxofemoral luxation and record the direction of luxation. Presence of concurrent lesions such as, hip dysplasia, osteophytes, fracture of the pelvis and fracture of the long bones was noted for planning of surgery. Basher *et al.* (1986), Denny and Butterworth (2000) and Fossum *et al.* (2013) also recommended performing at least two orthogonal radiographs to accurately describe the direction of luxation and detect any complicating lesions.

The data depicting direction of luxation, additional affections and implants used is represented in table 4.8.

In the present study, all dogs showed craniodorsal coxofemoral luxation. Two dogs showed dysplasia and osteoarthritis in the opposite hip. One dog showed ipsilateral proximal diaphyseal femoral fracture and mid-shaft tibial fracture. Two dogs had concurrent pelvic fracture, while one case showed supracondylar fractrure of the displaced femur.

4.2.3 Selection of implants

In all cases, the luxated hip was reduced and stabilized using Titanium Endobuttons as suture anchors and Fiberwire as prosthetic round ligament of femoral head. Two titanium endobuttons each of 4 mm x 2 mm dimensions and size 0 Fiberwire were used. In cases where concurrent long bone fractures were present, fracture reduction and stabilization was done in addition to toggle pinning.

4.3 Patient preparation and positioning

Patient preparation involved shaving of the affected hip and the surrounding area up to the stifle joint, followed by scrubbing the surgical site using povidone iodine scrub. The surgical site was painted with iodine solution and the distal limb was covered with sterile gauze bandage. This method of patient preparation was used in all 8 cases and provided effective asepsis of the surgical site.

4.3.1: Positioning

The animal was positioned in lateral recumbency with the affected hip upward. The limb was covered using sterile gauze bandage from the stifle upto the distal extremity of the limb followed by repainting of the surgical site with 5% betadine solution.

Denny and Butterworth (2000), and Piermattei and Johnson (2004) also recommended positioning the animal in lateral recumbency with affected hip placed upward.

4.3.2 Preoperative medication

Broad-spectrum antibiotic amoxicillin-sulbactam at 12.5 mg/kg body weight was administered intravenously 0.5-1 hr prior to surgery and provided adequate protection of against microbial infection. Rosin *et al.* (1993) recommended administration of antimicrobial agent about 30-60 minutes prior to surgery in order to obtain adequate antimicrobial concentration in the tissues during surgery.

NSAID meloxicam at 0.5 mg/kg body weight SC was administered as preemptive analgesic. Fossum (2013) recommended the administration of analgesics at least 30 minutes prior to surgery as NSAIDs require 30-60 minutes for onset of action.

4.4 Anaesthesia

The patient was fasted for 8-12 hrs, while water intake was allowed for upto 2-4 hrs before surgery. Anaesthetic protocol included premedication with anticholinergic drug atropine sulphate at 0.04 mg/kg body weight SC, followed by administration of xylazine hydrochloride at 1 mg/kg body weight IM 10 minutes later. Once the animal was in lateral recumbency, anesthesia was induced using propofol at 5 mg/kg body weight IV. Diazepam was administered at 0.2 mg/kg body weight IV. Endotracheal tube of appropriate size was placed after induction of general anaesthesia and Ringer's lactate drip was maintained throughout the surgery. Anaesthesia was maintained using propofol at 2.5mg/kg IV given as intermittent bolus injections.

Kelawala and Parsania (1997), Kushwaha *et al.* (2012) and Saikia, (2016) achieved good muscle relaxation using propofol as anaesthetic agent. A similar anaesthetic protocol was followed by Garnier *et al.* (2023) for surgical fixation of coxofemoral luxation in dogs.

4.5 Surgical procedure

4.5.1 Approach to hip joint

A craniolateral skin incision was taken over the greater trochanter and extended halfway down the femur. The attachment between the fascia lata and biceps femoris was incised and muscles separated to expose the vastus lateralis muscle. The superficial and middle gluteal muscles were elevated to expose the tendon of the deep gluteal muscle and a partial tenotomy of this tendon was done. The gluteal muscles were retracted dorsally and the vastus lateralis was retracted caudally to expose the dislocated femur head and the acetabulum.

This approach is in accordance with the approach described by Piermattei and Johnson (2004), Ash *et al.* (2012) and Fossum (2013).

4.5.2 Technique of joint stabilization

After exposing the hip joint, the acetabulum was cleared of debris, hematoma, or fibrin to palpate and locate the acetabular fossa. A hole was drilled in the centre of the acetabular fossa using a 3.5mm drill bit. The toggle pin i.e. endobutton with suture strand looped through it was pushed through the drilled hole to rest against the medial surface of the acetabulum, within the pelvic cavity. This was followed by outward rotation of the limb to expose the femur head. The remnants of the ruptured round ligament of femoral head were cleared from the fovea capitis and a tunnel was drilled from the fovea capitis to the greater trochanter using a 2.7mm drill bit. Using a guidewire, the suture strands attached to the toggle pin were passed through the tunnel. After reducing the joint, the ends of the suture strands were secured over the lateral surface of the femur, just below the greater trochanter using a 2^{nd} titanium endobutton. Joint capsule was sutured using No. 2-0 polyglactin 910. The partially incised tendon of the deep the gluteal muscle was sutured with simple interrupted sutures using No. 2-0 polyglactin 910. This was followed by routine closure of muscle and skin.

