EVALUATION OF POLYVINYL CHLORIDE SPLINTS FOR THE TREATMENT OF LONG BONE FRACTURES IN DOGS

DIVYA BALAN

Thesis submitted in partial fulfillment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

2003

Department of Veterinary Surgery and Radiology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR - 680 651
KERALA, INDIA

DECLARATION

I hereby declare that this thesis entitled **"EVALUATION OF POLYVINYL CHLORIDE SPLINTS FOR THE TREATMENT OF LONG BONE FRACTURES IN DOGS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy
29.12.2003

DIVYA BALAN

CERTIFICATE

Certified that the thesis entitled **"EVALUATION OF POLYVINYL CHLORIDE SPLINTS FOR THE TREATMENT OF LONG BONE FRACTURES IN DOGS"** is a record of research work done independently by **Divya Balan,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

29/12/03

Dr. C.B. Devanand
(Chairman, Advisory Committee)
Assistant Professor (Sr. Scale)
Department of Veterinary Surgery & Radiology
College of Veterinary and
Animal Sciences, Mannuthy

Mannuthy
29.12.2003

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Divya Balan,** a candidate for the degree of Master of Veterinary Science in Surgery, agree that the thesis entitled **"EVALUATION OF POLYVINYL CHLORIDE SPLINTS FOR THE TREATMENT OF LONG BONE FRACTURES IN DOGS"** may be submitted by Divya Balan, in partial fulfilment of the requirement for the degree.

29/12/03

Dr. C.B. Devanand
(Chairman, Advisory Committee)
Assistant Professor (Sr. Scale)
Department of Veterinary Surgery & Radiology
College of Veterinary and Animal Sciences, Mannuthy, Thrissur

29/12/03

Dr. T. Sarada Amma
Associate Professor & Head
Department of Veterinary Surgery & Radiology
(Member)

29/12/03

Dr. S. Ajith Kumar
Assistant Professor
Department of Clinical Medicine
(Member)

29/12/03

Dr. K. Rajankutty
Associate Professor
Department of Veterinary Surgery & Radiology
(Member)

26/2/04

External Examiner
(DR. V. RAMASWAMY)
Associate Professor and Head
Department of Veterinary Surgery and Radiology
Veterinary College and Research Institute,
NAMAKKAL - 637 001.

ACKNOWLEDGEMENT

With great devotion I would like to express my sincere gratitude and indebtedness to Dr. C.B. Devanand, Assistant Professor (Sr. Scale), Department of Veterinary Surgery and Radiology and Chairman of the Advisory Committee for his expert planning and meticulous guidance. The incessant help rendered by him in all possible ways throughout the period of this study, has resulted this thesis.

I am much obliged to Dr. T. Sarada Amma, Associate Professor and Head, Department of Veterinary Surgery and Radiology for having given expertise, personal attention and intimate help as a member of advisory committee during each phase of this research work.

I express my great sense of gratitude to Dr. K. Rajankutty, Associate Professor, Department of Veterinary Surgery and Radiology for his enduring interest and constructive and erudite suggestions rendered as a member of advisory committee.

I am very much grateful to Dr. S. Ajith Kumar, Assistant Professor, Department of Clinical Medicine, for his advice and encouragement as a member of advisory committee.

I owe my deep sense of gratitude to Dr. K.N. Muraleedharan Nayar, Professor and Head (Retd.), Department of Veterinary Surgery and Radiology for having given the expert advice and encouragement. It is indeed, a chance of a life time to be under the tutelage of Dr. K.N. Muraleedharan Nayar and I consider myself very fortunate in this regard.

I express my great sense of gratitude to the Dean, College of Veterinary and Animal Sciences, Mannuthy for providing me the necessary facilities for carrying out this work.

I am indebted to my teachers Dr. K.D. John Martin, Dr. M.K. Narayanan, Dr. Syam K. Venugopal, Assistant Professors, Department of Veterinary Surgery and Radiology for all their advice and suggestions given to me, that helped me to complete my research work and thesis.

This work would not have been possible but for the sincere helping hand, remarkable cooperation, tremendous patience and sustained encouragement extended by colleague Dr. D. Prasanna. I express my sincere gratitude to him.

I express my sincere gratitude to Dr. P.T. Dinesh, Dr. S. Sooryadas and Dr. S. Anoop, Teaching Assistants, Department of Veterinary Surgery and Radiology, Dr. Joshi George, my senior colleague, Dr. Ashalatha, Dr. Sachin J. Shenoy, Dr. Philip Varghese, Dr. Reshma, my junior colleagues, Department of Veterinary Surgery and Radiology for their whole hearted support and cooperation during the entire period of my research work.

My sincere thanks are due to Dr. Usha Narayanan Pillai, Assistant Professor (Sr. Scale) , Department of Clinical Medicine, Dr. Renjith and Dr. Rani Gopinath, P.G. Scholars, Department of Clinical Medicine for the help rendered in conducting biochemical analysis.

I remember with gratitude Mrs. Indira Devi, Radiographer, Department of Veterinary Surgery and Radiology for the help extended in taking radiographs.

I hereby record my sincere thanks to Ms. Mary and Mr. Jayesh, N.J. for their physical assistance and moral support rendered to me through out the period of research work.

I express my sincere gratitude to all those final year students for their help and co-operation extended during my research work.

I am thankful to Kerala Agricultural University for awarding me the KAU Fellowship for the period of study.

My thanks to the staff of the University and College libraries for their help rendered in scanning the literatures.

I appreciate M/s. Peagles, Mannuthy for the prompt and meticulous typing of the manuscript.

Last but not the least, I am indebted to the almighty for his blessings, my parents who inspired me to take up this task and my husband who motivated me through out the period.

Divya Balan

CONTENTS

Sl. No.	Title	Page No.
1	INTRODUCTION	1
2	REVIEW OF LITERATURE	3
3	MATERIALS AND METHODS	11
4	RESULTS	21
5	DISCUSSION	59
6	SUMMARY	71
	REFERENCES	75
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1.	Pre treatment observations on the day of presentation (Group I)	30
2.	Observations on physiological parameters (mean ± SE) before and after immobilization (Group I)	31
3.	Haematological parameters (mean ± SE) before and after immobilization (Group I)	32
4.	Physical parameters during the first two weeks (Group I)	33
5.	Physical parameters on 15th day (Group I)	34
6.	Physical parameters on 30th day (Group I)	35
7.	Radiological studies before and after immobilization (Group I)	36
8.	Biochemical parameters (mean ± SE) before and after immobilization (Group I)	37
9.	Pre treatment observations on the day of presentation (Group II)	49
10.	Observations on physiological parameters (mean ± SE) before and after immobilization (Group II)	50
11.	Haematological parameters (mean ± SE) before and after immobilization (Group II)	51
12.	Physical parameters during the first two weeks (Group II)	52
13.	Physical parameters on 15th day (Group II)	53
14.	Physical parameters on 30th day (Group II)	54
15.	Radiological studies before and after immobilization (Group II)	55
16.	Biochemical parameters (mean ± SE) before and after immobilization (Group II)	56

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Dog with its right limb immobilized by plaster of Paris cast	19
2a	The prepared polyvinyl chloride splints provided with lining of cotton	19
2b	The prepared polyvinyl chloride splints (convex side)	20
3.	The animal after immobilization of the limb by polyvinyl chloride splints and bandages	20
4.	Skiagram of fracture of radius and ulna of a dog in Group I showing complete transverse fracture with angulation at the middle third of diaphysis on zero day	38
5.	Skiagram of radius and ulna of a dog in Group I on 15^{th} post treatment day showing small amount of periosteal reaction	38
6.	Skiagram of radius and ulna of a dog in Group I on 30^{th} post treatment day showing moderate degree of periosteal callus	39
7.	Skiagram of radius and ulna of a dog in Group I on 15^{th} post treatment day showing displacement of fragments and moderate degree of periosteal reaction	39
8.	Skiagram of fracture of radius and ulna of a dog in Group II showing complete oblique fracture at the distal third of diaphysis on zero day	57
9.	Skiagram of radius and ulna of a dog in Group II on 15^{th} post treatment day showing mild periosteal reaction	57
10.	Skiagram of radius and ulna of a dog in Group II on 30^{th} post treatment day showing moderate amount of periosteal callus	58
11.	Skiagram of radius and ulna of a dog in Group II on 15^{th} post treatment day showing displacement of fragments and marked degree of periosteal reaction	58

Introduction

INTRODUCTION

Fracture repair has always been a matter of greater concern to the orthopaedic surgeons. The factors like age of the animal, blood supply to the fragments, structure of the bone involved and type of fracture have been established to affect the process of fracture healing. The goal of any ideal method of fracture repair should be early return of weight bearing and stress adaptability of the fractured bone and prevention of fracture diseases.

Fracture of long bones are common in companion animals and are usually the result of traumatic events such as automobile accidents, animal fights and fall from height (Aithal *et al.*, 1999). Radius is the principal weight bearing bone of the forelimb (Rochat and Payne, 1993) and hence it is more prone to fracture (Aithal *et al.*, 1999).

The incidence of fractures of radius and ulna varies from 16.92% to 31.4% (Phillips, 1979; Thilagar and Balasubramanian, 1988; Balagopalan *et al.*, 1995 and Aithal *et al.*, 1999).

As a treatment regimen for the fracture of radius and ulna, closed reduction and external coaptation procedures have got an important role in stabilizing the fracture region for early healing to take place. Favourable factors associated with closed reduction and external coaptation are preservation of soft tissues, haematoma and blood supply to the fracture site resulting in a shortened healing time (Roush and McLaughlin, 1998).

The conventional method commonly employed under field condition for the treatment of fracture of long bones in dogs is immobilization of the fracture fragments with plaster of Paris cast. Though it is a popular immobilizing material it has got several inherent deficiencies like slow setting time, high setting temperature, permeability to water, low strength, poor radiolucency, irritant to the animal's skin leading to its mutilation, additional weight to the applied limb and its cost. Thus there arises the need for other alternative techniques.

Presently, resin bonded fibre glass cast has become popular in human treatment due to its light weight and durability. But due to its prohibitive cost, its routine use in animals becomes impracticable. Use of polyvinyl chloride (PVC) splint for external immobilization is another alternative. Its advantages are light weight, radiolucent, can be cut to desirable length, mouldable according to the contour of the limb and free from any chemical reaction on contact with skin. It can be changed as and when required and it restricts the movement of fracture fragments without rendering the ambulation.

Use of PVC splints for immobilization of fracture of long bones in caprines and bovines has been studied with satisfactory results (Sarkate *et al.*, 1993; Thilagar *et al.*, 1998). Perusal of the available literatures did not reveal any detailed report on the use of PVC splints for immobilization of long bone fractures in dogs. Hence, the present study was undertaken, with an objective to evaluate the efficacy of PVC splints and its immobilizing effects in the management of long bone fractures in dogs.

Review of Literature

REVIEW OF LITERATURE

West (1963) reported, slow setting time, high setting temperature, permeability to water, low strength and poor radiolucency were the disadvantages of plaster of Paris cast in equines and bovines.

Sittnikow and Paatsama (1970) studied the bone healing pattern in fractures of distal radius and ulna after treatment with simple coaptation, plaster of Paris cast, intramedullary pinning and bone plating in dogs. It was observed that fracture healing commenced from third post fracture day onwards and at that time the strongest osteogenic activity was observed in the endosteum. After one week, healing was equally stronger at periosteum and the callus consisted of cartilaginous and fibrous cells. The earliest callus was observed within 12 days after fracture and was clearly visible within 21 days after fracture. Sixteen weeks after fracture, most of the callus was ossified and new bone from periosteum bridged the fracture line completely.

Brinker (1974) explained the closed reduction of fracture fragments in dogs by grasping the fragments through soft tissues and bringing to their original position as nearly as possible by distraction, toggling and by providing traction and counter traction by holding the limb well above and below the fracture.

Sumner-Smith (1974) conducted a comparative clinical study after internal fixation of fracture in Miniature Poodles and Mongrel dogs and

reported the existence of fracture gap radiographically even when the fractured limb was clinically sound.

Singh and Nigam (1975) reported simple coaptation using plaster of Paris cast as the easiest and well suited technique under field conditions and was suitable for immobilization of fractures below knee and hock joint in large animals. They also found that strong and pliable aluminium splints to be the most satisfactory reinforcing material.

