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Original Reserach

Use of String of Pearls Locking Plate System for Stabilization of Femoral Fractures in Canines

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Abstract

The present clinical study was conducted to evaluate String of Pearls Locking plates (SOP) in the treatment of femoral fractures in dogs. The symptoms observed in the dogs were pain on manipulation, abnormal angulation, lameness swelling, non-weight bearing, dangling of the limb and crepitation at the fracture site. Fractures were confirmed using radiography and evaluated preoperative haematological and serum biochemical parameters. Fractures were stabilized with string of pearls locking plates. String of Pearls Locking plates (SOP) was successful in the treatment of femoral fractures and offered good recompense and remarkable improvement in limb function in five out of seven dogs.

Keywords: Femoral Fractures, Plate Breakage, Radiographic Evaluation, String of Pearls Locking Plate

Introduction

Fracture of long bones is the most common musculoskeletal condition reported in small animal practice especially in dogs. Among the long bones, the incidence of fractures were highest in femur (45.87%), followed by radius-ulna (18.34%) and tibia-fibula (12.44%) (Gahlod *et al*., 2004). Among different types of fractures recorded, transverse (47.5%) was most common followed by communited and short oblique (23.8%), long oblique (3.8%) and multiple (1.3) types (Kallianpur *et al.*, 2018). External coaptation methods, such as casts or splints are ineffective and contraindicated for repair of femur in dogs due to the anatomical orientation of the hind limb. Bone plating was the commonly used modality for femur fractures in dogs. Due to the limitations in conventional plate designs viz., dynamic compression plate (DCP) and limited contact-dynamic compression plate (LC-DCP) paradigm shift to locking plate designs has occurred. Newer locking plate designs has evolved over the period of time such as, unilock plate, advanced locking plate system (ALPS), fixing systems and string of pearls locking plate (SOP).

SOP is a novel orthopaedic plate system designed for Veterinary and Human orthopaedic use. The SOP consists of a series of cylindrical sections (internodes) and spherical components (pearls). The SOP can be contoured in six degrees of freedom; medial to lateral bending, cranial to caudal bending and torsion (Kraus and Ness, 2014). The use of inserts (SOP bending tees) placed into the pearls protects the pearl absolutely and preserves locking function completely during contouring. Mechanical testing using ASTM (American Society for Testing and Materials) standards has demonstrated that the 3.5 mm SOP is approximately 50% stiffer, and has a bending strength (load at which the plate bends) of 16-30% greater than 3.5 mm LCP, DCP, or LC-DCP (DeTora and Kraus, 2008; Kraus and Ness, 2014). SOP bent through 40 degrees remain almost (96%) as stiff as an untouched 3.5 mm DCP and SOP twisted through 20 degrees remains significantly stiffer than the new and untouched 3.5 mm DCP (Kraus and Ness, 2014).

Materials and Methods

The present study was conducted on seven dogs with femoral fractures. The age of seven dogs ranged from 4 – 48 months with a mean of 24 ± 7.94 months. The body weight of the dogs ranged from 4.5 to 27.2 kg with a mean body weight of 12.15 ± 3.25 kg. The type of fracture and severity were assessed by clinical examination and radiography. The details of the dogs are presented in Table 1.

Table 1: Clinical history of the dogs selected for SOP locking plate procedure

S. No.	Breed	Age (in months)	Sex	Body Weight (Kgs)	Cause of fracture	Limb affected	Location of fracture	Type of fracture
1	Non-Descript	16	M	18.2	Automobile accident	Right	Mid diaphyseal	Closed Complete communited overriding
2	Non-Descript	4	M	4.5	Fall from Height	Left	Proximal diaphyseal	Closed Complete short oblique overriding
3	Non-Descript	48	M	16.4	Automobile accident	Right	Distal diaphyseal	Closed Complete transverse overriding
4	German shepherd	4	F	5.6	Fall from Height	Right	Distal diaphyseal	Closed Complete transverse overriding
5	Spitz	44	F	6.8	Fall from Height	Right	Mid diaphyseal	Closed Complete short oblique overriding
6	Non-Descript	46	M	27.2	Automobile accident	Right	Proximal diaphyseal	Closed Complete transverse overriding
7	Non-Descript	6	F	6.4	Automobile accident	Left	Distal diaphyseal	Closed Complete transverse overriding

