RESEARCH ARTICLE

Lameness and Radiological Evaluation of Elastic Plate Osteosynthesis using Veterinary Cuttable Plates for Tibial Fracture Repair in Immature Dogs with and without Platelet Rich Plasma

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Abstract

The present study was carried out on 12 clinical cases to compare elastic plate osteosynthesis using veterinary cuttable plates for tibial fracture repair in young dogs with and without platelet rich plasma. Young dogs with tibial diaphyseal fractures were randomly divided into two groups: Group A, dogs stabilized with Veterinary Cuttable Plate (VCP) and application of activated Platelet rich plasma (PRP) perioperatively, whereas Group B, stabilized with VCP without application of PRP. Fracture stabilization using VCP provided relative stability, micromotion at the fracture site resulting in secondary bone healing. All the dogs of group A had Grade V lameness preoperatively, showed Grade I lameness by end of 60 days, whereas out of six dogs in group B which had Grade V lameness preoperatively, one dog had Grade II lameness by the end of study period. Radiologically, all dogs of group A and B showed alignment of bone fragments and implants *in situ* on 1st post-operative day. In group A callus formation was noticed on 30th day and by end of 60th day remodelling was observed with corticomedullary continuity. In group B, varying amount of callus formation was noticed by 45th day and complete bone healing via bridging callus formation by 60th day suggesting complete bone healing. Considering lameness grade and radiological healing during the study period, group A dogs showed marginally early fracture healing, and weight-bearing compared to group B dogs. PRP application accelerated bone healing and improved early limb function.

Key words: Dog, Elastic plate osteosynthesis, Platelet rich plasma, Tibial fracture, Veterinary cuttable plates.

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Introduction

Fracture of the long bone is a commonly encountered orthopaedic problem in canine practice especially in young dogs (Abd El Raouf *et al*., 2017). Tibial fractures are common in dogs due to less soft tissue coverage on the medial part and superficial anatomical position making it more vulnerable to fracture (Dilip, 2007). Stabilization by internal fixation of long bone diaphyseal fractures in skeletally immature dogs is challenging and need to consider the surgical technique that would ensure alignment, proper reduction of the bone fragments and preservation of blood supply at fracture site preventing any inadvertent damage to growth plates. Following the traditional AO principles of achieving anatomical reduction and rigid internal fixation during the early growth phase often leads to severe implant failure, such as screw pullout and the stress shield effect at the fracture site can be significant enough to cause delayed fracture union. The critical evaluation of these failures has led to the development of a new biological, Elastic Plate Osteosynthesis technique (EPO) better suited for the treatment of diaphyseal fractures in juvenile dogs. Veterinary cuttable plates have several advantages such as large number of screw holes per unit length and ability to be cut to desired length as per the length of bone (Dejardin and Cabassu, 2008).

Platelet rich plasma (PRP) is the volume of the plasma fraction of autologous blood having platelet concentration above baseline. PRP deposition at the fracture site has shown

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to accelerate bone healing (Lopez *et al*., 2019). Combining elastic plate osteosynthesis technique with platelet rich plasma as part of regenerative medicine therapy for tibial fracture repair in immature dogs offers new opportunities and promising outcomes for veterinary practitioners. With this background, the present clinical study was designed to evaluate the effect of platelet rich plasma on bone healing in skeletally immature dogs with tibial fractures stabilized with elastic plate osteosynthesis technique with veterinary cuttable plates.

Materials and Methods

The study was carried out on 12 clinical cases of tibial fractures in skeletally immature dogs presented to Department of Veterinary Surgery and Radiology, Veterinary College, Hebbal, Bengaluru (India) from March 2023 to February 2024. The 12 dogs were randomly divided into two groups, Group A - Six dogs with tibial diaphyseal fractures were stabilized with elastic plate osteosynthesis with the application of platelet rich plasma at the fracture site. Group B - Six dogs with tibial diaphyseal fracture were stabilized with elastic plate osteosynthesis without application of platelet rich plasma. All the dogs were evaluated by lameness grade and radiological healing.

Preparation and Activation of Platelet Rich Plasma (PRP)

8.5 mL of venous blood was collected into acid citrate dextrose (ACD-A) vials, 4 h before surgery and divided into aliquots of 2 mL in sterile screw cap Eppendorf tube and subjected to double centrifugation. First centrifugation was done at 408 x g for 5 min at 16° C. The obtained haematocrit was separated by removing upper plasma and buffy coat carefully which was placed into another 2 mL sterile Eppendorf tube. Second centrifugation was done at 487 x g for 10 min at 16° C and upper 2/3rd plasma was discarded, while lower 1/3rd plasma was taken as platelet rich plasma. PRP was mixed with 10% $CaCl_2$ @ 10% volume of PRP which was left undisturbed for 3-5 min and was then deposited at the fracture site once the coagulum was formed.