Vaughan (1975) studied the complications associated with internal fixation of fractures in dogs. Movement at the fracture site of radius and ulna was observed after four weeks of application of plaster of Paris cast and mobility was greatest in antero-posterior plane.

Singh *et al.* (1976) observed a significant increase in the concentration of serum alkaline phosphatase at seventh and 14th post fracture day, followed by a fall to normal values in fracture repair in dogs. This increase was ascribed to fibrous tissue formation, that was related to the early stages of bone repair. No correlation was observed between bone healing and serum calcium and phosphorus levels.

Phillips (1979) reported the occurrence of fractures in 284 dogs and 298 cats and observed that 80 per cent of the cases occurred in animals less than three years old and greater incidence in males. Bones commonly affected in dogs were radius and ulna (17.3%), pelvis (15.8%), femur (14.8%) and tibia

(14.8%). Automobile accident was the major exciting cause of fracture followed by fall from height. Considering the site of fracture in radius and ulna, distal and middle third of diaphysis were more commonly affected. Treatments were carried out both by internal fixation and external fixation and complications like non-union were observed due to improper technique and infection.

Hunt *et al.* (1980) reviewed 100 cases of dogs with complications of diaphyseal fractures, treated surgically and by closed methods. They observed that the major cause of failure was instability resulting from poor technique and infection. Osteomyelitis was the most important complication of fracture repair when internal fixation was used. Use of external fixation often resulted in fracture disease characterized by muscle atrophy and joint stiffness. Plaster of Paris casts often failed to provide adequate immobilization, particularly when used for treatment of oblique fractures. Mutilation of the cast and growth disturbances to radius and ulna were also reported with the use of plaster of Paris cast.

Singh *et al.* (1984) reported mal-alignment and infection as the most common post-operative complications after external and internal immobilization of fractures in 270 cases of bovines, equines and ovines. External immobilization by simple coaptation, hanging pin cast and transfixation produced complications like malunion, delayed union and non-union.

Gourley and Vasseur (1985) attributed the changes in haemogram after fracture in dogs, to the transient period of cellular reaction to trauma, elicited towards healing process.

Stead (1988) detailed the general principles of cast application in dogs like all the casts regardless of the type must include the whole foot/extend to the tips of the toes, leaving the two central pads exposed for weight bearing. It was also stated that to end the cast above the foot was dangerous as the circulation would be impaired distally. For radius and ulna and tibia and fibula the cast need not extend above elbow and stifle respectively. Under the slab technique of plaster of Paris cast application, longitudinal strips of plaster bandage two to four layers thick and the length of proposed cast were smoothed into place to form a shell around the limb. Once hardened further plaster bandage was applied in overlapping rolls to finish. This method avoided the risk of ischaemia from too tight a cast or shrinkage during drying.

Thilagar and Balasubramanian (1988) studied the incidence and anatomical locations of fractures in 204 cases of dogs. Higher incidence of fractures were noticed in males (67.1%) than in females (32.9%). Breed wise study revealed higher incidence of fracture in nondescript dogs. As far as the site of fracture was concerned in radius and ulna, mid shaft was more commonly affected followed by lower third of diaphysis. Considering the age, it was more in age group between three to six months (26.6%), followed by

zero to three months of age (22%). Radius and ulna were found to be more commonly involved (31.4%), followed by tibia (30.4%) and femur (14.7%).

Rochat and Payne (1993) discussed the management of long bone fractures in dogs and cats and stated that, casts and splints were more suited for young animals as their healing time was fast. For adult animals a more rigid form of fixation was necessary as they had slow healing time and use of external coaptation resulted in complications like muscle atrophy, skin ulceration and joint stiffness.

Singh *et al.* (1993) discussed the use of polyvinyl chloride pipe as a splint for external immobilization of fractures in large animals and recommended proper padding on both the ends and placing it over well padded and bandaged limb to prevent pressure sores.

Sarkate *et al.* (1993) developed a technique for the immobilization of fracture in caprines and bovines after its closed reduction using PVC pipe. Two halves of PVC pipes were applied anterior and posterior sides of the fractured limb followed by tight bandage around the PVC pipe. Radiographic examinations of all cases revealed an optimum callus formation and callus organization on 30^{th} and 60^{th} post treatment day. Complete weight bearing was noticed on 80^{th} post operative day and full weight bearing was noticed much earlier in caprines than in bovines.

Aithal *et al.* (1995) observed variations in serum alkaline and acid phosphatase activity in goats having fractures corrected with different bone grafting techniques. It was found that the activity of serum alkaline phosphatase was more in fractures treated with autogenous cancellous bone grafts suggesting more osteogenic activity at and around the autogenous cancellous bone grafts and the activity of serum acid phosphatase was more in fractures corrected with autogenous cortical bone grafts due to the more osteoclastic activity required to resorb cortical bone grafts.

Balagopalan *et al.* (1995) analysed the incidence of fractures in dogs on the basis of age, sex, breed, bone, site and the type of fracture and reported the highest incidence in Alsatian (27.9%), followed by Dobermann Pinscher (17.8%), non descript (17.3%) and Pomeranian (15.4%). Dogs of age group three to six months (30.8%) were more commonly affected followed by day old to three months (27.9%). Fractures of femur (30.9%) were the highest followed by tibia (18.8%). Among the different orientation of fractures, oblique fractures (32.6%), transverse fractures (23.2%) and epiphyseal fractures (11.6%) were more common.

Morgan and Leighton (1995) opined that stable reduction of fracture resulted in production of a little or no callus. Early use of the limb and absence of pain on palpation at the fracture site should be relied on, to provide evidence of fracture healing.

Kumar *et al.* (1997) studied the haemato-biochemical changes following fracture repair using hydroxy apatite fibrillar collagen implants in calves. The rectal temperature, respiration rate, cardiac rate, total RBC count, total WBC count were within normal physiological limits with slight decrease in lymphocyte and increase in neutrophil counts observed at various time intervals. Plasma levels of calcium and phosphorus remained high upto 90 days and 60 days respectively. Alkaline phosphatase level was decreased upto 15^{th} day followed by an increase upto day 60, suggesting increase in osteoblastic and osteogenic activities at and around the implant.

Roush and McLaughlin (1998) observed that in dogs with fractures of lower extremities, where there was less soft tissue coverage would become an open fracture when not supported properly. The early signs of fracture healing evidenced in dogs were periosteal reaction near the fracture site, callus formation and remodeling of fractured ends of the bone. It was also opined that fractures proximal to elbow/stifle were difficult to manage with external coaptation and thus recommended the same for fractures below the elbow/stifle.

Aithal *et al.* (1999) studied the incidence of occurrence of fractures in dogs and observed that males (63%) were more commonly affected than females (37%) and majority of the fractures were recorded in animals aged less than one year (54%) . The occurrence was highest in non-descript indigenous breeds and the causes of trauma were mainly due to automobile accidents (46.86%) and fall from height (39.11%). Among different types of fractures

oblique/spiral fractures (54.86%) were significantly higher than comminuted (16.5%), transverse (14.86%), incomplete (6.57%) and multiple (5.17%). The highest incidence were seen in femur (38.56%) followed by tibia and fibula (17.16%) , radius and ulna (16.92%) and humerus (7.71%) and the incidence of diaphyseal fractures were more than epiphyseal and metaphyseal fractures. In femur, humerus and radius and ulna the distal and middle third of diaphysis was more commonly affected and in tibia and fibula the occurrence was more in middle and proximal third.

Thilagar *et al.* (1998) performed rehabilitation, physiotherapy, fluid therapy and antibiotic therapy as supportive measures along with polyvinyl chloride splint to promote healing in a dog with traumatic carpal luxation.

Anoop (2001) reported that plaster of Paris cast favoured the early return of limb function and disappearance of the symptoms of fracture than with Thomas splint in fracture of tibia in dogs. Though complications like oedema, soft tissue trauma, pain on palpation and mutilation were noticed in both the groups, it was comparatively less in animals treated with plaster of Paris cast. No variations in haemogram and serum biochemical parameters were detected in either treatment. Complications like oedema, pain and mobility at the fracture site in animals treated with Thomas Splint due to mutilation by the animals were also reported.

Materials and Methods

MATERIALS AND METHODS

The study was carried out in twelve clinical cases of long bone fractures in dogs of either sex, presented to the clinics of College of Veterinary and Animal Sciences, Mannuthy. Fracture of radius and ulna alone was included in this study as a representative example of long bone fracture. The animals were randomly divided into two groups viz., Group1 and Group II consisting of six animals in each. In Group I, the animals were numbered as A1, A2, A3, A4, A5 and A6 and in Group II, the animals were numbered as B1, B2, B3, B4, B5 and B6. In both groups information regarding the breed, sex, age, body weight, etiology of the fracture, duration of illness and the limb affected were recorded.

After clinical examination of the animals, and confirmation of fracture of radius and ulna, the fracture was corrected by closed method in both the groups. After reduction, immobilization of the fractured limb was carried out in two methods.

In Group I: By using plaster of Paris cast.

In Group II: By using polyvinyl chloride (PVC) splint.

Pre-treatment observations

All the animals were examined for its clinical status and the physiological parameters were recorded. The weight of the animal was noted. The lame limb was examined for its functional status, weight bearing, posture,

joint mobility and muscle mass both while standing and walking. Palpation of the lame limb was performed to ascertain the region of fracture for the presence of pain, swelling and crepitation. The type, location of fracture and the extent of damage to the nearby tissues were determined by lateral and antero-posterior radiography of affected region. Blood samples were collected in EDTA coated vials before anaesthesia and at 15^{th} and 30^{th} day of the treatment for evaluation of haematological parameters.

Fracture reduction techniques:

Anaesthesia

To facilitate closed reduction of fracture fragments into proper apposition, all the animals were premedicated with atropine sulphate* at a dose rate of 0.045 mg/kg body weight intramuscularly and after 10 minutes sedation was achieved by administering xylazine hydrochloride** at a dose rate of 1 mg/kg body weight intramuscularly. In 25 per cent cases 2.5 per cent solution of thiopentone sodium*** was also administered intravenously 'to effect' general anaesthesia.

---

*Atrowok : Atropine sulphate injection (0.65 mg), Wockhardt Ltd., Nans Daman

**Xylaxin: Xylazine hydrochloride 23.32 mg (equivalent to 20 mg of xylazine), Indian Immunologicals Ltd., Guntur

***Pentothal sodium: Thiopentone sodium injection (0.5 g), Abbott Laboratories (India Ltd.), Ankleshwar

Fracture Reduction

The animals were controlled on lateral recumbency with the affected limb above. The position of the bone fragments were determined by means of palpation and from radiographs. The bone fragments were brought into apposition by providing traction, counter traction and toggling by holding the limb well above and below the fracture (Brinker, 1974).

Technique of immobilization

Group I

In this group, the treatment was carried out using plaster of Paris cast* (10 cm x 2.7 m). The animals were placed in lateral recumbency with the affected limb above. The lame limb was covered with a thin layer of cotton pad and longitudinal strips of 10 centimeter wide plaster of Paris bandage of three to five layers were applied longitudinally over the limb surface extending from well above the elbow to the distal end of the foot and further plaster bandage was applied in over lapping rolls to finish (Brinker, 1974; Stead, 1988). Plaster of Paris cast was applied in a figure of eight pattern at the elbow region to provide additional strength and support (Fig.1).

---

*Rapidur : Plaster of Paris bandage, B.P. Beiersdorf India Ltd., Curti

Group II

Preparation of PVC Splint

Polyvinyl chloride pipe of four centimeter diameter and 25-35 cm length was split longitudinally into two equal halves. One half of the splint was selected and appropriate length of the limb to be immobilized was measured from elbow joint to the distal end of the affected limb. The splint was moulded according to the contour of the limb by heating over the flame. The edges of the splint was smoothened by heating and vigorous rubbing with cotton before cooling. The upper and lower edges of the splint was bent backwards to a width of one centimeter to facilitate support of lame limb on the ground and to avoid injury due to constant rubbing at the elbow region. A lining of cotton was provided in the splint for smooth placement over the limb (Sarkate *et al.*, 1993) (Fig.2a and 2b).

