RESEARCH ARTICLE

Elastic Plate Osteosynthesis of Long Bone Fractures using Veterinary Cuttable Plates in Young Dogs

Sai Bhavani D[1]*, Hari Krishna NVV[2], Sreenu M[3], Venkata Naidu G[4]

Abstract

Twelve dogs below one year of age presented with a history of forelimb or hindlimb lameness, suggestive of either radius or tibia fracture were selected to study the fracture stabilisation by Elastic Plate Osteosynthesis (EPO) technique using 2.0/2.7 mm Veterinary Cuttable Plate (VCP). The implants were selected according to body weight and bone size. Post-operatively, the dogs were evaluated by clinical, radiographical and lameness grading. Primary healing was observed in eight cases and secondary healing in four cases. Fracture healing was observed by 30th post-operative day in most of the cases. The dogs regained full limb functionality by 15-30 days post-surgery. All the animals regained normal return to weight bearing early (within one month) with excellent to good limb usage. Plate removal was done in all cases on 5-8 weeks post-surgery. No major post-operative complications were observed. To conclude, the VCP used was inexpensive and the EPO technique using VCP was useful for long bone fractures of young dogs making it suitable for use in Veterinary practice and the technique resulted in early weight bearing and good functional limb out come without any complications.

Key words: Elastic Plate Osteosynthesis (EPO), Tibial and radial diaphyseal fractures, Veterinary Cuttable Plates (VCP), Young dogs.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.5.03

Introduction

Fracture of the long bones is a common orthopedic issue in young dogs (Aithal *et al*., 1999). The most commonly fractured bones are the radius and ulna, as well as the tibia and fibula (Thilagar and Balasubramanian, 1988; Dvorak *et al*., 2000). The primary goal of fracture repair is to restore limb function quickly, using either external coaptation or internal fixation. Internal fixation methods include pins, wires, plates, and screws, chosen based on fracture type, animal size and age, biological considerations, and financial resources (Cabassu, 2001; Dejardin and Cabassu, 2008).

Young dogs' bones differ from adult bones in strength and stiffness, with thinner diaphyseal cortices, making them prone to implant failure via screw pullout (Dejardin and Cabassu, 2008). Therefore, rigid anatomical internal fixation is unsuitable for growing dogs. Surgical techniques must align and appose bone fragments, avoid growth plate damage, and preserve the periosteum. Plate osteosynthesis is preferred for treating diaphyseal fractures in juvenile dogs due to the poor outcomes of intramedullary pinning and external skeletal fixation.

Failure of rigid internal fixation often occurs due to screw pullout, prompting the development of Elastic Plate Osteosynthesis (EPO) for diaphyseal fractures in puppies (Dejardin and Cabassu, 2008). Veterinary Cuttable Plates (VCP), designed for small dogs and cats, offer advantages such as multiple screw holes, customizable length, and plate thickness (Cabassu, 2001; Bruse *et al.,* 1989). Implant elasticity allows for rapid periosteal callus formation due to micromotion of bone fragments (Aro and Chao, 1993). The aim of this study was to evaluate the efficiency of elastic osteosynthesis in the treatment of radial and tibial diaphyseal fracture in puppies.

[1]Department of Veterinary Surgery and Radiology, NTR College of Veterinary Science, SVVU, Gannavaram-521101, Andhra Pradesh, India

[2]Department of Veterinary Surgery & Radiology, College of Veterinary Science, SVVU, Garividi- 535101, Andhra Pradesh, India

[3]Associate Dean, College of Veterinary Science, SVVU, Garividi-535101, Andhra Pradesh, India

[4]Directorate of Extension, SVVU, Tirupati-517501, Andhra Pradesh, India

Corresponding Author: Sai Bhavani D, Department of Veterinary Surgery and Radiology, NTR College of Veterinary Science, SVVU, Gannavaram-521101, Andhra Pradesh, India, e-mail: dasarisaibhavani@gmail.com

How to cite this article: Sai Bhavani, D., Hari Krishna, N. V. V., Sreenu, M., & Venkata Naidu, G. (2024). Elastic Plate Osteosynthesis of Long Bone Fractures using Veterinary Cuttable Plates in Young Dogs. Ind J Vet Sci and Biotech. 20(5), 15-20.