Surgical Procedure

The surgical site of all the dogs were aseptically prepared by clipping hairs, scrubbing the site with 7.5% povidone iodine solution and mopped with surgical spirit. Pre-anaesthetics, Inj. Atropine sulphate @ 0.04 mg/kg and Inj. Xylazine @ 1 mg/kg, I/M, were administered 10 min prior to induction of general anaesthesia using 2.5% Thiopentone sodium @ 12.5 mg/kg I/V. The animals were placed in lateral recumbency with affected limb down and medial surface of tibia facing upwards. Linear incision was made on cranio-medial border of tibia and subcutaneous tissue was dissected to expose the fracture fragments, bone fragments were reduced to anatomical position and with suitable sized Veterinary cuttable plates (VCP) selected based on radiographic image, bone plating was done by elastic plate osteosynthesis technique wherein minimum of two non-locking self-tapping cortical screws and maximum of three screws were fixed on either side of fragments on most proximal and most distal screw holes. In Group A, activated PRP was deposited at the fracture site after bone plating. Subcutaneous tissue was sutured in two layers using Polydiaxone No. 1-0 and skin with monofilament polyamide in cross mattress pattern. Post-operatively, Inj. Ceftriaxone @ 25 mg/kg, I/V and Inj. Meloxicam @ 0.2 mg/kg, I/M were administered for 7 days.

Post-Operative Evaluation

Lameness scoring / weight bearing pattern, anterio-posterior and medio-lateral radiographs of affected tibia were recorded on 1st, 7th, 15th, 30th, 45th and 60th post-operative days. Lameness was graded from Grade I to V as: Grade I- animal capable of bearing its weight whether while standing or when using all four limbs for gait. Grade II- While at rest, the animal can support its weight normally, but when walking, it favoured the injured limb. Grade III - animal bearing partial weight at rest and while walking. Grade IV - animal shows partially weight-bearing at rest but does not walk with any weight on the injured limb. Grade V-while at rest or during gait, the animal does not support its weight on its limb. Post-operative radiographic assessment for fracture fragment apposition and alignment, implant positioning, callus formation, healing patterns and overall progress of fracture healing was done as recommended by Piermattei *et al*. (2016).

Results and Discussion

Lameness Grading

In group A, pre-operatively all 6 dogs showed Grade V lameness before fracture stabilization using elastic plate osteosynthesis and use of platelet rich plasma. On 1st post operative day, 2 dogs had progressed to grade III lameness, 3 dogs had progressed to grade IV lameness, while one dog still showed grade V lameness. On 7th post-operative day, 5 dogs had progressed to grade III lameness, while one dog showed grade IV lameness and on 15th post-operative day, 3 dogs progressed to grade II lameness and 3 dogs progressed to grade III lameness. On 30th post-operative day, one dog progressed to grade I lameness, while 4 dogs progressed to grade II lameness and one dog still showed grade III lameness. On 45th post-operative day, one dog progressed to grade I lameness, while 5 dogs progressed to grade II lameness. By 60th post-operative day, all the six dogs progressed to grade I lameness (Plate 1)

In group B, pre-operatively all 6 dogs showed Grade V lameness before fracture stabilization using elastic plate osteosynthesis, while one dog showed Grade III lameness, one dog showed grade IV lameness, but 4 dogs showed grade V lameness on 1st post-operative day. On 7th post-

operative day, 2 dogs progressed to Grade III lameness, while 2 dogs progressed to Grade IV lameness and other 2 dogs still showed Grade V lameness. Post-operative day 15, 3 dogs showed Grade II lameness, 2 dogs showed Grade III lameness, but one dog still showed Grade IV lameness. Post-operative day 30, 3 dogs showed Grade II lameness and 3 dogs showed Grade III lameness. On 45th post-operative day, 2 dogs started bearing weight completely showing only Grade I lameness and 4 dogs showed Grade II lameness, while 5 dogs progressed to Grade I lameness on 60th post-operative day and only one dog showed Grade II lameness (Plate 2).

In group A, lameness score decreased on 7th and 30th post-operative days compared to group B, indicating that there was improvement in lameness when platelet rich plasma was used, which might be due to early reduction in post-operative pain by faster induction of periosteal and endosteal reaction, callus formation, accelerating fracture consolidation and thereby promoted healing (Lopez *et al*., 2019). Numerous growth factors in the alpha granules of platelets such as platelet derived growth factor (PDGF), transforming growth factor-β1 (TGF-β1, β2), vascular endothelial growth factor (VEGF), osteocalcin, osteonectin, vitronectin etc., promotes production of extracellular matrix, stimulates synthesis of type I collagen and induces deposition of bone matrix (Alsousou *et al*., 2009). However, the overall outcome of lameness grade was satisfactory by the end of 60th post-operative day in both the groups.These findings were in correlation with reports of Nagata *et al.* (2010) and Aryazand *et al.* (2023).