The animals were controlled in lateral recumbency with the lame limb above. After reduction of fracture the lame limb was padded with a thick layer of cotton wool from elbow joint to the distal end, and a bandage was wrapped over it. The prepared polyvinyl chloride splint was applied over the posterior aspect of the limb which covered almost $3/4^{th}$ of thickness of the limb except at the anterior side and was secured tightly in position by application of the bandage (Fig.3).

Post-treatment management

Clinical observations were recorded on the day of treatment and on 15th and 30th post-treatment day. All the animals were given cage rest for a period of one month. Radiographs of the fractured region were taken on 15th and 30th post-treatment day. In both the Groups damaged/mutilated cast/splint was replaced whenever necessary. All the animals were observed for the carriage of the limb and other abnormalities.

Main items of observation

General condition of animal

The general health status of the animal was evaluated based on

- General appearance of the animal
- Feed intake
- Urination and defecation (voiding habits)

Condition of lame limb

- The lame limb was evaluated based on its functional status, angulation and weight bearing.

Physiological parameters

Respiration rate, pulse rate and rectal temperature were recorded before the treatment and on 15th and 30th day of treatment.

Haematological parameters

blood samples collected in EDTA* – coated vials were estimated for packed cell volume, haemoglobin concentration, total leucocyte count and differential leucocyte count on the day of presentation of the animal and on 15th and 30th post-treatment day as per the method described by Schalm (1975).

Physical parameters

The treated limb was observed for any swelling, loosening and/or damage of the cast/splint and presence of any exudate.

The clinical evaluation of the lame limb was carried out based on the parameters given below on the day of presentation of the animal and at 15th and 30th post-treatment day.

- Weight bearing
- Carriage of the limb
- Immobilizing effect
- Loosening of the splint
- Self mutilation
- Complications if any

---

*EDTA : EDTA Disodium salt (Nice Laboratory Reagent), New India Chemical Enterprises, Kochi.

Radiological studies

Radiological studies of the affected limb were performed (lateral and antero-posterior view) before immobilization to determine the type and location of the fracture and the extent of damage to nearby tissues and on 15^{th} and 30^{th} post-treatment day to evaluate the progress of healing as evidenced by callus formation and bridging of the gap at fracture site.

Biochemical parameters

The serum collected by the standard procedure on the day of presentation of the animal and on 15^{th} and 30^{th} post-treatment day were used for the estimation of biochemical parameters.

Serum alkaline phosphatase*

Serum alkaline phosphatase was estimated using alkaline phosphatase kit. The rate of increase in 4 nitro phenolate, which was directly proportional to the alkaline phosphatase was determined using spectrophotometer (Bergmeyer, 1972).

---

* *Alkaline phosphatase kit : Merck Diagnostics. E. Merck (India) Ltd., Worli, Mumbai.*

Serum acid phosphatase*

Serum acid phosphatase was estimated using acid phosphatase kit. The rate of increase in azo dye, which was directly proportional to the acid phosphatase activity was determined using spectrophotometer (Hillmann, 1971).

Statistical analysis

The data were analysed using paired t test and Student's t test (Snedecor and Cochran, 1994).

---

*Acid phosphatase kit: Merck Diagnostics. E. Merck (India) Ltd., Worli, Mumbai.

Fig.1. **Dog with its right limb immobilized by plaster of Paris cast**

Fig.2a **The prepared polyvinyl chloride splints provided with lining of cotton**

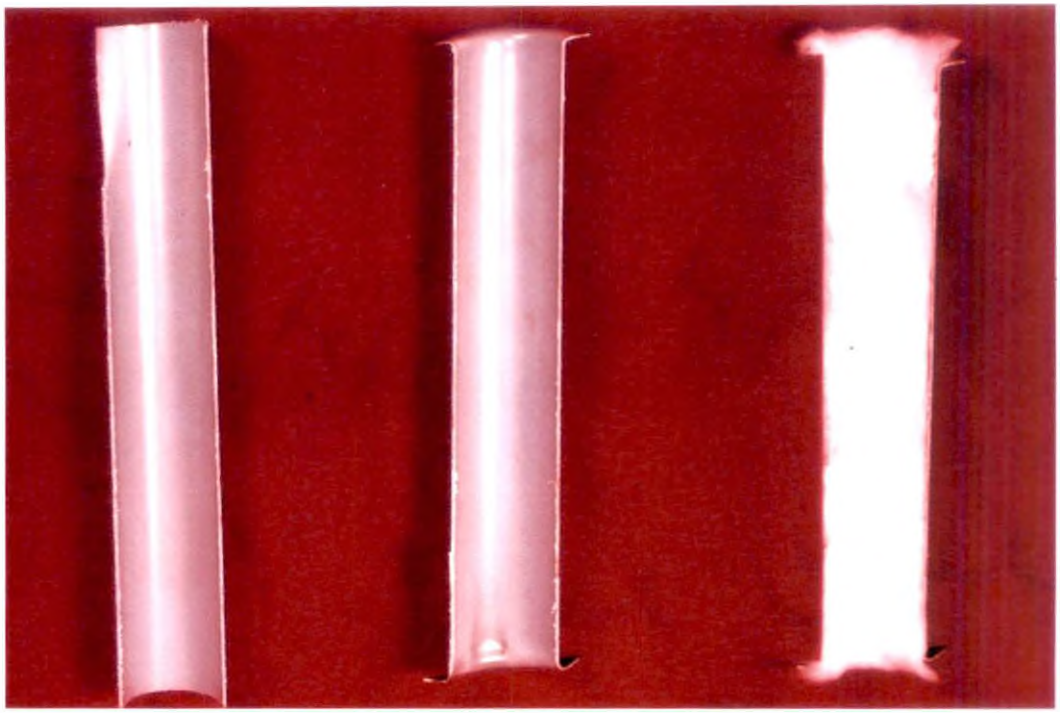
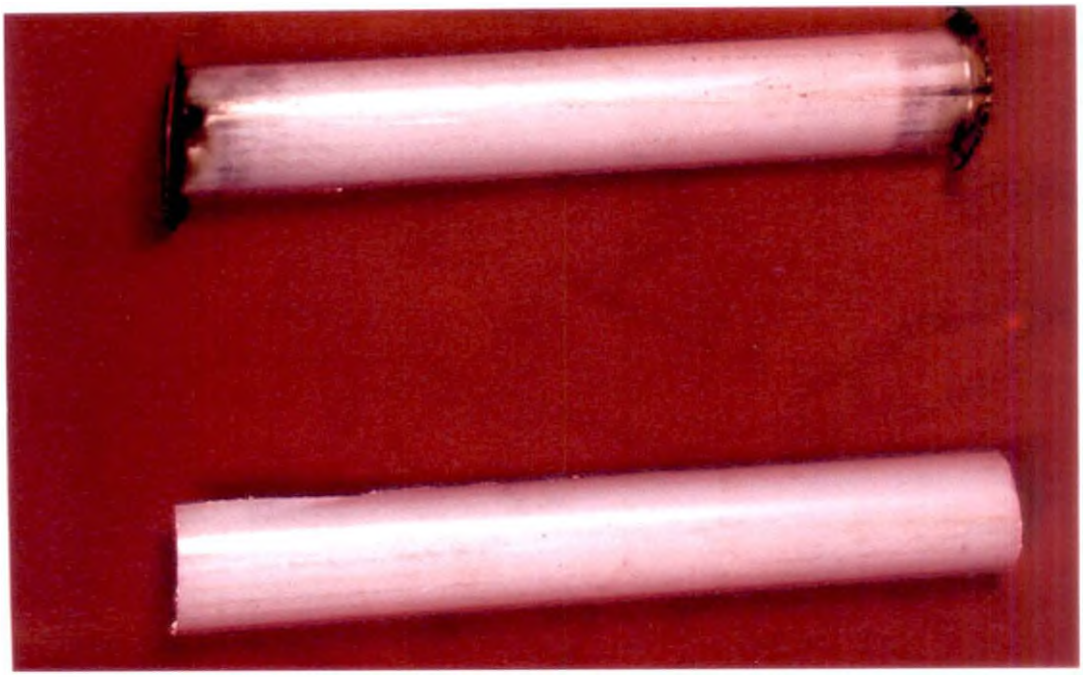


Fig.2b **The prepared polyvinyl chloride splints (convex side)**

Fig.3. **The animal after immobilization of the limb by polyvinyl chloride splints and bandages**



Results

RESULTS

GROUP I

Pre-treatment observations

Observations are presented in Table 1

Breeds of animals affected in this group were Alsatian (3) Pomeranian (2) and Lhasa Apso (1). The animals were aged between one and three years, with majority of animals between one and one and a half years. The body weight of animals ranged between 9 and 25 kgs. Among six animals, four were males and two were females.

Automobile accident was the major exciting cause for the fracture. This was noticed in animals A2, A4 and A6. In animals A3 and A5, cause of the fracture was fall from height and in animal A1, fracture was resulted due to blow.

The animals A2, A5 and A6 were presented to the clinic on the same day of occurrence of fracture. The animals A3 and A4 were presented on the second post fracture day and animal A1 on the third post fracture day.

The right forelimb sustained fracture in animals A1, A3, A4 and A6 and left forelimb in animals A2 and A5. All the animals in this group were active and alert except for the lameness of the affected limb.

Post-treatment observations

General condition

General appearance of all the animals of this group were apparently normal.

Physiological parameters

Observations are presented in Table 2.

Respiration rate

The mean respiration rate (per min.) was 59.16 ± 5.44 on 0 day, 58.30 ± 5.16 and 60.33 ± 6.81 respectively on 15th and 30th post-treatment day. The variation in respiration rate was within normal physiological range through out the period of observation.

Pulse rate

The mean pulse rate (per min.) was 89.00 ± 5.21 on 0 day, 93.66 ± 3.83 and 90.00 ± 3.25 respectively on 15th and 30th post-treatment day. There was slight rise in pulse rate on 15th post-treatment day and it decreased towards normal by 30th post-treatment day.

Rectal temperature

The mean rectal temperature (°C) was 39.13 ± 0.38 on 0 day, 39.10 ± 0.46 and 39.07 ± 0.24 respectively on 15th and 30th post-treatment day. The

variation in rectal temperature was within normal physiological range through out the period of observation.

Haematological parameters

Observations are presented in Table 3.

Packed cell volume (PCV)

The mean packed cell volume (%) was 39.33 ± 0.84 on 0 day, 39.66 ± 0.55 and 39.16 ± 0.54 respectively on 15th and 30th post-treatment day. The variation in packed cell volume was within normal physiological range through out the period of observation.

Haemoglobin concentration

The mean haemoglobin concentration (g/dl) was 11.91 ± 0.32 on 0 day, 13.41 ± 0.23 and 13.16 ± 0.30 respectively on 15th and 30th post-treatment day. There was significant increase ($p<0.05$) in heamoglobin on 15th post-treatment day and it remained elevated on 30th post-treatment day.

Total leucocyte count

The mean total leucocyte count ($x10^3/mm^3$) was 13.32 ± 0.34 on 0 day, 13.64 ±0.34 and 13.65 ± 0.28 respectively on 15th and 30th post-treatment day. The variation in total leucocyte count was within normal physiological range through out the period of observation.

Differential leucocyte count

Neutrophil count

The mean neutrophil count (%) was 67.33 ± 1.52 on 0 day, 69.33 ± 1.62 and 67.33 ± 1.17 respectively on 15th and 30th post-treatment day. There was rise in neutrophil count on 15th post-treatment day and it decreased towards normal by 30th post-treatment day.

Lymphocyte count

The mean lymphocyte count (%) was 29.66 ± 1.42 on 0 day, 29.50 ± 1.14 and 29.16 ± 0.90 respectively on 15th and 30th post-treatment day. The variation in lymphocyte count was within normal physiological range through out the period of observation.

Eosinophil count

The mean eosinophil count (%) was 0.30 ± 0.30 on 0 day, 0.40 ± 0.40 and 0.20 ± 0.20 respectively on 15th and 30th post-treatment day. The variation in eosinophil count was within normal physiological range through out the period of observation.