Source of support: Nil

Conflict of interest: None

Submitted 02/05/2024 **Accepted** 22/06/2024 **Published** 10/09/2024

Materials and Methods

Dogs below one year of age presented to Veterinary Clinical Complex, NTR College of Veterinary Science, Gannavaram during 2022-2023 with a history of forelimb or hindlimb lameness, suggestive of either radius or tibia fracture were considered for the study. Among these, twelve young dogs with unstable radius (n=6) or tibia fracture (n=6) were selected to study the fracture stabilisation by Elastic Plate Osteosynthesis technique using 2.0/2.7 mm Veterinary Cuttable Plate (VCP) (Fig. 1, 2). Radius was approached craniolateral (Fig. 3) and tibiae medially (Fig. 4) (Piermattei and Johnson, 2004). Age, weight of the dog and size of the bone were considered in choosing the size of the VCP and cortical screws. Dogs weighing less than 6 kg were stabilised with 2.0 mm VCPs, dogs weighing 6-10 kg were stabilised with 2.7 mm VCPs, whereas young dogs weighing more than 10 kg were stabilised with stacked 2.0 mm VCPs. Two or three cortical screws were implanted without tapping the thread in each bone fragment as far as possible from the fracture while preserving the periosteum.

Clinical and radiographic follow-up was performed on immediate and every 15th, 30th and 60th post-operative days to assess the position of implants, reduction, apposition and alignment of fracture fragments, progress of fracture healing and to determine the type of fracture healing. Fractures were considered healed when the periosteal callus bridged both bone fragments on two orthogonal radiographic projections. When the fracture was healed, removal of the osteosynthesis material was suggested.

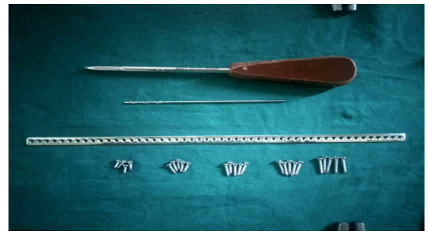

Fig. 1: 2.7 mm VCP plate compatible with 2.7 mm cortical screws

Fig 2: Lameness Evaluation: a) Preoperative nonweight bearing (Case No 1). b) Complete weight bearing on 60th postoperative day. (Case No 1)

Fig. 3: Technique of application of VCP plate for radial fracture (Case No: 2) – a) Positioning and preparation of the limb for left radius fracture repair; b) Cranio-lateral skin incision for radius; c) Exposure of fracture fragments – radius; d) VCP in-situ with central screw holes; e) Closure of muscle; f) Closure of skin incision

Results and Discussion

The age of the 12 puppies included in our study ranged from 3 to 8 months weighing from 3 to 19.6 kg. Selection of appropriate size of plate and screws according to the size of the bone, weight of the dog and type of fracture configuration in each animal provided good fracture stability. Backhaus towel clips were more useful in reduction to prevent periosteal damage and thin cortex of juvenile fractured fragments. No technical difficulties were encountered while application of VCP by EPO technique in all the cases and was appeared to be easy for diaphyseal region of thin cortical bones with advantages like long thin plate, more plate hole density, limited number of cortical screws at each fracture fragment (2 or 3) away from fracture site without involving growth plates. Screw positioning and their application without tapping gave good results in all selected cases. A small bandage was applied on the surgical wound in all cases. All dogs were discharged the following day.

Lateral and cranio-caudal radiographic views taken on immediate, 15th, 30th and 60th post-operative days for evaluation of fracture reduction, healing pattern and to assess the progress of fracture healing in all the cases (Fig. 5, 6) revealed excellent post-operative healing of cortical union, absence of fracture line with bridging and periosteal callus on 30th post-operative day and further remodeling changes with complete cortical union observed in all cases by 60th post-operative day. On 60th post-operative day, all the animals were evaluated for limb usage. Out of 12 fractures treated 6 (50.00%) were excellent, 4 (33.33%) were good and 2 (16.67%) were fair (Fig. 2), and all the animals regained normal full functional limb, except case no. 4 which still had occasional mild gait abnormality. Removal of the osteosynthesis material was accepted by the owners as soon as radiographic evidence of bone healing was evident in all the cases. The implants were removed 5-8 weeks post-surgery after observing radiographic union of the fractures in all the cases under general anaesthesia. All puppies used their treated limbs soon after the surgery.

