*Theriogenology Insight: An International Journal of Reproduction of Animals*
Citation: Theriogenology Insight: **13**(01): 33-38, June 2023
**DOI:** 10.30954/2277-3371.01.2023.6
**Peer-reviewed Journal**

**Research Paper**

# Evaluation of Veterinary Cuttable Plates and Reconstruction Plates for Repair of Long Bone Fracture in Young Dogs

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**Received:** 16-02-2023 **Revised:** 26-05-2023 **Accepted:** 03-06-2023

**ABSTRACT**

**Background:** To record the occurrence of long bone fractures in young dogs and to evaluate the efficacy of Veterinary Cuttable Plate versus Reconstruction plate in long bone fractures of young dogs on the basis of clinical, haemato-biochemical and radiographic examination. **Methods:** The present study was conducted on 12 young dogs (3-10 months) irrespective of sex and breed having body weight <15 kg and were randomly divided into two groups containing 6 animals each. The animals were treated by open reduction and internal fixation using Veterinary Cuttable Plate (group I) and Reconstruction Plate (group II). Occurrence of long bone fractures, Clinical, haemato-biochemical and radiographic examinations were examined at different time intervals. **Results:** Transverse femur fracture due to automobile accident in non-descript male dogs below 6 months of age was most commonly observed. Veterinary cuttable plates provided complete weight bearing on affected limb by day 45 while Reconstruction plates provided the same by day 60 post-operatively. Radiographic interpretation revealed absence of radiolucent line in animals with VCP plate while discrete radiolucent line was observed in animals with recon plate by day 60.

**Keywords:** Veterinary Cuttable plate, Reconstruction plate, Long bone fracture, Fracture healing, Alkaline phosphatase

Bone is a dynamic biological tissue composed of active cells embedded in a rigid framework. A fracture is a break in a bone's continuity. Long bone fractures are common orthopaedic problem in canine practice, particularly in young dogs. Fracture occurs when the physiological forces transmitted to the bone via joint surfaces and muscle contraction exceed the ultimate strength of bone (Aithal *et al.* 1999).

The method of fixation is determined by the fracture configuration, the animal's size and age, the number of limbs involved, biological considerations, concurrent musculoskeletal injuries and the patient's financial resources (Kolata *et al.* 1974). In young dogs, surgical technique should ensure not only the alignment and apposition of bone fragments, but also the prevention of iatrogenic injury to the growth plates and periosteum. During the initial growth phase, both structural and material properties of immature bone are significantly different from those of adult bone and are characterized by lower strength, as well as lower yield stress and elastic modules (Nanoboina, 2016). As the majority of dogs raised under Indian conditions are hyperactive or vicious, internal fixation continues to be the surgical

**How to cite this article:** Verma, A., Singh, R., Jawre, S., Jain, P., Ramyavani, K.B. and Sinha, A. (2023). Evaluation of Veterinary Cuttable Plates and Reconstruction Plates for Repair of Long Bone Fracture in Young Dogs. *Theriogenology Insight: An Int. J. Reprod. of Anim.*, **13**(01): 33-38.

**Source of Support:** None; **Conflict of Interest:** None

method of choice for fracture fixation (Newton and Nunamaker, 1985).

Veterinary Cuttable Plates (2.7mm) are becoming popular among veterinarians as they can be cut to fit the length of the bones. They are narrow and thin, as well as having elasticity and are appropriate for fracture repair in growing dogs as well as internal fixation of long bone fractures in puppies (Nanaboina, 2016). Reconstruction Plates are ideal for distal femur fractures due to their ability to contour in three planes, particularly in small and medium-sized dogs and chondrodystrophoid breeds (Lidbetter and Glyde, 2000).

Therefore, looking into the ability of bone plates in fracture management, the present study was designed with the objective of comparative evaluation of VCP and recon plates on the basis of clinical, haemato-biochemical and radiographic studies.