The size of plates used for fracture fixation was determined by body weight of the dogs. 2.7 mm SOP plate was used in dogs weighing less than 10kg and 3.5 mm SOP plate was used in dogs weighing more than 10kg. Food was withheld for 12 hours and water was withheld for 6 hours before surgery in all the dogs. The dogs were premedicated with atropine sulphate @ 0.04 mg/kg subcutaneously followed by xylazine hydrochloride @ 1mg/kg intramuscularly. Then general anaesthesia was induced by ketamine hydrochloride @ 10 mg/kg intramuscularly.

Following induction, the dogs were intubated with endotracheal tubes of suitable size. Anaesthesia was maintained with intravenous infusion of propofol @ 4mg/kg body weight. Additional doses of propofol were administered whenever necessary during surgical procedure through the intravenous line. The surgical site was prepared aseptically. The dogs were positioned in lateral recumbency by keeping the fractured limb upwards and the distal extremity was covered with a sterile gauge bandage.

A skin incision was made along the craniolateral border of the thigh extending from the trochanter major to the lateral condyle of femur. Subcutaneous tissue was incised to expose the tensor fascia lata muscle. The tensor fascia lata was incised along its insertion to the cranial border of biceps femoris muscle. Biceps femoris muscle was retracted caudally to expose the vastus lateralis muscle. These muscles were separated and retracted to expose the shaft of the femur (Piermattei and Johnson, 2014). The fracture fragments were exposed and reduced. Stabilization of the femoral fractures was done with precontoured SOP plates. Prior to bending of SOP plate, the holes in the SOP plate were loaded with SOP bending tees to protect the pearl integrity. The SOP plate was bent using the SOP plate benders by engaging the adjacent pearls. Once the plate was contoured the bending tees were removed. The contoured SOP plate was placed on the bone and the contour was reviewed. The screws were placed in the most proximal and most distal screw holes. The length of the screws was determined by measuring the medial to lateral cortex diameter in preoperative radiographs and confirmed by depth gauge. The screws were directed perpendicular to the spherical component of the SOP. Following fracture repair, the tensor fascia lata was closed in a simple continuous pattern using 2-0 polyglactin 910. Subcutis and skin wounds were closed using 2-0 sizes of polyglactin 910 and polyamide respectively.

Due to failure in 2 dogs due to plate breakage, in a dog weighing 27.2 kg SOP plate nesting was performed. The surgical approach followed was as described earlier. Instead of one plate, two 3.5 mm SOP plates were contoured to match the topography of the lateral aspect of femur and were nested side by side (Fig. 1).

Figure 1: SOP plate nesting side by side on femur in a dog weighing 27.2 kg.

The suture line was covered with a thin layer of gauze with 5% povidone iodine. The dressing was changed every alternate day until the sutures were removed on the 12th post-operative day. Ceftriaxone sodium was given @ 25 mg/kg body weight as intravenous injection once daily for 7 days post-operatively. Meloxicam was administered once a day @ 0.3 mg/kg as intramuscular injection for 3 days post-operatively. Owners were advised to restrict the movement of the animal for first 2 weeks of surgery and then allowed leash walking for next few days. Elizabethan collar was advised to prevent self-mutilation of the wound.