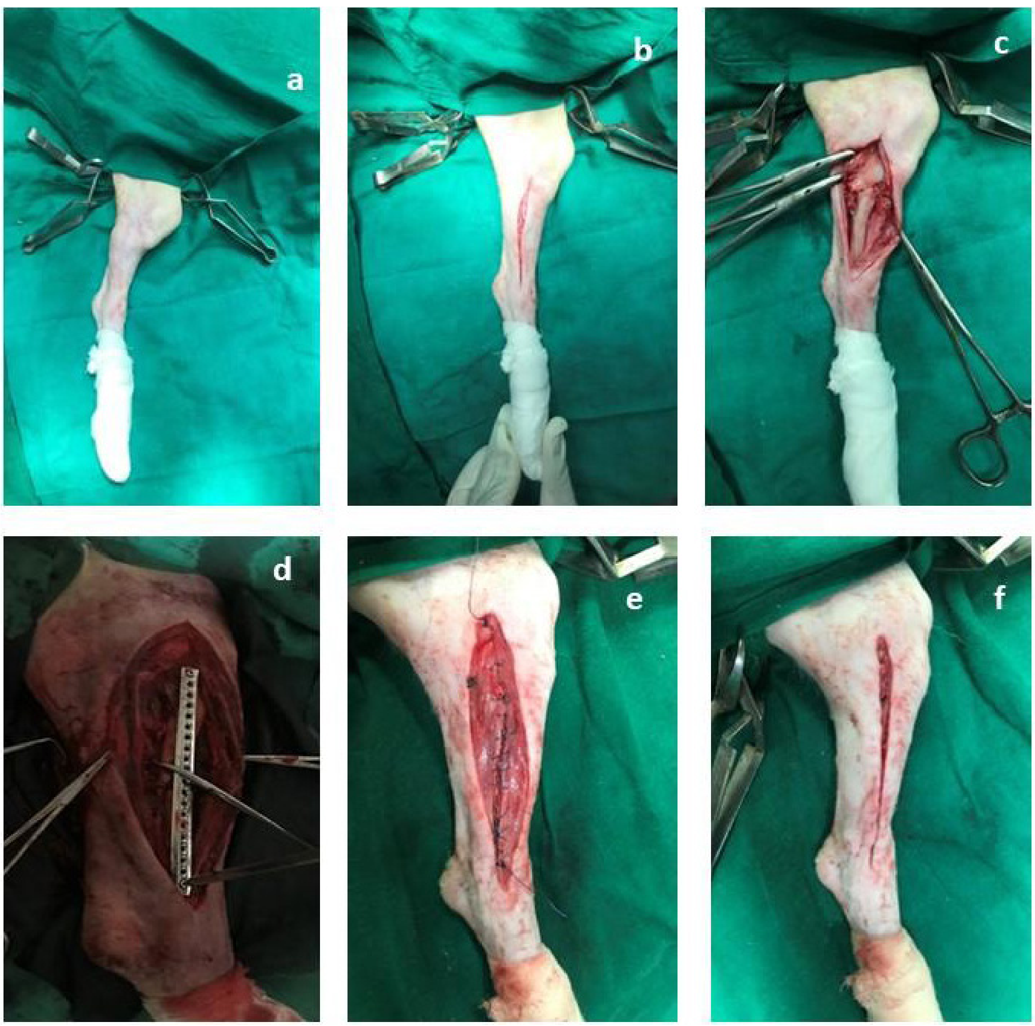

Fig. 4: Technique of application of VCP plate for tibial fracture; a) Positioning and preparation of the limb for tibia fracture repair; b) Medial skin incision for tibia; c) Exposure of fracture fragments – tibia; d) VCP in-situ with central screw holes unoccupied; e) Closure of muscle; f) Closure of subcutaneous tissue