4.6 Intraoperative observations

Intraoperative observations including extent of tear of the round ligament of femoral head and joint capsule, damage to surrounding muscles, integrity of the bone surfaces, congruency of articulating surfaces, ease of joint reduction, etc. are summarized in table 4.9.

It was observed that reduction was easier in cases presented early while in long-standing cases, manipulation of the femoral head was difficult. This observation was in accordance with that of Harasen (2005). The round ligament of femoral head was completely torn in all cases and in 6 cases, the joint capsule was completely torn while in 2 cases, incomplete tearing was present. Cases presented with polytrauma showed greater extent of muscle damage. These findings were similar to those of Basher (1986) and Centikaya and Olcay, (2010).

Table 4.9 Intraoperative observations

Sr. No.	Case No.	Duration of luxation (days)	Intra-operative findings
1	1	10	Moderate muscle swelling Round ligament of femoral head ruptured Completely torn joint capsule Normal structure of acetabulum and femur head Easily reducible
2	2	2	Moderate muscle swelling Round ligaments of femoral heads ruptured

			Completely torn joint capsules Normal structure of both acetabula and femur heads Easily reducible
3	3	10	Severe muscle swelling Round ligament of femoral head ruptured Completely torn joint capsule Slight incongruency of articulating surfaces Difficult to reduce
4	4	15	Moderate muscle swelling Round ligament of femoral head ruptured Incompletely torn joint capsule forming a layer over the acetabulum Normal structure of acetabulum and femur head Difficult to reduce
5	5	1	Severe periarticular muscle damage Round ligament of femoral head ruptured Completely torn joint capsule Cranial acetabular rim unstable Normal structure of acetabulum and femur head Easily reducible
6	6	3	Moderate periarticular trauma and muscle swelling Round ligament of femoral head ruptured Incompletely torn joint capsule Normal structure of acetabulum and femur head Easily reducible
7	7	5	Moderate muscle swelling Round ligament of femoral head ruptured

			Completely torn joint capsule Normal structure of acetabulum and femur head Easily reducible
8	8	4	Severe muscle swelling Round ligament of femoral head ruptured Completely torn joint capsule Normal structure of acetabulum and femur head Difficult to reduce

4.7 Post-operative care and management

Post-operatively, antibiotic amoxicillin-sulbactam was administered orally at 12.5 mg/kg body weight twice a day for 7 days. Analgesic carprofen at 4mg/kg body weight was administered orally once a day for 3 days. No external limb support was applied and the dogs were kept under restricted movement for 4-5 days followed by gradual increase in movement over the next week. A similar approach for post-operative care was followed by Ash *et al.* (2012) and Karsli *et al.* (2022).

4.8 Evaluation

The post-operative outcome was evaluated using clinical, haemato-biochemical and radiological parameters.

4.8.1 Clinical examination

a) Lameness evaluation

The summary of the lameness scores for each case recorded on different post-operative days along with their mean ± standard error (SE) is given in table 4.10 and figure 4.7.

Table 4.10: Mean ± SE values of lameness scores on various post-operative days

Case No.	Day 0	Day 15	Day 30	Day 60
1	3	2	1	0
2	3	1	0	0
3	3	1	1	0
4	3	2	2	1
5	3	2	0	0
6	3	1	0	0
7	3	1	0	0
8	3	0	0	0
Mean ± SE	3.000 ± 0.000^{a}	1.250 ± 0.250^{b}	0.500 ± 0.267^{c}	0.125 ± 0.125^{c}
F value	43.567**			
P value	0.000			

Mean ± S.E. with different superscripts differ significantly between days. **- Significant (P<0.05); NS- Non-significant

The day of initial weight bearing of each case was noted and lameness evaluation was done on post-operative days 15, 30 and 60. In almost all cases, initial weight bearing began by 3rd to 5th post-operative day. Significant reduction in mean lameness scores was seen from day 0 (3.000 ± 0.000) to day 15 (1.250 ± 0.250) and again from day 15 (1.250 ± 0.250) to day 30 (0.500 ± 0.267). A statistically non-significant reduction in lameness was seen from day 30 (0.500 ± 0.267) to day 60 (0.125 ± 0.125) post-operatively.

Beckham *et al.* (1996) stated that early weight bearing and ambulation after toggle pinning positively influenced the outcome of orthopedic procedures done on other limbs.

b) Muscle atrophy

The mid-thigh circumference for each case recorded on different post-operative days along with their mean ± standard error (SE) is shown in table 4.11.