Basophil count

The mean basophil count was (%) 0.00 ± 0.00 on 0 day, 0.33 ± 0.21 and 0.20 ± 0.20 respectively on 15th and 30th post-treatment day. The variation in

basophil count was within normal physiological range through out the period of observation.

Monocyte count

The mean monocyte count was (%) 1.16 ± 0.40 on 0 day, 1.16 ± 0.54 and 0.60 ± 0.49 respectively on 15th and 30th post-treatment day. The variation in monocyte count was within normal physiological range through out the period of observation.

Physical parameters

0 Day

Observations are presented in Table 4.

All the animals were unable to bear weight on the affected limb and were holding the limb high above the ground level. The lifted limb was held flexed at the carpal joints. Oedema and fracture instability at the site of fracture were noticed in all the animals. The site of fracture was painful to touch and crepitation was felt on palpation in all the animals. Soft tissue injury to neighbouring tissue was noticed in animal A1. None of the animals, except animal A2 showed rotational deformity. In animal A4, the affected limb was shortened when compared to opposite limb.

After application of plaster of Paris cast, all the animals were dragging the immobilized limb during progression and were unable to bear weight on the limb.

On third post-treatment day in animal A4, soft tissue trauma developed at the lower extremity of the limb due to pressure from plaster of Paris cast and it healed later when the pressure was relieved. Oedma at the lower extremity of the limb due to pressure from the plaster of Paris cast was noticed on second post-treatment day in animals A1 and A3. Loosening of the cast was reported in animal A2 on second post-treatment day. Animals A2 and A4 mutilated the cast and it was reapplied on eighth and fourth post-treatment day respectively.

15th day

Observations are presented in Table 5.

Animals A1, A4 and A6 started bearing weight on the immobilized limb. The affected limb was carried high above the ground level in animals A2, A3 and A5. While reapplying the plaster cast in animal A2, slight mobility and pain at the site of fracture was noticed. A hard palpable mass could be felt at the fractured site in animals A2 and A4. Immobilizing effect was good in all animals except A2 and A4, where the reapplication of cast continued as and when it gets mutilated. In none of the animals loosening of the plaster of Paris cast was reported.

30th day

Observations are presented in Table 6.

All the animals were able to use the immobilized limb actively and were able to bear weight on the affected limb. The plaster of Paris cast was intact and was removed in all the animals. Animal A3 and A4 evinced pain on palpating the fractured site. Carriage of the limb was normal in all the animals except animal A2 where occasional limping was noticed. Rashes on the skin were noticed due to the loss of hair after the removal of plaster of Paris cast in all the animals. A well palpable hard callus at the site of fracture was felt in all the animals.

Radiological studies

Observations are presented in Table 7.

0 day

In all animals except animal A3, a complete transverse fracture of radius and ulna was noticed (Fig.4) and in animal A3 complete transverse fracture of radius alone was observed. The fracture was noticed at distal third of diaphysis in animals A1 and A4 and at the middle third of diaphysis in animals A2, A3, A5 and A6. Over riding fracture was noticed in animals A2 and A5 and in animal A6 angulation at the middle third of diaphysis was noticed. There was

involvement of both cortex and medulla of the bones in all the animals. Lateral displacement of distal bone fragment was observed in animals A1, A3 and A5.

15th day

Small amount of periosteal reaction was demonstrated in animals A2, A3 and A6 (Fig.5). No periosteal reaction could be observed in animals A1and A4. Animals A1, A3 and A4 revealed increased radio-opacity in the fracture line. Medullary canal at the fracture site was obliterated in all animals. Gap in between fracture fragments was clearly discernible in all the animals. Lateral displacement of distal bone fragment was noticed in animals A1, A2 and A5 and in animal A3, medial displacement of the distal bone fragment was noticed (Fig.7). A slight degree of angulation was noticed in animal A2.

30th day

Moderate amount of periosteal callus was demonstrated in all animals. Complete bridging of the fracture gap was noticed in animals A1 and A6 (Fig.6). In all other animals, gap between the bone fragments was evident partially. Lateral displacement of distal bone fragment persisted in animal A2 and bone healed in mild degree angulation. There was complete displacement of distal bone fragment in animal A5, but moderate amount of periosteal callus on the lateral aspect effected bone union.

Biochemical parameters

Observations are presented in Table 8.

Serum alkaline phosphatase

The mean serum alkaline phosphatase level (IU/L) was 166.83 ± 1.47 on 0 day, 183.70 ± 15.84 on 15th post-treatment day and 103.10 ± 8.50 on 30th post-treatment day. A significant increase ($p<0.05$) in serum alkaline phosphatase level on 15th post-treatment day followed by a significant decrease on 30th post-treatment day was observed.

Serum acid phosphatase

The mean serum acid phosphatase level (IU/L) was 1.33 ± 0.20 on 0 day, 2.20 ± 0.18 on 15th post-treatment day and 0.91 ± 0.25 on 30th post-treatment day. A significant increase ($p<0.05$) in serum acid phosphatase level was noticed on 15th post-treatment day and it showed a significant decrease towards normal by 30th post-treatment day.

Table 1. Pre treatment observations on the day of presentation (Group I)

Animal No.	Breed	Age	Sex	Weight (Kg)	Etiology	Limb affected	Duration of illness (days)	Location of fracture	Type of fracture
A1	Alsatian	1 year and 3 months	Male	23	Blow	Right	3	Distal third of diaphysis	Complete transverse fracture in radius and ulna
A2	Pomeranian	3 year	Female	9	Automobile accident	Left	1	Middle third of diaphysis	Complete transfverse with over riding in radius and ulna
A3	Alsatian	1 year and 6 months	Male	25	Fall from height	Right	2	Middle third of diaphysis	Complete transverse fracture of radius
A4	Alsatian	1 year	Male	16	Automobile accident	Right	2	Distal third of diaphysis	Complete transverse fracture in radius and ulna
A5	Pomeranian	2 year	Female	11	Fall from height	Left	1	Middle third of diaphysis	Complete transverse fracture in radius and ulna
A6	Lhasa Apso	1 year and 3 months	Male	9	Automobile accident	Right	1	Middle third of diaphysis	Complete transverse fracture with angulation in radius and ulna

Table 2. Observations on physiological parameters (mean ± SE) before and after immobilization (Group I)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Respiration rate (per min.)	59.16 ± 5.44	58.50 ± 5.16	60.33 ± 6.81
Pulse rate (per min.)	89.00 ± 5.21	93.66 ± 3.83	90.00 ± 3.25
Rectal temperature (°C)	39.13 ± 0.38	39.10 ± 0.46	39.07 ± 0.24

Table 3. Haematological parameters (mean ± SE) before and after immobilization (Group I)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Packed cell volume (%)	39.33 ± 0.84	39.66 ± 0.55	39.16 ± 0.54
Haemoglobin (g/dl)	11.91 ± 0.32	13.41 ± 0.23*	13.16 ± 0.30
Total leucocyte count ($10^3/mm^3$)	13.32 ± 0.34	13.64 ± 0.34	13.65 ± 0.28
Neutrophil count (%)	67.33 ± 1.52	69.33 ± 1.62	67.33 ± 1.17
Lymphocyte count (%)	29.66 ± 1.42	29.50 ± 1.14	29.16 ± 0.90
Eosinophil count (%)	0.30 ± 0.30	0.40 ± 0.40	0.20 ± 0.20
Basophil count (%)	0.00 ± 0.00	0.33 ± 0.21	0.20 ± 0.20
Monocyte count (%)	1.16 ± 0.40	1.16 ± 0.54	0.60 ± 0.49

*Significant ($p<0.05$)

Table 4. Physical parameters during the first two weeks (Group I)

Parameters	A1	A2	A3	A4	A5	A6
Weight bearing	-	-	-	-	-	-
Carriage of the limb	Lifted high	Lifted high	Lifted high	Lifted high	Lifted high	Lifted high
Immobilizing effect	Effective	Not Effective	Effective	Not Effective	Effective	Effective
Loosening of splint	-	+	-	-	-	-
Self mutilation	-	+	-	+	-	-
Complications if any	Oedema at the lower extremity of the limb	-	Oedema at the lower extremity of the limb	Soft tissue trauma at the lower extremity of the limb	-	-

Present (+)
Absent (-)

Table 5. Physical parameters on 15th day (Group I)

Parameters	A1	A2	A3	A4	A5	A6
Weight bearing	+	-	-	+	-	+
Carriage of the limb	Normal	Lifted high	Lifted high	Normal	Lifted high	Normal
Immobilizing effect	Effective	Not Effective	Effective	Not Effective	Effective	Effective
Loosening of splint	-	-	-	-	-	-
Self mutilation	-	+	-	+	-	+
Complications if any	-	Pain and mobility at fracture site	-	-	-	-

Present (+)
Absent (-)

Table 6. Physical parameters on 30th day (Group I)

Parameters	A1	A2	A3	A4	A5	A6
Weight bearing	+	+	+	+	+	+
Carriage of the limb	Normal	Limping	Normal	Normal	Normal	Normal
Immobilizing effect	Effective	Not effective	Effective	Effective	Effective	Effective
Loosening of splint	-	-	-	-	-	-
Self mutilation	-	-	-	-	-	-
Complications if any	-	-	Pain at the fracture site	Pain at the fracture site	-	-

Present (+)

Absent (-)

Table 7. Radiological studies before and after immobilization (Group I)

Animal No.	0 day	15th post treatment day	30th post treatment day
A1	Complete transverse fracture at distal third of diaphysis in both radius and ulna	No periosteal reaction at fracture site, radio opacity in fracture line, lateral displacement of bone fragments	Moderate amount of periosteal callus and complete bridging of fracture gap
A2	Complete transverse fracture with over riding at middle third of diaphysis in both radius and ulna	Small amount of periosteal reaction at the fracture site, lateral displacement and slight angulation of the bone fragments	Moderate amount of periosteal callus and lateral displacement of bone fragments
A3	Complete transverse fracture at the middle third of diaphysis of radius	Small amount of periosteal reaction at the fracture site, increased radio opacity in fracture line and medial displacement of bone fragments	Moderate amount of periosteal callus, gap between bone fragments evident partially
A4	Complete transverse fracture at the distal third of diaphysis in both radius and ulna	No periosteal reaction at fracture site, radio opacity in the fracture line	Moderate amount of periosteal callus, gap between bone fragments evident partially
A5	Complete transverse fracture with over riding at middle third of diaphysis in both radius and ulna	Small amount periosteal reaction and lateral displacement of bone fragments	Moderate amount of periosteal callus, complete displacement of bone fragments
A6	Complete transverse fracture with angulation at the middle third of diaphysis of radius and ulna	Small amount of periosteal reaction at the fracture site	Moderate amount of periosteal callus and complete bridging of fracture gap

Table 8. Biochemical parameters (mean ± SE) before and after immobilization (Group I)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Serum alkaline phosphatase (IU/L)	166.83 ± 1.47	183.70 ± 15.84*	103.10 ± 8.50*
Serum acid phosphatase (IU/L)	1.33 ± 0.20	2.20 ± 0.18*	0.91 ± 0.25*

*Significant ($p<0.05$)

Fig.4. **Skiagram of fracture of radius and ulna of a dog in Group I showing complete transverse fracture with angulation at the middle third of diaphysis on zero day**

Fig.5. **Skiagram of radius and ulna of a dog in Group I on 15th post treatment day showing small amount of periosteal reaction**