Most of the diaphyseal fractures in our study were low-energy fractures caused by falls or minor trauma. All twelve dogs were successfully treated with elastic osteosynthesis, leading to rapid bone healing without premature closure of growth plates or implant failure. The fractures were stabilized by inserting two or three screws per fragment, positioned as far as possible from the fracture site, which increased the implant's elasticity (Gentry *et al.,* 1993; Dejardin and Cabassu, 2008). A third screw was inserted when there was doubt concerning the one or both of the initial screws. The screws were inserted without tapping and preserving the periosteum (Sarrau *et. al*., 2007; Dejardin and Cabassu, 2008). Two adjacent screws were oriented in different planes to increase the resistant to pullout. The screw distribution away from the fracture site decreases the stress riser effect of a single empty screw hole, reducing the risk of implant failure. It increased the overall compliance of the repaired implant-bone construct and reduced bone/screw interface stresses, which limits the risk of implant failure via screw pullout (Dejardin and Cabassu, 2008). The partial screw loosening observed in one case (Case no. 1) did not affect the stability of the implant, which was found not properly

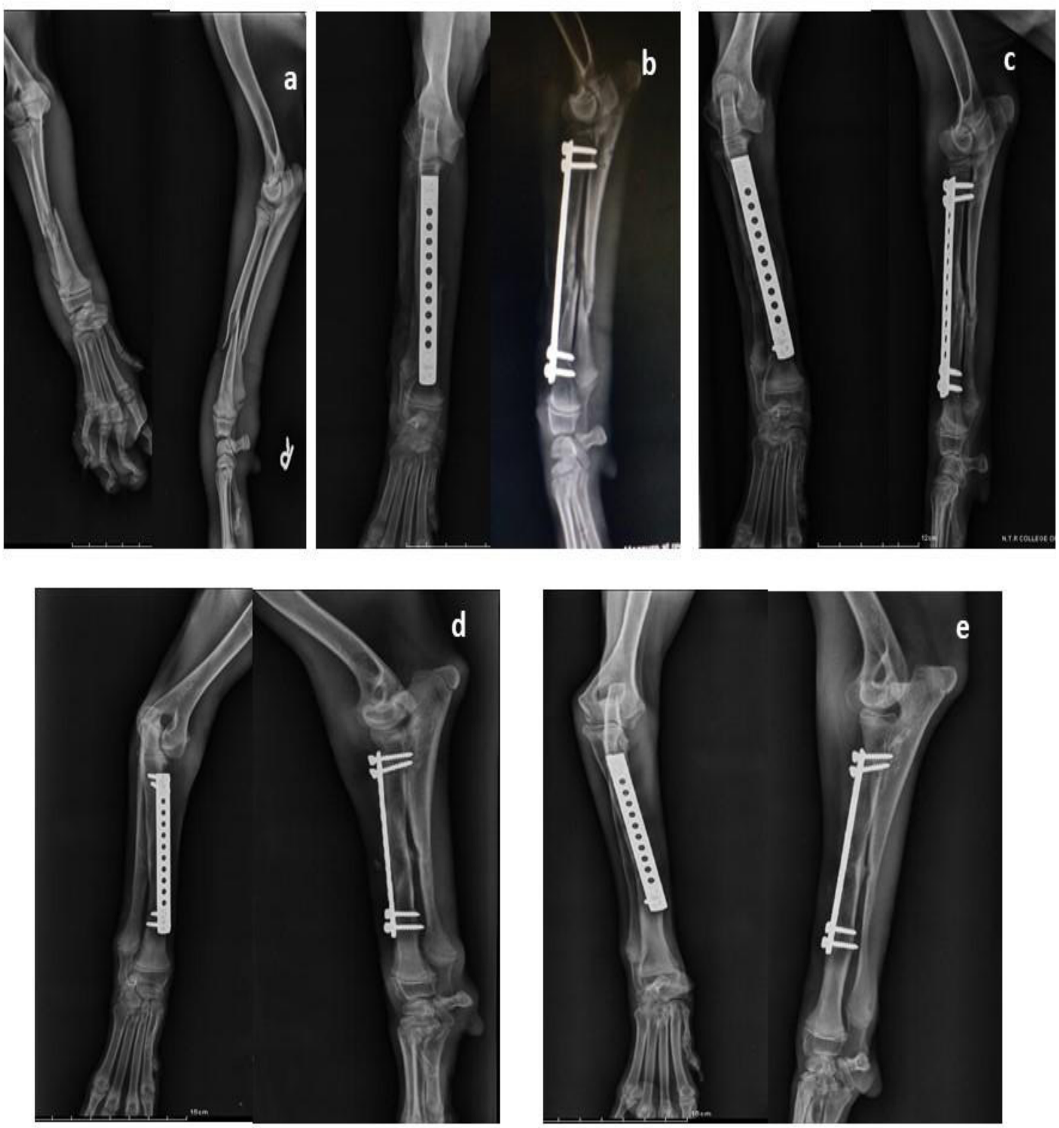

Fig 5: Radiographic evaluation of fracture healing (Case No: 4). a) Skiagram showing comminuted, slight overriding distal 3^{rd} fracture of right radius and ulna designated as 2 2 B 2; b) Skiagram showing craniocaudal and mediolateral view of adequate apposition and alignment of fractured fragments on immediate post operative day; c) Skiagram showing craniocaudal and mediolateral view of small bridging periosteal callus with cortical continuity on 15^{th} post operative day; d) Skiagram showing craniocaudal and mediolateral view of complete cortical continuity with disappearance of fracture line on 30^{th} post operative day; e) Skiagram showing mediolateral view of remodelling of bone 60^{th} post operative day