Table 4.11: Mean ± SE values of mid-thigh circumference (cm) on various post-operative days

	Mid-thigh circumference (cm)			
Case No.	Day 0	Day 15	Day 30	Day 60
1	26cm	24cm	24cm	24cm
2	29.5cm	24.4cm	28cm	28cm
3	24.6cm	24.2cm	25cm	25cm
4	31.5cm	31.2cm	32.5cm	32.8cm
5	21cm	20cm	20.8cm	22cm
6	27cm	26cm	26.5cm	26.5cm
7	15.2cm	15cm	14.8cm	15cm
8	32.5cm	32.9cm	32cm	32cm
Mean ± SE	26.36 ± 1.70	25.12 ± 1.76	25.88 ± 1.76	26.23 ± 1.68
F value	0.104^{NS}			
P value	0.957			

**- Significant (P<0.05); NS- Non-significant

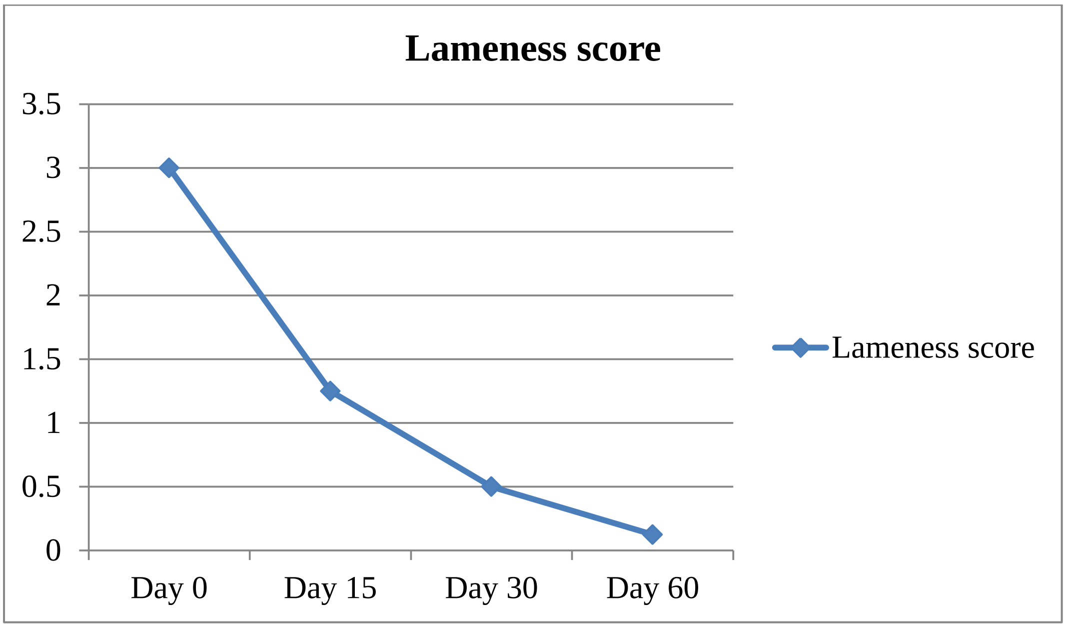


Fig. 4.7: Mean lameness scores on various post-operative days

Mid-thigh circumference pre-operatively of Case 8

Mid-thigh circumference on day 15 of Case 2

Mid-thigh circumference on day 30 of Case 2

Mid-thigh circumference on day 60 of Case 2

Plate 4.1 Measurement of mid-thigh circumference as a measure of muscle atrophy

Mid-thigh circumference was measured on day 0 i.e. pre-operatively and on post-operative days 15, 30 and 60 and compared, to detect limb atrophy (Plate 4.4). No significant difference was seen in the mid-thigh circumference, indicating that no significant muscle atrophy occurred.

These results were similar to those of Beckham *et al.* (1996) who found no significant change in mid-thigh circumference after stabilization of coxofemoral joint using toggle pinning. Enstig *et al.* (2022) recorded thigh circumference to note post-operative muscle atrophy in dogs undergoing femoral head ostectomy (FHO) and found muscle atrophy, reduced joint extension, and reduced static weight bearing in the FHO limb.

4.8.2 Postoperative radiographic evaluation

Radiographic evaluation was done immediately post-surgery and on the 15^{th}, 30^{th} and 60^{th} post-operative days to assess the joint structure, alignment of the reduced joint and the implant position.

Immediate post-operative radiographs revealed femur head replaced into the acetabular cavity with the 1^{st} toggle locked along the medial surface of acetabulum and the 2^{nd} toggle was visible over lateral surface of femur just below the greater trochanter (Plate 4.1, 4.2 and 4.3).

Radiographs taken on post-operative days 15, 30 and 60 for all cases were assessed for implant position, maintenance of joint reduction and also for post-operative osteoarthritic changes including joint effusion and osteophyte formation. Implant position and joint reduction were well maintained in all cases except one case (Case No. 5) in which reluxation along with displacement of the 1^{st} toggle through the acetabular canal was seen.

No post-operative degenerative lesions were detected in any of the cases (i.e. osteoarthrosis score 0). One dog (Case No. 3) which showed mild osteoarthritis (i.e. osteoarthrosis score 1) pre-operatively was monitored post-operatively and did not show further progression of arthritic lesions.