A6 0
A6 0
LAT

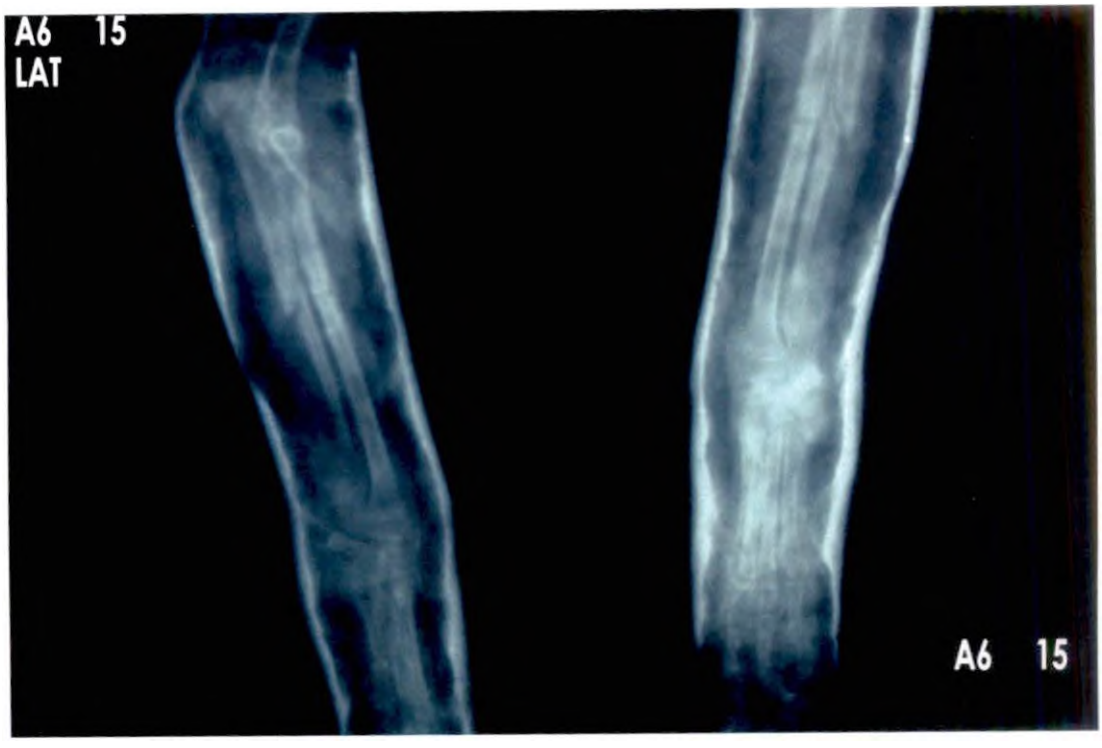

A6 15
LAT
A6 15

Fig.6. **Skiagram of radius and ulna of a dog in Group I on 30th post treatment day showing moderate degree of periosteal callus**

Fig.7. **Skiagram of radius and ulna of a dog in Group I on 15th post treatment day showing displacement of fragments and moderate degree of periosteal reaction**


A6 30
LAT

GROUP II

Pre-treatment observations

Observations are presented in Table 9.

Breeds of animals affected in this group were Pomeranian-Non-descript cross (2), Alsatian (1), Pomeranian (1), Non-descript (1) and Boxer (1). The animals were aged between seven months and 10 years with majority of animals between seven months and one and a half years. Body weight of animals ranged between 7 and 26 kgs. Among six animals, five were males and one was female.

Automobile accident was the major exciting cause for fracture. This was noticed in animals B2, B3, B5 and B6. In animals B1 and B4, fracture resulted due to fall from height of terrace.

The animals B1, B2 and B6 were presented to the hospital on the same day of occurrence of fracture. The animals B3 and B5 were presented on the second post fracture day and animal B4 on the third post fracture day.

The right forelimb sustained fracture in animals B1, B2 and B3 and left forelimb in animals B4, B5 and B6. All the animals of this group were active and alert except for lameness of affected limb.

Post-treatment observations

General condition

General appearance of all the animals of this group were apparently normal.

Physiological parameters

Observations are presented in Table 10.

Respiration rate

The mean respiration rate (per min.) was 60.00 ± 6.22 on 0 day, 52.83 ± 1.49 and 54.00 ± 1.48 respectively on 15th and 30th post-treatment day. There was slight fall in respiration rate on 15th post-treatment day and it increased towards normal by 30th post-treatment day.

Pulse rate

The mean pulse rate (per min.) was 96.88 ± 3.70 on 0 day, 94.16 ± 2.03 and 90.66 ± 2.74 respectively on 15th and 30th post-treatment day. There was decrease in pulse rate on 15th post-treatment day and it remained low on 30th post-treatment day.

Rectal temperature

The mean rectal temperature (°C) was 39.14 ± 0.37 on 0 day, 39.03 ± 0.36 and 39.16 ± 0.29 respectively on 15th and 30th post-treatment day. The

variation in rectal temperature was within normal physiological range through out the period of observation.

Haematological parameters

Observations are presented in Table 11.

Packed cell volume

The mean packed cell volume (%) was 37.50 ± 1.15 on 0 day, 39.33 ± 1.08 and 39.66 ± 0.66 respectively on 15th and 30th post-treatment day. There was rise in packed cell volume on 15th post-treatment day and it remained elevated on 30th post-treatment day

Haemoglobin concentration:

The mean haemoglobin concentration (g/dl) was 11.83 ± 0.58 on 0 day, 13.00 ± 0.45 and 12.40 ± 0.52 respectively on 15th and 30th post-treatment day. There was significant increase ($p<0.05$) in haemoglobin on 15th post-treatment day and it decreased towards normal by 30th post-treatment day.

Total leucocyte count

The mean total leucocyte count ($x10^3/mm^3$) was 12.39 ± 0.27 on 0 day, 13.26 ± 0.39 and 13.33 ± 0.17 respectively on 15th and 30th post-treatment day. There was rise in total leucocyte count on 15th post-treatment day and it remained high on 30th post-treatment day.

Differential leucocyte count

Neutrophil count

The mean neutrophil count (%) was 65.33 ± 1.35 on 0 day, 66.00 ± 2.87 and 67.00 ± 1.54 respectively on 15th and 30th post-treatment day. There was rise in neutrophil count on 15th post-treatment day and the value remained elevated on 30th post-treatment day.

Lymphocyte count

The mean lymphocyte count (%) was 33.50 ± 1.05 on 0 day, 29.33 ± 2.47 and 31.33 ± 1.05 respectively on 15th and 30th post-treatment day. There was fall in lymphocyte count on 15th post-treatment day and it increased towards normal by 30th post-treatment day.

Eosinophil count

The mean eosinophil count (%) was 1.00 ± 0.68 0n 0 day, 0.50 ± 0.34 and 0.00 ± 0.00 respectively on 15th and 30th post-treatment day. The variation in eosinophil count was within normal physiological range through out the period of observation.

Basophil count

The mean basophil count (%) was 0.00 ± 0.00 on 0 day, 0.66 ± 0.33 and 1.00 ± 0.44 respectively on 15th and 30th post-treatment day. The variation in

basophil count was within normal physiological range through out the period of observation.

Monocyte count

The mean monocyte count (%) was 1.00 ± 0.44 on 0 day, 0.00 ± 0.00 and 1.30 ± 0.02 respectively on 15th and 30th post-treatment day. The variation in monocyte count was within normal physiological range through out the period of observation.

Physical parameters

0 Day

Observations are presented in Table 12.

All the animals were unable to bear weight on the affected limb and were carrying the limb high above the ground level. The lifted limb was held flexed at the carpal joints. Oedema and fracture instability was noticed in all the animals. All the animals evinced pain on palpation and crepitation at the site of fracture. None of the animals except animal B6 showed rotational deformity. In animal B2 the entire limb was swollen and hyperaemic due to the infestation with *Demodex canis*.

After the application of PVC splint, animals B1, B3, B4 and B5 were lifting the immobilized limb above the ground surface during progression and

animals B2 and B6 were dragging the limb. All the animals were unable to bear weight on the immobilized limb after the application of PVC splint.

There was oedema and soft tissue trauma developed at the lower extremity of the limb on second day in animals B1 and B2 due to the pressure from the bandage applied around the splint. Thereafter oedema subsided and soft tissue trauma healed when the pressure was relieved. Animals B3, B4 and B6 mutilated the splint and it was reapplied. Loosening of the splint and reapplication was done in animals B2, B3 and B6 five to six times.

15th day

Observations are presented in Table 13.

The PVC splint was intact in all the animals. Animals B1 and B5 started bearing weight on the affected limb. All other animals were dragging the limb during progression. While reapplying the PVC splint slight instability of fracture site was noticed in animals B2, B3 and B6. Animals B2, B3, B4 and B6 evinced pain on palpation of fracture site. Immobilizing effect was good only in animals B1and B5. In all other animals reapplication of PVC splint continued when it was loosened. Rotational deformity was noticed in animal B6. A well palpable callus could be palpated at the site of fracture in all animals.

30th day

Observations are presented in Table 14.

All the animals except B2, B4 and B6 were able to use the immobilized limb actively during progression. The PVC splint was intact and was removed in all the animals. Carriage of the limb was normal in all the animals, except B2, B3, and B6. In animal B2, slight limbing while walking was noticed. In animal B6 rotational deformity at the lower extremity of the limb still noticed. The lower extremity of the affected limb in animal B2 was oedematous and hypereamic due to the reinfestation with *Demodex canis*. A well palpable hard callus at the site of fracture could be detected in all the animals. Immobilizing effect was good in three animals B1, B4 and B5.

Radiological studies

Observations are presented in Table 15.

0 day

A complete oblique fracture with impaction of proximal fragment was noticed at the distal third of diaphysis in animal B1 (Fig.8). In animal B2 and B6 complete transverse fracture with over riding was observed at the distal third of diaphysis and middle third of diaphysis. A complete oblique fracture was noticed in animal B3 at the middle third of diaphysis. In animal B4, a complete oblique fracture with over riding was observed at the distal third of diaphysis. In animal B5, a complete transverse fracture of radius and ulna with impaction of radius was observed at the middle third of diaphysis. In all the animals there was involvement of both cortex and medulla of the bones. Lateral

displacement of distal bone fragment was observed in animal B3. Over riding of distal bone fragment was observed in animals B2, B4 and B5. Lateral displacement of distal bone fragment was observed in animal B3. Moderate degree of angulation was noticed in animal B2.

15th day

Periosteal reaction was mild in animals B1, B4 and B6 (Fig.9). In animals B1, the degree of periosteal proliferation was more at the fracture site of ulna. In animal B5, proliferation of periosteal tissue was mild and the apposition of bone fragment was perfect. In animals B2, B4 and B6 though the apposition of fragments were not absolute proliferation of periosteum was comparatively mild. In animals B1, B5 and B6 the endosteal proliferation has been noticed. Lateral displacement of distal bone fragment was noticed in animals B4 and B6 and in animal B2, the fragment revealed medial displacement (Fig. 11).

30th day

Mild periosteal callus reaction was observed in animal B1 where as moderate amount of periosteal callus was noticed at the site of fracture in animals B2 and B3. The callus had completely bridged the gap between the fragments in animals B1, B2, B3, and B6 (Fig.10). Lateral displacement of distal bone fragment still persisted in animals B4 and B6. A mild degree of angulation was noticed in animal B6.

Biochemical parameters

Observations are presented in Table 16.

Serum alkaline phosphatase

The mean serum alkaline phosphatase level (IU/L) was 145.38 ± 11.30 on 0 day, 161.58 ± 7.80 on 15th post-treatment day and 79.83 ± 18.12 on 30th post-treatment day. A significant increase ($p<0.05$) in serum alkaline phosphatase level on 15th post-treatment day followed by a significant decrease ($p<0.05$) on 30th post-treatment day was noticed.

Serum acid phosphatase

The mean serum acid phosphatase level (IU/L) was 0.61 ± 0.11 on 0 day, 1.10 ± 0.21 on 15th post-treatment day and 0.88 ± 0.17 on 30th post-treatment day. There was a significant increase ($p<0.05$) in serum acid phosphatase level on 15th post-treatment day followed by a significant decrease ($p<0.05$) towards normal on 30th post-treatment day.