fitting during intraoperatively itself. This might be due to third screw implanted in that case. No screw pullout was observed in any of the cases. In stabilizing fractures for dogs weighing more than 10 kg, stacked 2.0 mm VCPs were used instead of a single thicker plate, like a 2.7 mm VCP, due to several advantages. Thinner 2.0 mm plates are more flexible and can better fit the complex shapes of bones, which is crucial for young, growing dogs. By stacking two 2.0 mm plates, stability and strength are increased by spreading forces across multiple layers, reducing the risk of implant failure in larger dogs. This method also improves load distribution, minimizing stress on any single plate and aiding healing. Additionally, thinner plates are less invasive, preserving more of the bone's blood supply and enhancing healing._Dogs weighing more than 10 kg were stabilized with full-length stacked 2.0 mm VCPs to increase the rigidity and fatigue life of the implant, providing good mechanical stability, which concurs with findings by Bruse *et al.* (1989), Fruchter and Holmberg (1991), and Hammel *et al.* (2006). Bruse *et al.* (1989) opined that sandwiching two plates was essential when the fracture was comminuted; otherwise, the plate might break or bend. While 2.7 mm plates work well for dogs weighing 6-10 kg due to their balance of rigidity and flexibility, stacked 2.0 mm plates are superior for dogs over 10 kg,

Fig 6: Radiographic evaluation of fracture healing (Case No: 6). a) Skiagram showing cranio-caudal and mediolateral view of adequate apposition and alignment of fractured fragments on immediate post operative day; b) Skiagram showing mediolateral and craniocaudal view of large bridging periosteal callus with partial cortical continuity on 15th post operative day; c) Skiagram showing mediolateral and craniocaudal view of complete cortical continuity with disappearance of fracture line (secondary healing) on 30th postoperative day; d) Skiagram showing mediolateral view of remodelling of bone 60th post-operative day.

offering better flexibility, stability, load distribution, less biological disruption, and more adaptability during surgery. On similar lines stack plating was performed for one case (Case no. 2) of comminuted fracture whereas for the second case (Case no. 4) with an insignificant small wedge 2.7 mm VCP was applied without stacking.