4.8.3 Haematological observations

a) Haemoglobin (g/dL)

The mean ± standard error (SE) values of haemoglobin count (g/dL) of all the cases recorded at different post-operative intervals are summarized in table 4.12. The haemoglobin count showed non-significant increase from day 0 (11.08 ± 0.51) to 60^{th} post-operative day (12.31 ± 0.46) and remained within normal physiological range as also reported by Brar *et al.* (2002). Similar findings were documented by Smitha (2014), Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019)

b) Packed Cell Volume (%)

The mean ± standard error (SE) values of packed cell volume (%) of all the cases recorded at different post-operative intervals are summarized in table 4.12. Packed cell volume (PCV) showed non-significant variation from day 0 to day 60 post-operatively. The PCV levels remained within normal physiological range throughout the study period as described by Brar *et al.* (2002). Singh et al. (2008), Shivakumar (2015), Amith (2016), Manjunath et al. (2017) and Polat *et al.* (2021) documented similar findings.

c) Total erythrocyte count ($x10^6/\mu L$)

Table 4.12 gives the summary of the mean ± standard error (SE) values of total erythrocyte count as $N\times10^6$ /µL of all the cases, recorded on day 0 and at various post-operative intervals.

The total erythrocyte count (TEC) showed non-significant variation within normal physiological ranges during the complete study period, which is in accordance with the range given by Brar *et al.* (2002). The TEC showed non-significant increase from day 0 to day 60, which can be attributed to increased activity of the reticuloendothelial system during post-operative healing period. These findings were similar to those of Smitha (2014), Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019)

(a)

(b)

(c)

Plate 4.2 Pre-operative and immediate post-operative radiographs of Case no. 1 (a), Case no. 2 (b) and Case no. 4 (c)

(a)

(b)

(c)

(d)

Plate 4.3 Radiographs of case no 2 - pre operative – VD view (a) and lateral view (b) and day 0 - VD view (c) and lateral view (d)

(e)

(f)

(g)

Plate 4.4 Radiographs of case no 2 - post operative day 15 (e), day 30 (f) and day 60 (g)

d) Total leucocyte count (x10^3/µL)

The mean ± standard error (SE) values of total leucocyte count (x10^3/µL) of all the cases recorded at different post-operative intervals are summarized in table 4.12.

The mean ± standard error (SE) values of total leucocyte count (TLC) showed significant variation from day 0 to day 60. In all cases, the total leukocyte count was highest pre-operatively (day 0) and showed a gradual decrease over the post-operative period, which can be attributed to the gradual decrease in inflammatory response of the body. Similar trend was noted by Smitha (2014), Shivakumar (2015) and Amith (2016). Chaurasia *et al.* (2019) stated that leucocytosis can be expected during initial stage of inflammation.

e) Neutrophils (%)

The summary of the mean ± standard error (SE) values of neutrophil count in per cent (%) of all the cases recorded pre-operatively and at regular post-operative intervals is included in table 4.12.

The neutrophil count showed a highly significant decrease from day 0 (72.37 ± 0.70) to day 60 (62.62 ± 0.70). This variation might be due to the decrease in inflammatory response following joint stabilization. Similar findings were reported by Amith (2016) and Chaurasia *et al.* (2019).

f) Lymphocytes (%)

The summary of the mean ± standard error (SE) values of lymphocyte count in per cent (%) of all the cases recorded pre-operatively and at regular post-operative intervals is shown in table 4.12.

There was non-significant variation in the lymphocyte count and the values fluctuated within the normal physiological range throughout the post-operative period. These findings were in accordance with those reported by Amith (2016).

g) Monocytes (%)

The summary of the mean ± standard error (SE) values of monocyte count in per cent (%) of all the cases recorded pre-operatively and at regular post-operative intervals is included in table 4.12.

The monocyte count exhibited non-significant variation over the post-operative period and the values remained within the normal physiological range as described by Brar *et al.* (2002). Similar findings were recorded by Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019).

h) Eosinophils (%)

The summary of the mean ± standard error (SE) values of eosinophil count in per cent (%) of all the cases recorded pre-operatively and at regular post-operative intervals is included in table 4.12.

The eosinophil count in all cases exhibited non-significant variation over the post-operative period and the values remained within the normal physiological range as also described by Brar *et al.* (2002). Similar findings were reported by Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019).

i) Basophils (%)

The summary of the mean ± standard error (SE) values of basophil count in per cent (%) of all the cases recorded pre-operatively and at regular post-operative intervals is included in table 4.12.

The basophil count exhibited non-significant variation over the post-operative period and the values remained within the normal physiological range as reported by Brar *et al.* (2002). Similar findings were reported by Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019).

j) Platelets (x10^5/µL)

The mean ± standard error (SE) values of platelet count (x10^5/µL) of all the cases recorded at different post-operative intervals are summarized in table 4.12.

The platelet count varied non-significantly within the normal physiological range throughout the study period. These findings were similar to those of Shivakumar (2015), Amith (2016) and Chaurasia *et al.* (2019).

4.8.4 Biochemical observations

a) Serum Alkaline Phosphatase

The mean ± standard error (SE) values of serum alkaline phosphatase (IU/L) of all the cases recorded at different post-operative intervals are summarized in table 4.12.

The serum Alkaline Phosphatase (ALP) values fluctuated non-significantly within the normal physiological range throughout the study period. The mean ± standard error (SE) value of serum ALP was highest on day 15 (96.33 ± 2.06) and lowest on day 60 (92.67 ± 1.66). There was a non-significant increase in serum ALP on the 15^{th} post-operative day followed by gradual, non-significant decrease upto day 60.