## MATERIALS AND METHODS

### Preparation of animals

The study was conducted on 12 young dogs aged between 3-10 months brought to Department of Veterinary Surgery and Radiology, Veterinary Clinical complex (VCC), Nanaji Deshmukh Veterinary Science University (N.D.V.S.U), Jabalpur, Madhya Pradesh for the treatment of long bone fracture during the study period. These dogs were randomly divided into two groups, consisting of 6 animals in each group. The animals were selected irrespective of sex and breed. The animals were kept off water for 4-6 hours and off feed for 8-12 hours prior to surgery to reduce the anaesthetic risk. General anaesthesia was induced using Inj. atropine sulphate @ 0.02 - 0.04mg/kg body weight I/M as preanesthetic, followed by Inj. diazepam @ 1.0mg/kg body weight I/V and Inj. propofol @ 4-6 mg /kg body weight I/V. Anaesthesia was maintained by inhalant anaesthetic agent Isoflurane @ 2-3% (MAC) along with 100% oxygen using endotracheal tube.

### Surgical procedure

In all animals, the fracture site was approached following standard surgical procedure by anatomical separation of muscle bellies using muscle retractors. After reduction of fracture fragments to anatomical alignment, Veterinary Cuttable Plate and or pre contoured reconstruction plate were positioned over the bone in such a way that the fracture line was approximately mid-way between the ends of the VCP or recon plates in groups I and II respectively. The plate was secured to bone with the help of Lowman's bone holding forceps and a minimum of two holes each on proximal and distal fragments were drilled into the bone correspondingly in the proximal and distal fragments followed by application screws of appropriate size and length. Then, the incision was closed in a routine surgical manner. Limb was immobilized using Robert-Jones technique immediately after surgery and animals were administrated with ceftriaxone sodium @ 20 mg/Kg body wt. I/M, bid for 7 days and meloxicam @ 0.2mg/Kg body wt. I/M for 3-5 days postoperatively. The plate was removed 5-8 weeks after surgery in all the cases under general anaesthesia.

### Occurrence

Occurrence of fracture in different long bones in young dogs was recorded from the total cases registered at Veterinary Clinical Complex, NDVSU, Jabalpur during the study period (April, 2022 to September, 2022).

### Clinical examination

### Physiological parameters

Rectal temperature (°F) and heart rate (beats/minute) were recorded before surgery to evaluate the clinical status of animal.

### Degree of exudation

Degree of exudation of wound was assessed on days 3, 7 and 15 post-operatively and given a scoring i.e., no exudation (0 score), mild exudation (+ grade and 1 score), moderate exudation (++ grade and 2 score) and marked exudation (+++ grade and 3 score) (Bhowmick *et al.* 2013).

### Weight bearing

A lameness grading was assigned in all cases during pre and postoperative period based on the weight bearing during stance and while walking. Weight bearing was graded as follows: normal weight bearing on all limbs at rest and while walking


Print ISSN: 2249-6610

(grade 1), normal weight bearing at rest, favours affected limb while walking (grade 2), partial weight bearing at rest and while walking (grade 3), partial weight bearing at rest, does not bear weight on affected limb while walking (grade 4) and does not bear weight on limb at rest or while walking (grade 5) (Vasseur *et al.* 1995).

### Radiographic evaluation

Radiographs were taken in two views i.e., medio-lateral and cranio-caudal before the surgery and subsequently on days 14, 28, 45 and 60 post-operatively. Any complication such as implant failure, osteomyelitis, etc. if any were recorded. Radiographs were analyzed as per score card given by Hayashi *et al.* (2008) as follows: presence of recent fracture with no bone formation (score 0), irregularity at fragment lines of fracture site (score 1), initial/ discrete periosteal proliferation (score 2), exuberant/ organized periosteal proliferation (score 3), exuberant osseous callus in evolution with presence of periosteal proliferation (score 4), exuberant osseous callus in evolution and discrete radiolucent line at gap between the fracture fragments (score 5) and exuberant osseous callus and absence of radiolucent line (score 6).

### Haemato-biochemical estimations

Approximately 3 ml of blood was collected aseptically from the saphenous vein or cephalic vein for estimation of haematological and biochemical parameters by automatic blood analyzer and biochemical analyzer (ERBA) using commercially available standard kit. The parameters were estimated one day prior to surgery and on days 7, 14 and 45 postoperatively.

## STATISTICAL ANALYSIS

The quantitative data were analyzed using Completely Randomized Design as per the method described by Snedecor and Cochran (1994).

## RESULTS AND DISCUSSION

### Occurrence

A total number of 10041 dogs, irrespective of age, sex and breed were screened during the study period of 6 months (April, 2022 to September, 2022). Out of these, 110 dogs were affected with a fracture of limb making fracture occurrence as 1.09%. Out of 110 dogs, 61 were young (< 1 years). The occurrence of fracture in young dogs was 55.45 per cent.