Table 9. Pre treatment observations on the day of presentation (Group II)

Animal No.	Breed	Age	Sex	Weight (Kg)	Etiology	Limb affected	Duration of illness (days)	Location of fracture	Type of fracture
B1	Alsatian	1 year and 8 months	Male	26	Fall from height	Right	1	Distal third of diaphysis	Complete oblique fracture of radius and ulna
B2	Boxer	7 months	Female	16	Automobile accident	Right	1	Distal third of diaphysis	Complete transverse and over riding fracture of radius and ulna
B3	Pomeranian non-descript cross	2 years	Male	9	Automobile accident	Right	2	Middle third of diaphysis	Complete oblique fracture of radius and ulna
B4	Pomeranian	7 months	Male	13	Fall from height	Left	3	Distal third of diaphysis	Complete oblique with over riding fracture of radius and ulna
B5	Non-descript	8 months	Male	10	Automobile accident	Left	2	Middle third of diaphysis	Complete transverse fracture of radius and ulna
B6	Pomeranian non-descript cross	10 years	Male	7	Automobile accident	Left	1	Middle third of diaphysis	Complete transverse with over riding fracture of radius and ulna

Table 10. Observations on physiological parameters (mean ± SE) before and after immobilization (Group II)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Respiration rate (per min.)	60.00 ± 6.22	52.83 ± 1.49	54.00 ± 1.48
Pulse rate (per min.)	96.88 ± 3.70	94.16 ± 2.03	90.66 ± 2.74
Rectal temperature (°C)	39.14 ± 0.37	39.03 ± 0.36	39.16 ± 0.29

Table 11. Haematological parameters (mean ± SE) before and after immobilization (Group II)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Packed cell volume (%)	37.50 ± 1.15	39.33 ± 1.08	39.66 ± 0.66
Haemoglobin (g/dl)	11.83 ± 0.58	13.00 ± 0.45*	12.40 ± 0.52
Total leucocyte count ($10^3/mm^3$)	12.39 ± 0.27	13.26 ± 0.39	13.33 ± 0.17
Neutrophil count (%)	65.33 ± 1.35	66.00 ± 2.87	67.00 ± 1.54
Lymphocyte count (%)	33.50 ± 1.05	29.33 ± 2.47	31.33 ± 1.05
Eosinophil count (%)	1.00 ± 0.68	0.50 ± 0.34	0.00 ± 0.00
Basophil count (%)	0.00 ± 0.00	0.66 ± 0.33	1.00 ± 0.44
Monocyte count (%)	1.00 ± 0.44	0.00 ± 0.00	1.30 ± 0.02

*Significant ($p<0.05$)

Table 12. Physical parameters during the first two weeks (Group II)

Parameters	B1	B2	B3	B4	B5	B6
Weight bearing	-	-	-	-	-	-
Carriage of the limb	Lifted high	Lifted high	Lifted high	Lifted high	Lifted high	Lifted high
Immobilizing effect	Effective	Not effective	Not effective	Effective	Effective	Not effective
Loosening of splint	-	+	+	-	-	+
Self mutilation	-	-	+	+	-	+
Complications if any	Wound and swelling on the Digits	Wound and swelling on the Digits	-	-	-	-

Present (+)

Absent (-)

Table 13. Physical parameters on 15th day (Group II)

Parameters	B1	B2	B3	B4	B5	B6
Weight bearing	+	-	-	-	+	-
Carriage of the limb	Normal	Dragging	Dragging	Dragging	Normal	Dragging
Immobilizing effect	Effective	Not-effective	Not-effective	Not-effective	Effective	Not-effective
Loosening of splint	-	+	+	+	-	+
Self mutilation	+	-	+	+	+	+
Complications if any	-	Pain at fracture site	Pain at the fracture site	Pain at the fracture site	-	Pain at the fracture site

Present (+)

Absent (-)

Table 14. Physical parameters on 30th day (Group II)

Parameters	B1	B2	B3	B4	B5	B6
Weight bearing	+	-	+	-	+	-
Carriage of the limb	Normal	Limping	Limping	Normal	Normal	Limping
Immobilizing effect	Effective	Not effective	Not effective	Effective	Effective	Not effective
Loosening of splint	-	-	-	-	-	-
Self mutilation	-	-	+	-	-	-
Complications *if any*	-	Oedema and hyperemia on the digits	-	-	-	Rotational deformity at the lower extremity

Present (+)
Absent (-)

Table 15. Radiological studies before and after immobilization (Group II)

Animal No.	0 day	15th post treatment day	30th post treatment day
B1	Complete oblique fracture at distal third of diaphysis in both radius and ulna	Periosteal reaction at fracture site, endosteal proliferation noticed.	Mild amount of periosteal callus reaction and complete bridging of fracture gap.
B2	Complete transverse fracture with over riding at distal third of diaphysis and mild degree of angulation in both radius and ulna	Mild periosteal reaction at the fracture site	Moderate amount of periosteal callus reaction, complete bridging of fracture gap.
B3	Complete oblique fracture at the middle third of diaphysis, lateral displacement of bone fragments of radius and ulna	Mild periosteal reaction at the fracture site	Moderate amount of periosteal callus reaction, complete bridging of fracture gap.
B4	Complete oblique fracture with over riding at the distal third of diaphysis in both radius and ulna	Periosteal reaction at fracture site, radio opacity in the fracture line	Moderate amount of periosteal callus, lateral displacement of bone fragments noticed.
B5	Complete transverse fracture of radius and ulna with impaction of radius at the middle third of diaphysis	Small amount periosteal reaction and perfect apposition of bone fragments	Moderate amount of periosteal callus, complete displacement of bone fragments
B6	Complete transverse fracture with over riding at the middle third of diaphysis of radius and ulna	Small amount of periosteal reaction at the fracture site, endosteal proliferation	Moderate amount of periosteal callus and complete bridging of fracture gap, mild degree angulation of bone fragments.

Table 16. Biochemical parameters (mean ± SE) before and after immobilization (group II)

(n = 6)

Parameters and units	Day of observations		
	0 day	15th post treatment day	30th post treatment day
Serum alkaline phosphatase (IU/L)	145.38 ± 11.30	161.58 ± 7.80*	79.83 ± 18.23*
Serum acid phosphatase (IU/L)	0.61 ± 0.11	1.1 ± 0.21*	0.88 ± 0.17*

*Significant ($p<0.05$)

Fig.8. Skiagram of fracture of radius and ulna of a dog in Group II showing complete oblique fracture at the distal third of diaphysis on zero day

Fig.9. Skiagram of radius and ulna of a dog in Group II on 15th post treatment day showing mild periosteal reaction


B1 0
B1 0
LAT

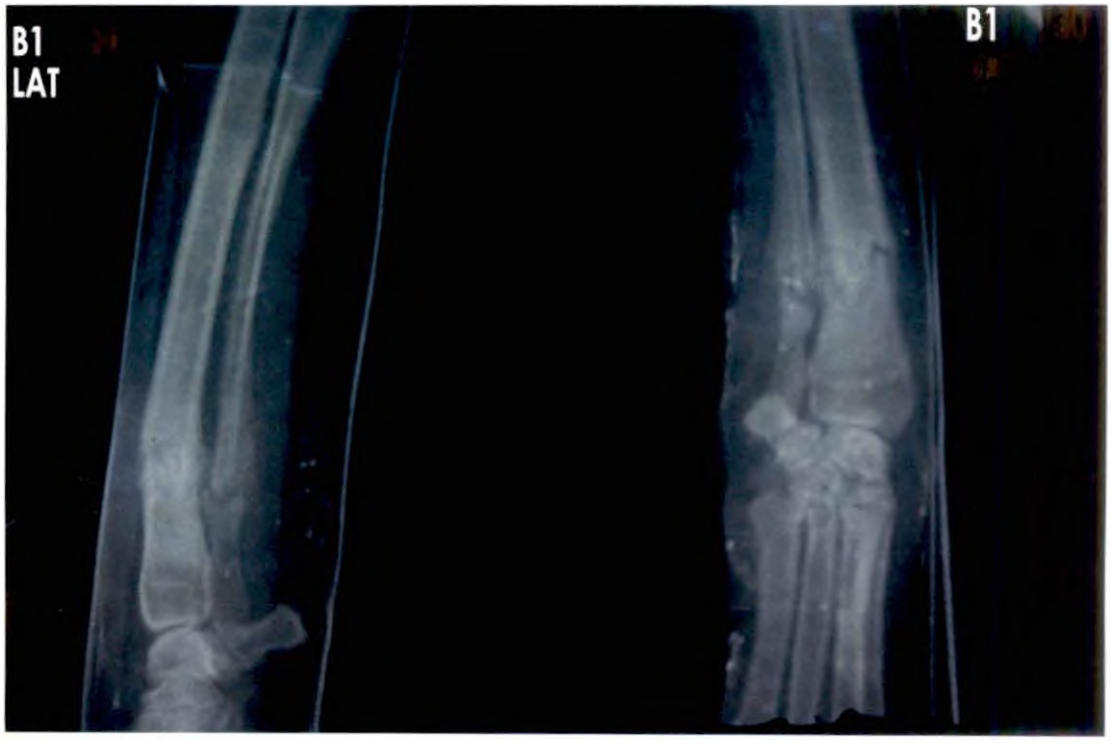
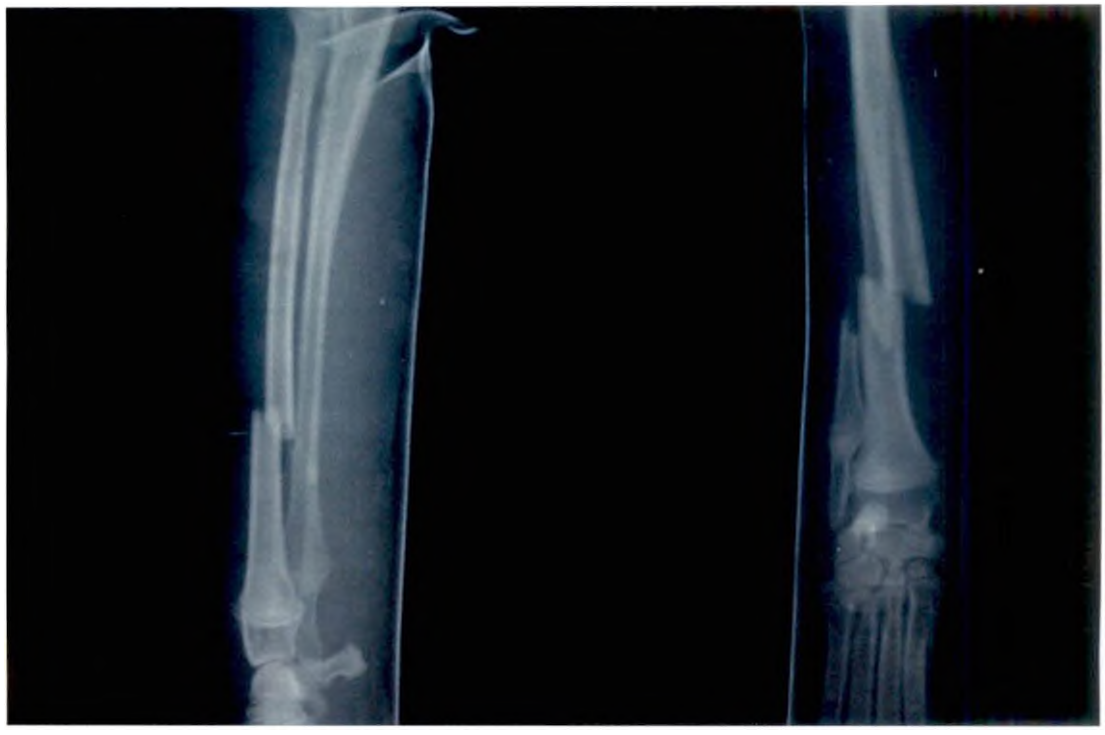

B1
LAT
B1

Fig.10. **Skiagram of radius and ulna of a dog in Group II on 30th post treatment day showing moderate amount of periosteal callus**

Fig.11. **Skiagram of radius and ulna of a dog in Group II on 15th post treatment day showing displacement of fragments and marked degree of periosteal reaction**


B1 30
LAT



Discussion

DISCUSSION

Fracture of long bones are common in companion animals and are usually the result of direct violence such as automobile accidents, animal fights, fall from height etc. Radius is the principal weight bearing bone of the forelimb and it is more prone to fracture (Aithal *et al.*, 1999). In young animals, closed reduction and external coaptation is preferred as a treatment for long bone fractures as they have faster healing time whereas a more rigid fixation is preferred in adults because of slow healing time (Rochat and Payne, 1993).

The present study was carried out with the objective to evaluate the efficacy of external coaptation with PVC splints/plaster of Paris and its immobilizing effects in managing long bone fractures of radius and ulna in dogs. Twelve clinical cases of fracture of radius and ulna in dogs of either sex presented to the clinics of College of Veterinary and Animal Sciences, Mannuthy were the subjects for this study. These animals were divided into two groups viz. Group I and Group II, consisting of six animals each. In Group I, after reduction the fractured limb was immobilized by application of plaster of Paris cast and in Group II, fractured limb was immobilized by application of PVC splint.