These findings were similar to those of Smitha (2014) who reported that the post-operative increase in serum ALP may occur due to muscle trauma. Polat *et al.* (2021) stated that inflammatory reaction in the hip joint will cause an increase in ALP values.

b) Serum Calcium

The mean ± standard error (SE) values of serum calcium (mg/dL) of all the cases recorded at different post-operative intervals are summarized in table 4.12.

The serum calcium varied non-significantly and was within the normal physiological range during the study period. Similar findings were reported by Budhwar *et al.* (2021) and Polat *et al.* (2021). Qiao *et al.* (2022) reported that dogs with normal serum calcium level showed better joint healing as compared with dogs with low serum calcium levels.

c) Serum Phosphorus

The mean ± standard error (SE) values of serum phosphorus (mg/dL) of all the cases recorded at different post-operative intervals are summarized in table 4.12. The serum phosphorus level varied non-significantly and was within the normal physiological range during the study period. Budhwar *et al.* (2021) and Polat *et al.* (2021) recorded similar findings in their respective studies.

4.9: Complications

One dog (case 5) showed suture dehiscence and reluxation along with pullout of implant through the acetabular canal on 7th post-operative day, which was detected radiographically (Plate 4.3). The exudate from the surgical site was sent for antibiotic sensitivity testing and based on its results, antibiotic ceftriaxone tazobactum at 20mg/kg bwt was administered IM once a day for 7 days. Reluxation was probably attributed to weakness of the pelvis due to multiple fractures. The affected limb subsequently underwent a femoral head and neck excision. Similar complication was encountered by Trostel *et al.* (2000) and Karsli *et al.* (2022).

(a)

(b)

Plate 4.5 Postoperative complication of suture dehiscence (a) and reluxation (b) of case no 5

Table 4.12: Mean ± SE values of haemato-biochemical parameters on various post-operative days

Parameter	Day 0	Day 15	Day 30	Day 60	F value	P value
			Haematological parameters			
Hb (g/dL)	11.08 ± 0.51[a]	11.50 ± 0.53[a]	12.01 ± 0.49[a]	12.31 ± 0.46[a]	1.17[NS]	0.33
Packed Cell Volume (%)	39.79 ± 0.44[a]	39.65 ± 0.65[a]	40.56 ± 0.39[a]	40.64 ± 0.32[a]	1.19[NS]	0.32
Total Erythrocyte Count (x106/µL)	5.14 ± 0.05[a]	5.18 ± 0.05[a]	5.22 ± 0.04[a]	5.25 ± 0.04[a]	0.80[NS]	0.50
Total Leucocyte Count (103/µL)	12.48 ± 1.13[a]	9.60 ± 0.66[ab]	8.90 ± 0.59[b]	8.60 ± 0.55[b]	5.24**	0.05
Neutrophils (%)	72.37 ± 0.70[a]	68.00 ± 0.70[b]	65.62 ± 0.62[b]	62.62 ± 0.70[c]	35.92**	0.00

Lymphocytes (%)	25.25 ± 0.59[a]	25.25 ± 0.64[a]	24.12 ± 0.69[a]	24.12 ± 0.58[a]	1.06[NS]	0.38
Monocytes (%)	1.25 ± 0.25[a]	1.50 ± 0.32[a]	1.25 ± 0.36[a]	1.12 ± 0.29[a]	0.25[NS]	0.85
Eosinophils (%)	1.62 ± 0.32[a]	1.50 ± 0.26[a]	1.25 ± 0.36[a]	1.12 ± 0.22[a]	0.57[NS]	0.63
Basophils (%)	0.50 ± 0.18[a]	0.50 ± 0.18[a]	0.50 ± 0.26[a]	0.12 ± 0.12[a]	0.88[NS]	0.46
Platelets (x105/µL)	3.01 ± 0.06[a]	3.06 ± 0.06[a]	3.15 ± 0.05[a]	3.20 ± 0.03[a]	1.86[NS]	0.15
Biochemical parameters						
Alkaline Phosphatase (IU/L)	93.35 ± 1..44[a]	96.33 ± 2.06 [a]	94.55 ± 1.65 [a]	92.67 ± 1.66 [a]	0.86[NS]	0.47
Calcium (mg/dL)	9.77 ± 0.23 [a]	10.21 ± 0.20 [a]	10.16 ± 0.24 [a]	10.18 ± 0.24 [a]	0.80[NS]	0.50
Phosphorus (mg/dL)	3.61 ± 0.13 [a]	3.91 ± 0.09 [a]	3.87 ± 0.15 [a]	3.90 ± 0.12 [a]	1.20[NS]	0.32

Mean ± S.E. with different superscripts differ significantly between days; **- significance (P<0.05); NS- Non-significant

Summary & Conclusions

CHAPTER V

SUMMARY AND CONCLUSIONS

The current study was conducted in 8 cases of coxofemoral luxation, out of 14 cases of dogs presented to Veterinary Clinical Complex, KNPCVS, Shirwal and District Veterinary Polyclinic, Pune from June 2024 to February 2025.

Distribution of luxation of various joints in dogs was recorded. The luxation of coxofemoral joint in dogs was studied in detail, which included its signalment, occurrence and etiology. The diagnosis of coxofemoral luxation was carried out on the basis of physical examination and orthogonal radiographic views.