The finding were similar to Jain *et al.* (2018) and Keosengthong *et al.* (2019) who reported occurrence of fracture in dogs as 1.14% and 1.70% respectively.

### Age

In the present study, out of 61 cases of fracture in young dogs, 41 cases were of age group upto 6 months (67.21%) and 20 cases were of 6 to 12 months (32.7%). The highest occurrence of fracture in young dogs may be due to the fact that the young dogs are most active and playful which makes them susceptible for automobile accident or falling from height leading to fracture.

The findings are in correlation with the findings of Kumar *et al.* (2007) and Simon *et al.* (2010) who have reported that incidence of fracture was higher in young dogs.

### Bone involved

In the present study, it was observed that femur (47.54%) was most common bone involved in fracture, followed by radius-ulna (29.50%), tibia (16.39%) and humerus (6.55%). These findings are in consistent with Haaland *et al.* (2009) who recorded highest occurrence in femur (34%) followed by radius-ulna (30%), tibia (25%) and humerus (11%).

### Clinical examination

### Rectal temperature and heart rate

Rectal temperature and heart rate were recorded prior to surgery to evaluate clinical status of animal. The mean rectal temperature was 101.68 ± 0.49 °F and 101.97 ± 0.34 °F in groups I and II respectively whereas the mean heart rate was 137.17 ± 5.72 bpm and 134 ± 4.63 in groups I and II respectively.

These values of rectal temperature (°F) were similar to the findings of Singh (2015), who reported that the values were within normal physiological range before the surgical procedure and a non-significant difference was there in between the groups.

### Exudation

Mean values of exudation score at incision site

were recorded on day 3, 7 and 15 post-operatively. In animals of groups I and II, the exudation score showed significant ($p<0.05$) decrease over 3rd and 7th day followed by non-significant decrease on 15th day making to the least score or absence of exudation.

The findings were similar to Kumar (2022) reported that mean value of exudation score showed significant decrease over day 3 to day 7 post-operatively followed by non-significantly decrease over 15th day treated with amniotic membrane and leucocyte-platlet-rich-fibrin (L-PRF) for repair of long bone fracture in dogs.

Mean value bearing different superscript in a row (uppercase) differ significantly ($p<0.05$)

**Weight bearing**

Weight bearing was assessed on day 0, 7, 14, 28, 45 and day 60 post operatively. The animals of group I showed significant increase ($p<0.05$) in weight bearing from day 7 post operatively which was depicted as partial weight bearing at rest and walking followed by normal weight bearing at rest and walking from 14 to 28 day and complete weight bearing on affected limb at rest and walking by 45 to 60th day post operatively. However, in group II toe touching was observed from day 14 onwards with normal weight bearing on 60th day post operatively.

Reddy *et al.* (2016) observed partial weight bearing at day 7 and complete weight bearing by the end of 5th weeks while repair of femoral shaft fracture by EPO using veterinary cuttable plates in young dogs. Similarly, Ramesh *et al.* (2018) reported partial weight bearing from the 1st post-operative day. Most dog showed complete weight bearing 30th day post-operatively using VCP in femoral diaphyseal fracture.

**Radiographic score**

Mean values of radiographic score varied from 0.00 ± 0.00 to 5.83 ± 0.16 at different time intervals in both the group. The preoperative radiographic scores showed no alignments between the fracture segments in most of the cases which were fixed using veterinary cuttable plate and reconstructive plate. The mean radiographic score was significantly ($p<0.05$) higher in group I, than group II on day 14, day 28, day 45 and day 60.

Mean value bearing different superscript in a row (uppercase) and column (lowercase) differ significantly ($p<0.05$)

These findings are in collaboration with Cabassu (2001) who observed partial callus formation two weeks post-operatively and was often complete by four weeks. Remodeling of the callus was observed after two months.

**Haemato-biochemical examinations**

**Haemoglobin**

Mean values of haemoglobin (g/dL) varied from 08.06 ± 0.33 to 10.76 ± 0.42. These values showed significant ($p<0.05$) difference between the group at different time intervals. On day 7, a non-significant increase was recorded in group I and non- significant decrease was observed in group II. Later the haemoglobin concentration showed gradual non-significant increase from day 14 to day 45 in group II and in group I there was non-significant decrease from day 7 to day 14 followed by gradual increase at day 45.