Plaster of Paris cast has got several inherent deficiencies like slow setting time, high setting temperature, permeability to water, low strength and poor radiolucency (West, 1963). The main cause of failure with the use of

plaster of Paris cast was the incorrect application resulting in inadequate immobilization and malalignment of the fragment. The plaster of Paris cast when applied will cause irritation to the animal's skin especially in hairy breeds and that may result in mutilation by the animal resulting in impaired immobilization. It failed to provide adequate immobilization particularly when used for the treatment of oblique fracture (Hunt *et al.*, 1980). Singh *et al.* (1984) also reported complications like malunion, delayed union and non-union with the use of plaster of Paris cast. The advantages of PVC splint are, it is light in weight, cost effective, does not create any strain, free from any sort of chemical reaction on contact with skin. It can be changed as per the need and equally effective in fractures with external injuries/infections, where repeated dressing and application of medicines are required.

Anaesthesia

All the animals were sedated with xylazine hydrochloride at a dose rate of 1 mg/kg body weight after premedication with atropine sulphate at a dose of 0.045 mg/kg body weight. In 2.5% cases, 2.5 per cent solution of thiopentone sodium was injected intravenously 'to effect' general anaesthesia. The anaesthesia was sufficient with adequate muscle relaxation for the reduction of fracture and immobilization of the fractured limb.

Technique of immobilization

Closed reduction technique was followed in all the animals to reduce the bone fragments into proper apposition and alignment. In Group I immobilization was effected by plaster of Paris cast and in Group II by PVC splint. In the present study preparation and application of PVC splint to immobilize the fractured limb was found satisfactory. The studies carried out by Sarkate *et al.* (1993) in caprines and bovines also reported PVC splint as an acceptable external immobilization device.

Pretreatment observations

Breed wise study of fractures revealed that incidence was highest in Alsatian (33.3%) followed by Pomeranian (22.5%). This was in agreement with the findings of Balagopalan *et al.* (1995). However, Thilagar and Balasubramanian (1988) and Aithal *et al.* (1999) reported higher incidence of fracture in non-descript dogs. The incidence of fractures in Alsatian may be attributed to more aggressive temperament of the animal.

Considering the age-wise incidence, fractures were more common in age group between seven months and One year (66.6%) followed by one and a half to three years (33.3%). This is in accordance with the findings of Phillips (1979) and Aithal *et al.* (1999). This may be due to the fact that young animals are more active and are not learnt to cope with hazards unlike their older counterparts (Aithal *et al.*, 1999). Thilagar and Balasubramanian (1988) and

Balagopalan *et al.* (1995) recorded a higher incidence of fracture in age group of three to six months followed by day old to three months.

Out of 12 animals presented to the clinics, 75% were males and 25% were females. Similar observations have been reported by Phillips (1979); Thilagar and Balasubramanian (1988); Balagopalan *et al.* (1995) and Aithal *et al.* (1999). This may be attributed to the fact that males are more aggressive and tend to wander more than their female counterparts, thus more prone to fracture (Aithal *et al.*, 1999).

As far as the etiology of fracture is concerned, automobile accident (50%) followed by fall from height (33.3%) and blow (16.6%) were the major exciting causes of fractures in dogs, as reported by Phillips (1979) and Aithal *et al.* (1999).

Among the 12 cases, 50% of the cases were presented on the same day of incidence of fracture, 25% on second post fracture day and 25% on third post fracture day.

General condition

The animals in both the group were active and alert except for the lameness on the day of presentation. Feeding and voiding habits were also found to be normal in all the animals of both the groups.

Physiological parameters

In Group I, the respiration rate was within the normal physiological range. Where as in Group II animals respiration rate was slightly low on 15th post-treatment day and was within the normal range by 30th post-treatment day. In Group I there was a slight rise in pulse rate on 15th post-treatment day followed by a decrease towards normal range by 30th post-treatment day. Where as in Group II, decrease in pulse rate was noticed on 15th and 30th post-treatment day. Rectal temperature was within normal physiological range in all the animals of both the groups through out the period of observation.

The observations on physiological parameters during the post-treatment period revealed that the incidence of fracture and immobilization procedure employed did not produce any untoward systemic effects.

Haematological parameters

Packed cell volume was within normal physiological range in Group I animals. Where as in Group II there was a rise in packed cell volume on 15th post-treatment day and it remained elevated on 30th post-treatment day.

Haemoglobin concentration was significantly increased on 15th post-treatment day in both Group I and Group II animals. It remained elevated in Group I and decreased towards normal in Group II on 30th post-treatment day.

Total leucocyte count was within normal physiological range in Group I animal. Increase in total leucocyte count on 15th and 30th post-treatment day was observed in Group II animals.

The little variation in the blood picture noticed may be due to the reduction in fluid and food in take as an after effect of fracture.

Neutrophil count revealed a rise on 15th post-treatment day in animals of both the groups. On 30th post-treatment day there was a decrease towards normal level in Group I and it remained high in Group II animals.

In Group I animals the lymphocyte count was within the normal physiological range on the day of presentation and on 15th and 30th post-treatment day. Animals of Group II showed a fall in lymphocyte count on 15th post-treatment day and a rise towards normal on 30th post-treatment day.

Eosinophil, basophil and monocyte counts revealed marginal and insignificant variation within normal physiological range throughout the period of observation.

Kumar *et al.* (1997) observed a slight decrease in the lymphocyte count, increase in neutrophil count, normal total leucocyte count and total RBC count at various time intervals as compared to pre fracture values. The changes observed in haemogram may be due to the transient period of cellular reaction to trauma, elicited towards healing process (Gourley and Vasseur, 1985).

Physical parameters

All the animals in both the groups exhibited limb dysfunction manifested as inability to bear weight and lifting the affected limb. In both the groups of animals oedema, fracture instability, pain on palpation and crepitation at the site of fracture were noticed. In Group I, one animal had soft tissue injury to the neighbouring tissues of the fracture site. Rotational deformity was observed in one animal in each group. This is in agreement with observations of Roush and McLaughlin (1998) in dogs.

In Group I, all the animals were not bearing weight on the immobilized limb and were dragging the limb during progression. In Group II also all the animals were not bearing the weight, but dragging of the limb was observed in two animals. The higher incidence of dragging of limbs noticed in Group I may be due to the heaviness of the plaster of Paris cast.

Soft tissue trauma at the lower extremity of the immobilized limb was noticed in one animal in Group I and two animals in Group II. Two animals each in Group I and Group II showed oedema at the lower extremity of the limb. This was due to the pressure of plaster of Paris cast and PVC splint on the lower extremity of the limb in both groups. Later oedema subsided and soft tissue trauma healed when the pressure was relieved from the limb. In Group II one animal had *Demodex canis* infestation throughout the body including the affected limb. In this particular case, immobilization of the limb with PVC splint was more effective for frequent dressing and topical application of

medicine over the affected area. Applications and removal of PVC splint was continued as and when dressing and topical medication of the area was required. Two animals in Group I and three animals in Group II mutilated the cast and PVC splint and it was reapplied. This is in agreement with the observations of Anoop (2001) in fracture of tibia in dogs when plaster of Paris cast was applied. Oedema at the site of fracture, soft tissue trauma and mutilation of plaster of Paris cast within one week of its application was also reported (Anoop, 2001). Hunt *et al.* (1980) also observed mutilation of plaster of Paris cast and growth disturbances of radius and ulna after fracture of the bone had been stabilized with casts in dogs. Loosening of the cast was noticed in one animal in Group I and three animals in Group II.

15th day

Three animals of Group I could bear weight on the affected limb and others were holding the immobilized limb high. Where as in Group II only two animals could bear weight on the immobilized limb and all others were dragging the affected limb. Slight instability at the site of fracture was noticed in one animal in Group I and three animals in Group II. This is in accordance with the observations of Anoop (2001) in dogs. Vaughan (1975) also observed movement at the fracture site of radius and ulna after four weeks of application of plaster of Paris cast and the mobility was greatest in the anterior-posterior plane. With plaster of Paris cast, the main cause of failure was incorrect application resulting in inadequate immobilization and/or malalignment of the

fragments (Hunt *et al.* , 1980). One animal in Group I and four animals in Group II exhibited pain on palpation. This is in agreement with the findings of Anoop (2001) in dogs. Immobilizing effect was good in all animals except two in Group I and in Group II immobilizing effect was good only in two animals. One animal in Group II showed rotational deformity. A hard palpable callus could be palpated at the site of fracture in all animals.

30th day

All the animals in Group I and three animals in Group II could actively use the immobilized limb during progression. Two animals in Group I evinced pain on palpation of fracture site. Occasional limbing was observed in one animal in Group I. In one animal in Group II rotational deformity was still noticed. Carriage of the limb was normal in all animals except one in Group I where as in Group II all other animals except two exhibited normal carriage of the limb. Morgan and Leighton (1995) reported that the use of limb and absence of pain on palpation of fracture site should be relied on as evidence of fracture healing.

Oedema of the limb, soft tissue trauma, loosening of the cast as noticed consequent to immobilization of the fracture could be minimized by removal and reapplication of the same immobilizing material, when PVC splint was used. Moreover repeated application of plaster of Paris cast incurred the cost of treatment also. Based on these facts, it could be assertained in the study that

PVC splint was a better option for treatment of fracture of radius and ulna considering the cost effectiveness and ease of application.

Radiological studies

Four animals in Group I (66.66%) and three animals in Group II (50%) had fracture of radius and ulna at the middle third of diaphysis. Distal third of diaphysis of radius and ulna was involved in two animals (33.33%) in Group I and three animals (50%) in Group II. This is in agreement with the findings of Phillips (1979) and Aithal *et al.* (1999). The highest incidence of fractures was recorded at distal third and middle third of diaphysis. Thilagar and Balasubramanian (1988) also recorded higher incidence of fracture involving mid shaft followed by lower third of diaphysis.

All the animals in Group I had complete transverse fracture with over riding in only one animal. Three animals in Group II had complete transverse fracture and three animals had complete oblique fracture. Overriding was noticed in two animals. Balagopalan *et al.* (1995) and Aithal *et al.* (1999) reported higher incidence of oblique fractures followed by transverse fractures in dogs.

15th day

By 15th day periosteal reaction started developing at the site of fracture in three animals each in Group I and Group II. Perfect apposition of bone fragments was noticed in one animal in Group II. Obliteration of medullary

canal was noticed in all the animals of Group I and Group II. Singh and Nigam (1975) also observed periosteal reaction by second week and blurring of fracture gap. Roush and McLaughlin (1998) reported early signs of fracture healing as periosteal reaction near the fracture site, callus formation and remodelling of fractured ends of the bone.

Settnikow and Paatsama (1970) observed earliest callus in 12 days after fracture and clearly visible callus was detected within 21 days after fracture. Gap between fracture fragments were clearly discernible in all the animals of Group I and Group II. Two animals in Group I and Group II showed lateral displacement of distal bone fragment. Medial displacement of distal bone fragments were noticed in one animal each in Group I and Group II. This is in agreement with the observations of Singh and Nigham (1975) in dogs.

30th day

Moderate amount of periosteal callus was noticed in all animals of Group I and only two animals in Group II. Complete bridging of fracture gap was noticed in two animals in Group I and four animals in Group II. In all other animals gap between the bone fragments was evident partially. Sumner-Smith (1974) observed the persistence of fracture gap radiographically even when the fracture was clinically stabilized. One animal each in Group I and II still showed lateral displacement of distal bone fragments. Settnikow and

Paatsama (1970) observed complete bridging of fracture gap by sixth week in dogs in external coaptation and internal fixation. Singh and Nigam (1975) observed partial obliteration of fracture gap at the end of sixth week in internal fixation of fracture in dogs.

The observations on radiological studies reveal that callus formation was better in the group of animals where PVC splints was used.

Biochemical parameters

A significant increase in serum alkaline phosphatase level followed by decrease was observed on 15th and 30th post-treatment day was respectively in both the groups. This is in agreement with the observations of Singh *et al.* (1976); Kumar *et al.* (1997) and Anoop (2001) in dogs. The increase in serum alkaline phosphatase was related to the time during which fibrous formation was at its peak and as the healing progressed in the form of bony callus or fibrous union, the alkaline phosphatase concentration declined to normal level (Singh *et al.*, 1976).