The present study found that coxofemoral joint was the most commonly luxated joint (58.33%) in dogs, followed by patellar luxations (20.83%), elbow luxation (8.33%), carpal luxation (8.33%) and tarsal luxation (4.16%). Coxofemoral luxation was most common in non-descript breeds (28.57%), followed by Indian Spitz (14.2%), Siberian Husky (14.2%), Golden Retriever (14.2%) German shepherd (7.14%), Caravan hound (7.14%), Lhasa Apso (7.14%) and Labrador Retriever (7.14%). Male dogs (71.42%) were affected more as compared to female dogs (28.58%).

Occurrence of coxofemoral luxations was higher in adult dogs as compared to skeletally immature dogs. This occurrence was highest in dogs above 3 years of age (50%), followed by dogs in the 2-3 years age group (21.4%), dogs between 1-2 years of age (14.2%) and less than 1 year of age (14.2%) respectively. When the body weight of the affected dogs was compared, highest number of cases were within the range of 10-20 kg b.w.t (57.14%), followed by 20-30 kg b.w.t (35.71%) and less than 10 kg b.w.t. (6.25%).

Road traffic accident was found to be the most common cause of coxofemoral luxation (71.42%). This cause was followed by slipping during playing (14.28%), slipping during mating (7.14%) and spontaneous luxation (7.14%). In 3 cases, wherein road traffic accident was the principal etiology, the concurrent fractures of the femur, tibia or pelvis of the affected limb were also observed.

In every case, the open reduction and stabilization of the hip joint was carried out under general anaesthesia, using xylazine as sedative and propofol with diazepam being used for induction of general anaesthetia whereas the anaesthesia was maintained using propofol. This combination of anaesthetics provided adequate anaesthesia and muscle relaxation for reduction of the luxated joint and stabilization using toggle pinning.

Craniolateral approach was found to be suitable to expose the joint. Toggle pinning was performed using a size 0 Fiberwire for ligament reconstruction and 2 titanium endobuttons as suture anchors. In those cases where concurrent bone injuries such as long bone fractures were present, appropriate fracture fixation was done in addition to toggle pinning. Post-operatively, oral antibiotic and analgesic were administered and the animals were kept under restricted movement with gradual increase in exercise.

Clinical, radiographic and haemato-biochemical parameters were recorded on day, 15th, 30th and 60th post-operative days to evaluate the efficacy of the procedure performed in this study. All the cases showed severe (grade III) pre-operative lameness on day 0. Initial weight bearing was recorded by 3rd post-operative day in 5 cases, 5th post-operative day in 2 cases and by 7th post-operative day in 1 case. Lameness reduced significantly by day 15 in all cases with intermittent limping while walking (grade II) observed in 3 dogs and occasional lameness (grade I) recorded in the remaining cases. By day 30, intermittent lameness (grade II) was recorded in one dog, while 2 dogs showed occasional limping while walking (grade I) and 5 dogs showed normal gait (lameness grade 0). Normal gait was observed in 7 cases on 60th post-operative day.

For all cases, mid-thigh circumference was recorded pre-operatively and on 15th, 30th and 60th post-operative days as a measure of muscle atrophy. No significant muscle atrophy was observed in any of the cases.

Haemato-biochemical parameters were recorded pre-operatively and on 15th, 30th and 60th post-operative days. Haemoglobin, total erythrocyte count, packed cell volume, and platelets showed non-significant variation within the normal physiological ranges throughout the study period. Total leucocyte count and neutrophil count were highest on day 0 and showed a significant decline after surgery by day 60. Serum calcium and phosphorus values were within the normal physiological ranges throughout the study period. Serum alkaline phosphatase level showed a non-significant rise by day 15, followed by a gradual decrease within the normal range by day 60.

Radiographs were taken immediately after surgery and on 15th, 30th and 60th post-operative days to assess the implant position, alignment of the reduced joint and the joint structure. In 7 cases, post-operative radiographs showed normal implant position and joint reduction was properly maintained. In one case (Case No. 5) reluxation and displacement of implants was observed 7 days after surgery. Pre- and post-operative radiographs were critically assessed for signs of degenerative joint disease. One case (Case No. 3) showed mild osteoarthritis in pre-operative radiographs but did not show any progression of the osteoarthritis post-operatively. No post-operative degenerative lesions were observed in any of the cases.

Post-operative complication was observed in only one dog (Case No. 5) which showed reluxation of the operated hip along with displacement of both endobuttons. Subsequently, said dog underwent femoral head ostectomy for the reluxated hip.

The conclusions from the current study are:

1. Toggle pinning technique provided efficient stabilization by creating a temporary prosthetic round ligament of femoral head. Use of titanium endobuttons as suture anchors and Fiberwire for the surgery provided a durable construct for stabilization of the hip joint in adult dogs of medium body weight.

2. Dogs undergoing coxofemoral joint stabilization by toggle pinning showed early weight bearing. This was particularly beneficial in cases of polytrauma.

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Vita

VITA

Dr Shruti V. Mehendale was born on 21st November 1999 and was born and brought up in Pune. She completed her schooling from Bharatiya Vidya Bhavan S.N.V.M and attended junior college in D.E. Society's Fergusson College.