Radiological Evaluation

Post-operative radiographs of all the dogs revealed proper position of implants *in-situ* with proper alignment of fragments and relative stability in both the groups throughout the study with no complication of screw pullout or plate bending.

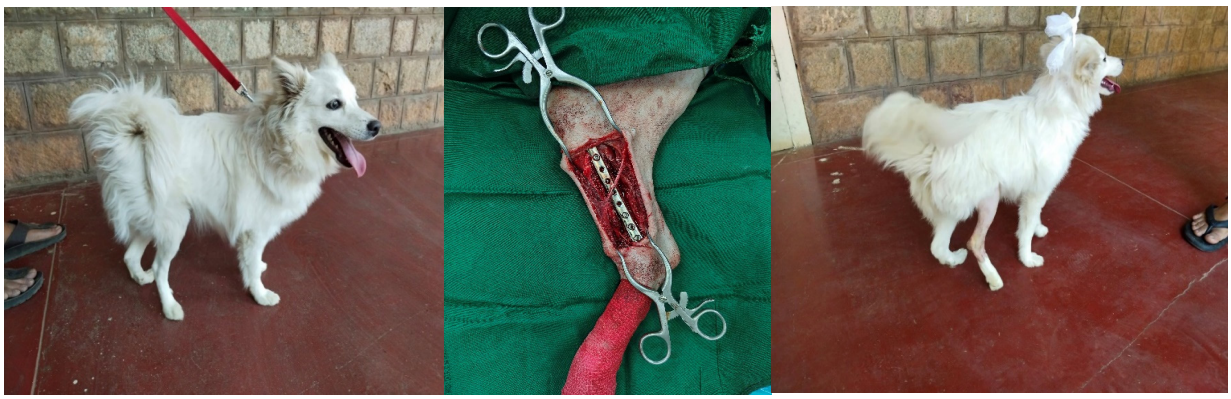
In group A: Post-operative 1st day radiographs revealed fracture line clearly visible in all the cases, 7th day radiograph

Preoperative photograph showing Grade I lameness in Case 2 of Group A

Platelet rich plasma applied onto fracture site after elastic plating

Complete weight bearing observed on 60th post operative day

Fig. 1: Pre-operative, operative and post-op erative photograph of group-A dog



Preoperativephotograph showing Grade I lameness in Case 5 of Groaup B

Plate Elastic plating done 2.7 mm 9 holes Veterinary cuttable platewithout application of platelet rich plasma

Plate Elastic plating done 2.7 mm 9 holes Veterinary cuttable plate

Fig. 2: Pre-operative, operative and post-operative photograph of group-B dog

revealed evidence of fracture gap and in 2 dogs fracture line was moderately visible and had started to faint. Post-operative 15th day radiograph revealed moderately formed callus in 2 dogs, but still poorly seen in 4 dogs. The fracture line was slightly visible in 5 dogs, whereas one dog showed clearly visible fracture line. Post-operative 30th day radiographs confirmed bridging callus in 5 cases and one dog showed dense bridging callus at fracture site. Post-operative 45th day radiograph showed dense abundant bridging callus in one case and moderate callus in 5 cases with no evidence of visible fracture line in any of the dogs. Post-operative 60th day radiograph confirmed good callus formation and invisible fracture line with cortico-medullary continuity in all cases (Plate 3).

In group B: Post-operative 1st and 7th day radiograph revealed clearly visible fracture line in all the cases, while on 15th day radiograph one dog showed bridging callus in the fracture gap, whereas 5 dogs showed callus formation. In 4 dogs, fracture line was slightly visible and 2 dogs showed visible fracture line. Post-operative 30th day radiograph showed bridging callus at fracture site. Two out of six cases showed faint fracture line. Post-operative 45th day radiograph established the evidence of callus formation in 2 dogs showing dense abundant bridging callus at fracture site and 4 dogs showing moderate amount of callus. Fracture line was invisible in 2 cases. Post-operative 60th day radiograph showed that 5 dogs had dense bridging callus and masked

Pre-operative radiograph showing transverse proximal diaphyseal fracture of left tibia

Day 15 radiograph showing plate and screws in-situ with fracture line and poor callus at fibular fracture fragments

Day 30 radiograph showing plate and screws in-situ with faintly visible fracture line and moderate amount of callus

Day 60 radiograph showing complete healing of bone with continuity of far cortex and remodelling

Fig. 3: Pre-operative, post-operative15th day , 30th day and 60th day radiographs of group-A dog

the fracture line. The cortico-medullary continuity was re-established in all the cases (Plate 4).