Post-operative radiographs revealed implants in-situ with adequate apposition and alignment of fractured fragments with good cortical contact between the fractured fragments in all the cases. A thin osteolytic area surrounding all the three proximal screws was noticed in case no. 3. Cabassu (2001) and Dejardin and Cabassu (2008) observed partial callus formation and clinical union two weeks post-surgery. Further they observed complete union by four weeks post-operatively. Sarrau *et al.* (2007) noticed bone healing between 4-8 weeks post-surgery.

In present study, no technical difficulties were encountered during application of VCP. No soft tissue irritation or difficulty in closing the skin incision was observed as reported by Tan and Balogh (2009). In all the animals the implants were stable, except in one case. where partial loosening of most proximal screw was noticed on 15th postoperative day. Similar finding was noticed by Theoret and Moens (2007), who observed complete screw loosening, which was treated by screw removal. No plate bending was noticed in any of the cases. On the contrary, one implant failure, *i.e.,* plate bending was observed by Sarrau *et al.* (2007).

Conclusion

In the present study, encouraging results were observed with early weight bearing, good limb usage and early clinical and radiographic union without any complications during Elastic Plate Osteosynthesis of radius and tibia fracture repair with VCP. The VCP is inexpensive which makes it suitable for use in veterinary practice together with excellent outcome.

Acknowledgement

We express our gratitude to Sri Venkateswara Veterinary University (SVVU), Tirupati, Andhra Pradesh for their support and resources that made this study possible.

References

Aithal, H.P., Singh, G.R., & Bisht, G.S. (1999). Fractures in dogs: A survey of 402 cases. *Indian Journal of Veterinary Surgergy, 20,* 15.

Aro, H., & Chao, E. (1993). Bone-healing patterns affected by loading, fracture fragment stability, fracture type, and fracture site compression. *Clinical Orthopedics and Related Research, 29,* 8-17.

Bruse, S., Dee, J., & Prieur, W.D. (1989). Internal fixation with a veterinary cuttable plate in small animals. *Veterinary and Comparative Orthopedics and Traumatology, 1,* 40-46.

Cabassu, J.P. (2001). Elastic plate osteosynthesis of femoral shaft fractures in young dogs. *Veterinary and Comparative Orthopedics and Traumatology, 14,* 40-45.

Dejardin, L.M., & Cabassu, J.P. (2008). Femoral fractures in young dogs. *AO Dialogue, 3,* 39-43.

Dvorak, M., Necas, A., & Zatloukal, J. (2000). Complications of long bone fracture healing in dogs: functional. *Journal of the American Animal Hospital Association*, 36(4), 324-330.

Fruchter, A.M., & Holmberg, D.L. (1991). Mechanical analysis of the veterinary cuttable plate. *Veterinary and Comparative Orthopedics and Traumatology, 4,* 116-119.

Gentry, S.J., Taylor, R.A., & Dee, J.F. (1993). The use of veterinary cuttable plates: 21 cases. *Journal of the American Animal Hospital Association, 29,* 455-459.

Hammel, S.P., Pluhar, G.E., Novo, R.E., Bourgeault, C.A., & Wallace, L.J. (2006). Fatigue analysis of plates used for fracture stabilization in small dogs and cats. *Veterinary Surgery, 35,* 573-578.

Piermattei, D.L., & Johnson, A.K. (2004). The forelimb. In: *An Atlas of Surgical Approaches to the Bones and Joints of the Dog and Cat.* 4th edn., Saunders, Elsevier, Philadelphia, pp. 246-253.

Sarrau, S., Meige, F., & Autefage, A. (2007). Treatment of femoral and tibial fractures in puppies by elastic plate osteosynthesis - A review of 17 cases. *Veterinary and Comparative Orthopedics and Traumatology, 20*(1), 51-58.

Tan, S.L.E., & Balogh, Z.J. (2009). Indications and limitations of locked plating. *Injury, 40*(7), 683-691.

Theoret, M.C., & Moens, N.M.M. (2007). The use of veterinary cuttable plates for carpal and tarsal arthrodesis in small dogs and cats. *Canadian Veterinary Journal, 48,* 165-168.

Thilagar, S., & Balasubramanian, N.N. (1988). A retrospective study on the incidence and anatomical location in 204 cases of fractures in dogs. *Cheiron, 17*(2), 68-71.