A significant increase in serum acid phosphatase level followed by decrease towards normal was observed on 15th and 30th post-treatment day respectively in both groups. But Aithal *et al.* (1995) could observe a gradual increase in serum acid phosphatase upto 30/60th post fracture day.

The observations on serum constituents suggest that both the immobilization methods did not alter the healing of fractured fragments.

Summary

SUMMARY

The present study was undertaken with the objective to evaluate the efficacy of PVC splints and its immobilizing effects in the management of long bone fractures in dogs.

The study was carried out in twelve clinical cases of fracture of radius and ulna in dogs of either sex presented to the clinics of College of Veterinary and Animal Sciences, Mannuthy. The animals were randomly divided into two groups (Group I and Group II) consisting of six animals each.

After clinical examination of the animals, the fracture was reduced by closed method under sedation by administering atropine sulphate followed by xylazine hydrochloride intramuscularly and in 25 per cent cases, thiopentone sodium was also administered 'to effect' general anaesthesia. The affected limb was immobilized by application of plaster of Paris cast in Group I and application of PVC splint in Group II.

All the animals were kept under observation for a period of 30 days after the treatment in both the groups.

A marginal decrease in respiration rate and pulse rate and a normal range of rectal temperature were observed during the early post-treatment period in all the animals of both the groups.

Fifty per cent of animals in each group were dragging the affected limb by the end of 15th post-treatment day. Symptoms like soft tissue trauma, oedema, instability, pain, loosening and mutilation of the immobilization devise were relatively more in animals of Group II, but these complications could be attended readily in animals of this group. By the end of 30th post-treatment day, all the animals in Group I could bear weight and were able to walk on the affected limb, but pain at the fracture site persisted in three animals. In Group II three animals were able to use the limb actively while other animals exhibited a little difficulty in walking but the gait became normal within one week.

A marginal increase in packed cell volume, haemoglobin concentration and total leucocyte count were observed on 15th post-treatment day in haemogram. Differential leucocyte count revealed neutrophilia and decrease in lymphocyte count on 15th post-treatment day. Eosinophil, basophil and monocyte counts exhibited marginal variation during the post-treatment period.

Radiological evaluation on 15th post-treatment day revealed periosteal reaction started developing at the site of fracture in majority of animals in each group. Perfect apposition of the bone fragment was observed in one animal in Group II. Obliteration of medullary canal was noticed in all the animals of both the groups. By 30th post-treatment day all animals in Group I and two animals in Group II exhibited moderate amount of periosteal callus. Complete bridging of fracture gap was noticed in two animals in Group I and four animals in

Group II. In all other animals gap between the bone fragments was evident partially.

An increase in serum alkaline phosphatase and serum acid phosphatase level was observed in the immediate post-treatment period in all the animals.

The following conclusions could be drawn from this study:

1. Premedication with atropine sulphate followed by sedation with xylazine hydrochloride / general anaesthesia with thiopentone sodium were found to be satisfactory for closed reduction of fracture of radius and ulna prior to immobilization by plaster of Paris cast and PVC splints.

2. Symptoms like pain at the site of fracture and mutilation of the splint were exhibited more in early post-treatment period in animals where PVC splint was used for immobilization. But later the animals tolerated the PVC splint much better than plaster of Paris cast.

3. Oedema of the affected limb, soft tissue trauma, loosening of the immobilizing material were evident in both methods of immobilisation. But it could attended readily when PVC splint was used for immobilization.

4. Being a light material, PVC splint favoured the early return of limb function and disappearance of symptoms of fracture earlier than plaster of Paris cast in fracture of radius and ulna.

5. Immobilization of fractured limb with PVC splint facilitated the repeated attention of concurrent complications associated with fracture, and application of same material, thus resulting cost effectiveness of treatment.

6. Radiographically complete bridging of the fracture fragments could be observed on 30th post-treatment day in both the groups.

7. Plaster of Paris cast and PVC splint used in immobilization of radius and ulnar fractures did not affect the haemogram and serum biochemical parameters and the healing of bone fragments in all the animals were comparable radiographically and clinically.

References

REFERENCES

Aithal, H.P., Mogha, I.V., Singh, G.R. and Swarup, D. 1995. Serum acid and alkaline phosphatase activities following bone grafting in goats. *Indian J. Vet. Surg.* **16**(1): 47-49

Aithal, H.P., Singh, G.R. and Bisht, G.S. 1999. Fractures in dogs: A survey of 402 cases. *Indian J. Vet. Surg.* **20**(1): 15-21

Anoop, S. 2001. Management of tibial fractures in dogs using plaster of paris cast and modified Thomas splint. M.V.Sc. Thesis, Kerala Agricultural University, Thrissur, p. 81

Balagopalan, T.P., Devanand, C.B., Rajankutty, K., Amma, T.S., Nayar, S.R., Varkey, C.A., Jalaluddin, A.M., Nayar, K.N.M. and George, P.O. 1995. Fracture in dogs – a review of 208 cases. *Indian J. Vet. Surg.* **16**(1): 41-43

Bergmeyer, H.U. 1972. *Methods of enzymatic analysis.* Fourth edition, Weinhein Bergstr Academic Press, New York, p.1064

Brinker, W.D. 1974. Types of fractures and their repair. *Canine Surgery.* (eds. Archebald, J.). Second edition. American Veterinary Publications Inc, California, pp: 964-972

Gourley, I.M. and Vasseur, P.B. 1985. *General Small Animal Surgery.* J.B. Lipponcott Co., Philadelphia, pp. 241-251

Hillmann, G.Z. 1971. *Clin. Chem. Biochem.* 9: 273

Hunt, J.M., Aithen, M.L., Denny, H.R. and Gibbs, C. 1980. The complications of diaphyseal fractures in dogs: a review of 100 cases. *J. Small Anim. Pract.* **21**: 103-119

Kumar, V., Varsheney, A.C., Singh, M., Sharma, S.K. and Nigam, J.M. 1997. Haemato-biochemical changes during fracture repair with hydroxy-apatite-fibrillar collagen implants in calves. *Indian J. Vet. Surg.* **20**(2): 90-93

Morgan, J.P. and Leighton, R.L. 1995. *Radiology of Small Animal Fracture Management.* W.B. Saunders, Philadelphia, p. 328

Phillips, I.R. 1979. A survey of bone fractures in the dog and cat. *J. Small Anim. Pract.* **20**: 661-674

Rochat, M.C. and Payne, J.T. 1993. Your options in managing long bone fractures in dogs and cats. *Vet. Med.* **10**: 946-956

Roush, J.K. and McLaughlin, R.M. 1998. Fundamentals of fracture management. *Vet. Med.* **12**: 1065-1070

Sarkate, L.B., Aher, V.D. and Bhokre, A.P. 1993. Repair of long bone fractures by external fixation using PVC pipe in bovine and caprine. A clinical study of 13 cases. Sixteenth Annual Congress of Indian Society for Veterinary Surgery and National Symposium – Technical programme and abstracts, 19-22 August 1993. College of Veterinary and Sciences, G.B. Pant University of Agriculture and Technology, Panthnagar. p. 23

Schalm, C.W. 1975. *Veterinary Haematology.* Third edition. Lea and Febiger, Philadelphia, p. 1236

Singh, A.P. and Nigam, J.M. 1975. Study on the fracture repair of metatarsus in bovine with special reference to homogenous bone grafting. *Indian Vet. J.* 43(9): 214-218

Singh, A.P., Nayar, K.N.M., Chandra, I.S., Chawla, S.K. and Nigam, J.M. 1984. Post operative complications associated with fracture repair of long bones in bovine, equine and ovine. *Indian J. Vet. Surg.* 5 (1): 47-57

Singh, H., Lovell, J.E., Schiller, A.G. and Kenner, G.H. 1976. Serum calcium, phosphorus and alkaline phosphatase levels in dogs during repair of experimental ulnar defects. *Indian Vet. J.* **53**(11): 862-865

Sittnikow, K. and Paatsama, S. 1970. The healing of distal fractures of the radius and ulna: an experimental study on dogs. *J. Small Anim. Pract.* **11**: 385-394

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods.* Eighth edition. Iowa State University Press, Ames, Iowa, p. 564

Stead, C. 1988. External support for small animals. *In practice* **6**: 139-149

Sumner-Smith, G. 1974. A comparative investigation into the healing of fractures in miniature poodles and mongrel dogs. *J. Small. Anim. Pract.* **15**: 323-328

Thilagar, S. and Balasubramanian, N.N. 1988. A retrospective study on the incidence and anatomical locations in 204 cases of fracture in dogs. *Cherion* **17**(2): 68-71

Thilagar, S., Ganesh, T.N., Kumar, B.R. and Nambi, A.P. 1998. Role of rehabilitation and physiotherapy for traumatic carpal luxation and femur fracture and its surgical management in a dog. Abstracts of the papers presented during 22nd annual convention of Indian Society for Veterinary Surgery, 5-7 November, 1998. Faculty of Veterinary Science and Animal Husbandry, Bhubaneswar. *Indian J. Vet. Surg.* **19**(2): 140

Vaughan, L.C. 1975. Complications associated with the internal fixation of fractures in dogs. *J. Small Anim. Pract.* **16**: 415-426

West, W.R.G. 1963. The application of resin-bonded fibre glass for the immobilization of fractured or damaged equine or bovine limbs. *Vet. Rec.* 75(16): 424-425

EVALUATION OF POLYVINYL CHLORIDE SPLINTS FOR THE TREATMENT OF LONG BONE FRACTURES IN DOGS

DIVYA BALAN

Abstract of the thesis submitted in partial fulfillment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

2003

Department of Veterinary Surgery and Radiology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR - 680 651
KERALA, INDIA

ABSTRACT

The present study was undertaken with the objective to evaluate the efficacy of PVC splints and its immobilizing effects in managing long bone fractures in dogs.

The study was carried out in twelve clinical cases of fracture of radius and ulna in dogs of either sex presented to the clinics of College of Veterinary and Animal Sciences, Mannuthy. The animals were randomly divided into two groups (Group I and Group II) consisting of six animals each.

After clinical examination of the animals, the fracture was reduced by closed method under sedation by administering atropine sulphate followed by xylazine hydrochloride intramuscularly and in certain cases, thiopentone sodium was also administered 'to effect' general anaesthesia. The affected limb was immobilized by application of plaster of Paris cast in Group I and application of PVC splint in Group II.

All the animals were kept under observation for a period of 30 days after the treatment in both the groups.

A marginal decrease in respiration rate and pulse rate and a normal range of rectal temperature were observed during the early post-treatment period in all the animals of both the groups.

Fifty per cent of animals in each group started bearing weight on the affected limb by the end of 15th post-treatment day. Symptoms like soft tissue

trauma, oedema, instability, pain, loosening and mutilation of the immobilization devise were relatively more in animals of Group II, but these complications could be attended readily in animals of this group. By the end of 30th post-treatment day, all the animals in Group I could bear weight and able to walk on the affected limb, but pain at the fracture site persisted in three animals. In Group II three animals were able to use the limb actively while other animals exhibited a little difficulty in walking but the gait became normal after some days.

A marginal increase in packed cell volume, haemoglobin concentration and total leucocyte count were observed on 15th post-treatment day in haemogram. Differential leucocyte count revealed neutrophilia and decrease in lymphocyte count on 15th post-treatment day. Eosinophil, basophil and monocyte counts exhibited marginal variation during the post-treatment period.

By the end of 15th post-treatment day, periosteal reaction started developing at the site of fracture in majority of animals in each group. Perfect apposition of the bone fragment was observed in one animal in Group II. Obliteration of medullary canal was noticed in all the animals of both the groups. By 30th post-treatment day all animals in Group I and two animals in Group II exhibited moderate amount of periosteal callus. Complete bridging of fracture gap was noticed in two animals in Group I and four animals in Group II. In all other animals gap between the bone fragments was evident partially.

An increase in serum alkaline phosphatase and serum acid phosphatase level was observed in the immediate post-treatment period in all the animals.