The decrease in haemoglobin values is in accordance with the findings of Jain *et al.* (2018) and Chaurasia *et al.* (2019) who also recorded post operative reduction in haemoglobin values. These findings can be substantiated to be as a result of intra-operative haemorrhage and increased perfusion of vascularity towards the surgical site due to local inflammation.

**Total leukocyte count**

The mean values of total leukocyte count ($10^3/\mu l$) ranged from 9.73±1.02 to 11.03±0.81 at different time intervals in both the groups which was within the physiological limits (5 - $14/10^3/\mu l$) and showed non-significant fluctuations between the groups and at different intervals within the group. The above observations correlated with the findings of De' Souza (2012) and Farooq *et al.* (2019), who reported that mean value of TLC showed a non-significant variation on subsequent post-operative days.

**Serum biochemistry**

The mean values of serum calcium (mg/dl) ranged from 8.06±1.50 to 10.75±1.67 at different time intervals in both the groups. In group I, serum calcium values showed non- significant increase on


Print ISSN: 2249-6610

day 7. Thereafter, a gradual decrease in the serum calcium was observed on subsequent post operative intervals. In group II, serum calcium values showed non- significant increase on day 14 followed by a gradual decrease on day 45.

These findings are in accordance with the findings of Singh (2019) who reported that the changes in values of serum calcium was statistically non-significant. However, a decreasing trend of serum calcium level was observed. Reddy (2015) observed that serum calcium values increased gradually from 1st day to 14th day then gradually reached to normal by 28th day. Decrease in serum calcium may be attributed to mobilization of calcium from blood to site of callus formation**.**

Serum phosphorus (mg/dl) varied from 5.83±0.41 to 7.93±0.42 at different time intervals in both the groups. Serum phosphorus level increased non-significantly at day 7 in both the groups. Thereafter, its value decreased gradually on subsequent post operative intervals. Serum phosphorus level showed significant ($p<0.05$) difference in both the groups.

These findings were in contrary to that of Kumar (2022) as he reported decrease in serum phosphorus level on day 7 post-operatively followed by gradual increase upto day 45. Decrease in serum phosphorus may be attributed to mobilization of phosphorus from blood to the site of callus formation along with the calcium.

Mean value of serum alkaline phosphatase (U/L) varied from 159.50±7.63 to 261.2±28.37 at different time intervals in both the groups. In group I, serum alkaline phosphatase level increase non-significantly from pre-operative to day 7 followed by decrease on subsequent post-operative days. There was significant ($p<0.05$) difference from day 7 to day 45.

In group II, serum alkaline phosphatase level decrease non-significantly from pre-operative to day 7, from day 7 to day 14 and from day 14 to day 45 post-operatively. There was significant difference from day 7 to day 45.

These findings are in accordance with Singh *et al.* (2019) who observed that serum alkaline phosphatase values were high on 0 day but after the treatment they showed a steady decrease throughout the study period. Increase in serum alkaline phosphatase level may be due to increased chondroblastic proliferation to cause bone formation during fracture repair and also maximum contribution was from the periosteum of destructed bone which was a rich source of alkaline phosphatase.

### Complications

Complication rate was found to be 8.33% (1 in 12 cases). The post operative complication like wound dehiscence and implant failure (plate bending) was observed on day 10 post-operatively in one animal of group II which was corrected by surgical removal of implant followed by external immobilization with provision of window over the wound along with intravenous administration of antibiotics, supportive therapy and regular antiseptic dressing till recovery. This might be because of mis-management by dog owner and temperament of the dog with early weight bearing. However, the case was not included in the study.

## CONCLUSION

On the basis of present study, it can be concluded that transverse femur fracture due to automobile accident in non-descript male dogs below 6 months of age was most commonly observed. On the basis of clinical, haemato-biochemical and radiographic observations it was observed that Veterinary Cuttable Plates (VCPs) were better and economic than Reconstruction Plates for fracture repair in young dogs. Veterinary Cuttable Plates (VCPs) provided early weight bearing with good functional limb outcome as compared to Reconstruction plates for young dogs.

## ACKNOWLEDGEMENTS

This study was financially supported by Nanaji Deshmukh Veterinary Science University, Jabalpur.

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Print ISSN: 2249-6610