Growing up in family of wildlife and nature lovers, she always had fish, birds, rabbits or dogs in the house and had decided by 9th standard that she wanted to enter the veterinary profession. She completed her Under graduation (B.V.Sc and A.H.) from Krantisinh Nana Patil College of Veterinary sciences Shirwal in the year 2022 with a CGPA of 8.7. During her college days she has attended various workshops and camps which broadened her perspective of veterinary medicine. She has also volunteered at veterinary NGOs to build clinical experience and attended vaccination camps for stray animals in Pune.

Being interested in clinical practice since her first year of undergraduate college, she knew that she wanted to pursue her masters in Veterinary Surgery and Radiology. She has achieved AIR 9 in ICAR for Veterinary Science in 2022. She has received the Best Student and Best Student In Paraclinical Subjects awards from the KNPVET Alumni association and the Late Shri Bhagwanrao Patil Memorial Award at the 11th MAFSU Convocation. Writing short stories about her experiences as a vet, painting, reading and Artistic-Yoga are some of her hobbies. She loves horseback riding and some of her most memorable experiences have been horseback trails in the countryside around Pune. She is fluent in German and likes reading German poems and children's stories to keep in touch with the language.

She is happiest when working with animals and hopes to keep building upon her knowledge as a veterinary surgeon and continue helping animals and their people. Having had incredible mentors during her journey as a veterinary student, she hopes to eventually be able to share her knowledge and be a mentor to younger vets.

Abstract

THESIS ABSTRACT

1)	Title of the thesis	:	**“Evaluation Of Toggle Pinning Technique For Surgical Management Of Coxofemoral Dislocation In Dog’’**
2)	Full name of student	:	Miss Mehendale Shruti Vidyesh
3)	Name and address of Major Advisor	:	**Dr. A. H. Ulemale** Associate Professor & Head Department of Veterinary Surgery & Radiology K. N. P. College of Veterinary Science, Shirwal, MAFSU, Nagpur- 440 001(M.S)
4)	Degree to be awarded	:	M.V.Sc.
5)	Year of award of degree	:	2025
6)	Major subject	:	Veterinary Surgery and Radiology
7)	Total number of pages in the thesis	:	60
8)	Number of words in the abstract	:	298
9)	Signature of Student	:	
10)	Signature, Name and Address of forwarding authority (HOD/SH)	:	**Dr. A. H. Ulemale** Associate Professor & Head Department of Veterinary Surgery & Radiology K. N. P. College of Veterinary Science, Shirwal, MAFSU, Nagpur- 440 001(M.S)

ABSTRACT

The study titled “Evaluation of Toggle Pinning Technique for Surgical Management of Coxofemoral Dislocation in Dog.” was conducted in 8 dogs presented with coxofemoral luxation at Veterinary Clinical Complex, KNPCVS, Shirwal and District Veterinary Polyclinic, Aundh, Pune.

For all cases, open reduction and stabilization of the luxated joint was performed by toggle pinning technique using titanium endobuttons and fiberwire suture. Clinical, radiographic and haemato-biochemical parameters recorded pre-operatively and post-operatively were used to evaluate the surgical outcome. Combination of xylazine, diazepam and propofol provided effective anaesthesia for the surgical procedure.

All the dogs showed early weight bearing within 3-5 days after surgery and significant improvement in gait was observed on day 15 and day 30 post operatively. Normal gait was observed in 7 out of 8 dogs by day 60. One dog showed intermittent limping on day 60.

Post-operative muscle atrophy was not observed in any of the cases. Radiographic evaluation was carried out pre-operatively and post-operatively on 15th, 30th and 60th day, which showed that alignment of the stabilized joint was maintained and no signs of DJD were observed. One case showed implant pullout and reluxation.

Haemato-biochemical parameters were found to be within normal ranges, except neutrophil count, which significantly decreased after surgery and reached baseline levels by day 60.

Open reduction with toggle pinning provided effective stabilization of the coxofemoral joint and allowed early return to normal limb function by creating a temporary artificial replacement of the round ligament of head of femur. Early weight bearing was especially beneficial in cases presented with polytrauma.

In conclusion, the study showed that, among joint luxations of the extremities, coxofemoral luxation was the most common. Coxofemoral luxations were more common in adult dogs and occurrence was higher in males. Automobile accident was the most common cause of hip luxation. Toggle pinning is an efficient technique for stabilization of coxofemoral luxation in dog.

<u>प्रबंध गोषवारा</u>

१	प्रबंधाचे शीर्षक	:	श्वानांतील निखळलेल्या खुब्याच्या उपचारासाठी टॉगल पिनिंग तंत्राचे मूल्यमापन.
२	विद्यार्थ्याचे पूर्ण नाव	:	मेहेंदळे श्रुति विद्येश
३	मार्गदर्शकाचे नाव व पत्ता	:	**डॉ. अ. हि. उलेमाले** सहयोगी प्राध्यापक पशुशल्यचिकित्सा आणि क्ष- किरण विभाग क्रां ना पा पशुवैद्यकीय महाविद्यालय, शिरवळ, जि. सातारा.
४	पदवीचे नाव	:	एम. व्ही. एससी
५	पदवी घेण्याचे वर्ष	:	२०२५
६	मुख्य विषय	:	पशुशल्यचिकित्सा आणि क्ष- किरण विभाग
७	प्रबंध मधील एकूण पृष्ठांची संख्या	:	**६०**
८	प्रबंध सारांशामधील एकूण शब्द	:	**२९५**
९	विद्यार्थी स्वाक्षरी	:	
१०	पुढे पाठविणाऱ्या अधिकाऱ्याची स्वाक्षरी, नाव व पत्ता	:	**डॉ. अ. हि. उलेमाले** सहयोगी प्राध्यापक व विभागप्रमुख, पशुशल्यचिकित्सा आणि क्ष- किरण विभाग क्रां ना पा पशुवैद्यकीय महाविद्यालय, शिरवळ, जि. सातारा.