Early healing with callus formation in both the groups might be due to micromotion at the fracture site provided by limited screws at either ends that hastens biological healing via bridging osteosynthesis forming periosteal callus by virtue of physiological loading and presence of significant fracture gap as reported by Cabassu (2001) and Berg and Saevik (2023). In addition to faster healing by elastic plating, group A dogs showed better radiographic healing by 15th day compared to group B dogs which might be due to positive effects of PRP as activated platelets release more than 30 bioactive proteins contained in their alpha granules (Plate 4). Mirajkar (2018) and Lopez *et al*. (2019) reported that among all the growth factors, TGF-β promotes the production of extracellular matrix and stimulates biosynthesis of type I collagen to induce deposition of bone matrix aiding in faster bone union.

Conclusion

To conclude, stabilization of immature fractures through using Veterinary Cuttable Plates by Elastic Plate Osteosynthesis Technique provided fracture fragment alignment, micromotion and maintenance of vascular supply at the

Pre-operative radiograph showing short oblique mid diaphyseal fracture of right tibia

Day 15 radiograph showing moderately visible fracture line, poor callus and implants in-situ

Day 30 radiograph showing moderate callus bridging the fracture gap and implants in-situ

Day 60 radiograph showing complete fracture healing and periosteal reaction

Fig. 4: Pre-operative, Post-operative 15th day, 30th day and 60th day radiographs of group-B dogs

fracture site, which resulted in secondary bone healing with callus formation. Application of activated PRP at the fracture site aided in faster bone healing.

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References

Abd El Raouf, A.E.M., Mekkawy, N.H.M., & Abd EL-Aal, A.M. (2017). Femur fractures and treatment options in 20 dogs admitted to our clinic from January 2013 to December 2015 dogs. *Iraqi Journal of Veterinary Science*, *31*(2), 117-112.

Alsousou, J., Thompson, M., Hulley, P., Noble, A. and Willett, K. (2009). The biology of platelet-rich plasma and its application in trauma and orthopaedic surgery: a review of the literature. *Journal of Bone Surgery*, *91*(8), 987-996.

Aryazand, Y., Buote, N.J., Hsieh, Y., Hayashi, K. and Rosselli, D. (2023). Multifactorial assessment of leukocyte reduced platelet trich plasma injection in dogs undergoing tibial plate auleveling osteotomy: A retrospective study. *PloS One, 18*(6), 0287922.

Berg, J.A., & Saevik, B.K. 2023. Minimally invasive percutaneous elastic plate osteosynthesis as a treatment option for tibial diaphyseal fracture in skeletally immature dogs. *Open Veterinary Journal, 13*(12), 1744.

Cabassu, J.P. (2001). Elastic plate osteosynthesis of femoral shaft fractures in skeletally immature dogs. *Veterinary and Comparative Orthopaedics and Traumatology*, *14*(1), 40-45.

Dejardin, L.M., & Cabassu, J.P. (2008). Femoral fractures in young dogs. *AO Dialogue*, *18*(2), 39-43.

Dilip, P.G. (2007). Comparison of type Ia and Ib external skeletal fixation for tibial fracture repair in dogs. *M.V.Sc. Thesis*. Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, India.

Lopez, S., Vilar, J.M., Sopena, J.J., Damià, E., Chicharro, D., Carrillo, J.M., Cuervo, B., & Rubio, M. (2019). Assessment of the efficacy of platelet-rich plasma in the treatment of traumatic canine fractures. *International Journal of Molecular Science, 20*(5), 1075.

Mirajkar, S.R. (2018). Evaluation of string of pearls interlocking plate with or without platelet rich plasma for repair of tibial fracture in canine. *M.V.Sc. Thesis*. Maharashtra Animal and Fishery Sciences University, Nagpur, India.

Nagata, M.J., Messora, M.R., Furlaneto, F.A., Fucini, S.E., Bosco, A.F., Garcia, V.G., Deliberador, T M., & de Melo, L.G. (2010). Effectiveness of two methods for preparation of autologous platelet-rich plasma: an experimental study in rabbits. *European Journal of Dentistry, 4*(4), 395-402.

Piermattei, D.L., Brinker, G.L, & Flo, G.L. (2016). Fractures: Classification, diagnosis, and treatment. In: *Handbook of Small Animal Orthopedics and Fracture Repair*. 5th edn., Elsevier Missouri, pp. 24-149.