सारांश

शैक्षणिक पशू चिकित्सा संकुल, क्रां.न.पा.प.म, शिरवळ व जिल्हा पशू सर्वचिकित्सालय, औंध, पुणे येथे आलेल्या लंगडणाऱ्या श्वानांची तपासणी करून खुबा निखळलेल्या ८ श्वानांमध्ये "श्वानांतील निखळलेल्या खुब्याच्या उपचारासाठी टॉगल पिनिंग तंत्राचे मूल्यमापन" या विषयाचा संशोधनात्मक अभ्यास करण्यात आला.

शस्त्रक्रियेपूवी श्वानांची वैद्यकीय व क्ष-किरण तपासणी करण्यात आली, तसेच रक्ताचे नमुने जैवरासायनिक पृथक्करणासाठी संकलित केले गेले. झायल्याजीन, डायझेपाम आणि प्रोपोफॉल याचा वापर करून देण्यात आलेली भुल, अस्थीभंगाच्या

शस्त्रक्रियेसाठी समाधानकारक असल्याचे आढळले. निखळलेला खुबा बसवण्यासाठी टीयटॅनियम एन्डोबटन व फायबरवायर चा टाका वापरून टॉगल पिनिंग साठीची शस्त्रक्रिया करण्यात आली.

शस्त्रक्रियेनंतर वैद्यकीय, क्ष-किरण व रक्ताच्या तपासण्यांद्वारे टॉगल पिनिंग तंत्राचे मूल्यमापन करण्यात आले. निखळलेल्या खुब्याच्या शस्त्रक्रियेनंतर त्या पायावर वजन पेलण्याची क्षमता ३-५ दिवसात येत असल्याचे निदर्शनास आले आणि १५व्या व ३०व्या दिवसापर्यंत श्वनाच्या चालीमध्ये लक्षणीय सुधारणा आढळली. ८ पैकी ७ श्वानांमध्ये ६०व्या दिवसापर्यंत चालण्याची क्रिया समाधानकारक होती. मात्र एक श्वान ६०व्या दिवशी सुद्धा चालताना अधून मधून लंगडत होता.

शस्त्रक्रियेनंतर एकाही श्वानामध्ये स्नायूंची क्षीणता झालेली आढळली नाही. तसेच, १५व्या, ३०व्या व ६०व्या दिवशी केलेल्या क्ष-किरण तपासणी मध्ये एकाही श्वानात संधिवाताची लक्षणे आढळली नाहीत. ८ पैकी ७ श्वानांमध्ये इम्प्लांट बसवलेल्या ठिकाणी स्थिर असल्याचे क्ष-किरण तपासणीत दिसले. मात्र एका श्वानामध्ये सातव्या दिवशी एन्डोबटन ची हालचाल होऊन खुबा पुन्हा निखळल्याचे दिसून आले.

रक्ताच्या तपासणीत पांढऱ्या पेशीचे प्रमाण शस्त्रक्रियेपूर्वी वाढलेले असल्याचे दिसून आले आणि शस्त्रक्रियेनंतर या पेशींचे प्रमाण ६०व्या दिवसापर्यंत सर्वसाधारण झाले.

टॉगल पिनिंग तंत्राची शस्त्रक्रिया निखळलेला खुबा परत जागेवर बसवून त्याला स्थिर करते व तात्पुरते कृत्रिम अस्थिबंधन तयार करते, ज्यामुळे त्या पायात वजन पेलण्याची क्षमता लवकर परत येण्यास मदत होते. महत्वाचे म्हणजे ज्या श्वानांमध्ये इतर हाडांचा सुद्धा अस्थिभंग झाला असेल अशा श्वानांकरिता हे तंत्र अत्यंत उपयुक्त ठरते.

या संशोधनात्मक अभ्यासाअंती असे दिसून आले की श्वानांमध्ये सांधा निखळण्याच्या वर्गीकरणामध्ये खुबा निखळण्याचे प्रमाण सर्वात जास्त होते. प्रौढ श्वानांमध्ये तसेच, माद्यांपेक्षा नरांमधे खुबा निखळण्याचे प्रमाण जास्त होते. वाहनांच्या अपघातामुळे श्वानांमध्ये खुबा निखळण्याचे प्रमाण जास्त असल्याचे निदर्शनास आले. या वरून टॉगल पिनिंग तंत्राची शस्त्रक्रिया श्वानांमध्ये निखळलेल्या खुब्याच्या स्थिरीकरणासाठी प्रभावी असल्याचे दिसून आले.