Results and Discussion

A total of 68 cases of long bone fractures were recorded in dogs during the study period. Out of 68 cases, fractures

involving femur were encountered in 32 cases. Out of these 32 cases, seven cases that were considered suitable for fixation with SOP plates were selected for the study. Out of these seven dogs, four dogs were male and three dogs were female. Five dogs belonged to non-descript breed, one was spitz and the others were German shepherd. The main cause of fractures was found to be automobile accident in 4 dogs (57.15%) followed by fall from a height in 3 dogs (42.85%). The dogs were presented for treatment between 2 to 6 days with a mean of 3.85 ± 0.5 days after sustaining fracture. Seven dogs in the age group of 4 – 48 months and body weight range between 4.5 – 27.2kg were selected for the study and the fractures were stabilized with SOP locking plates. No intraoperative complications were noticed during the application of SOP locking plates.

Implant Stability

In the present study with 2.7 mm and 3.5 mm String of Pearls Locking plates (SOP) with locking screws produced rigid fixation and remarkable improvement with normal limb function. Good implant stability throughout the observation period without any complications was achieved in five dogs. In two dogs, plate breakage was observed at the fracture site by post-operative 30th day due to subsequent fall from height in both the dogs (Fig. 2). Revision of surgery was not performed due to owner's noncompliance. However, intermittent weight bearing was observed by 45th post-operative day in both the dogs.

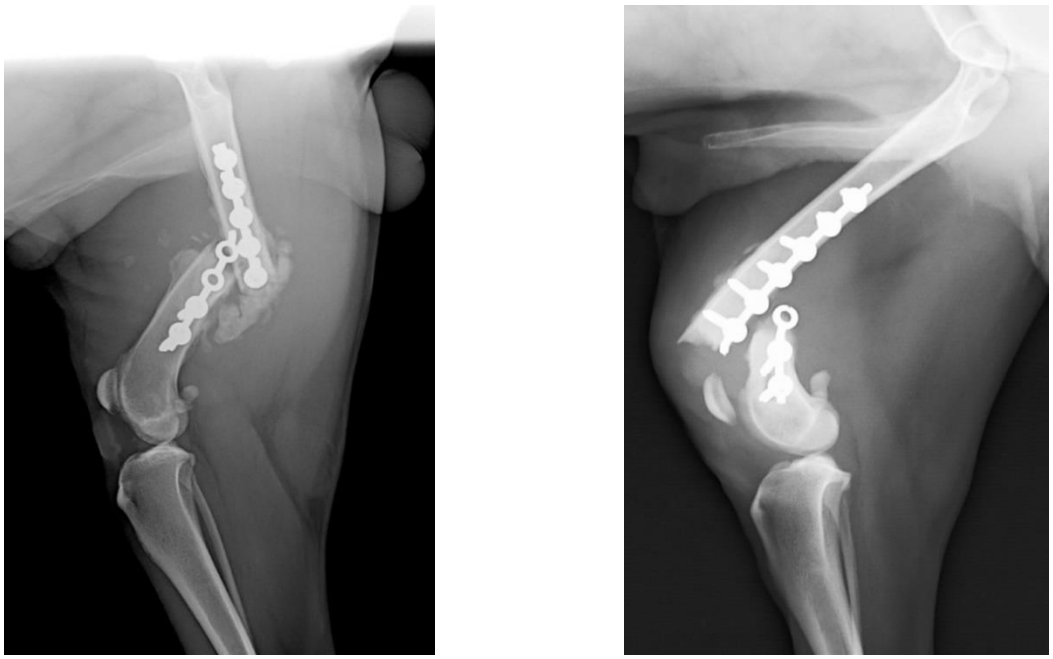

Figure 2: Radiographs showing implant failure in two dogs.

Lameness Grading

All the dogs in the present study preoperatively showed Grade V lameness before surgical stabilization of fractures. All the dogs in the present study showed partial weight bearing from 1st post-operative day. One dog achieved complete weight bearing by 7th post-operative day, four dogs by 15th post-operative day and two dogs by 45th post-operative day.

Radiographical Evaluation

The radiographical evaluation of fracture site for implant position, fragment alignment and callus formation are done immediate post-operatively and in weekly intervals. Immediate post-operative radiographic evaluation confirmed proper placement of the SOP plate and screws, good apposition and alignment of the fracture fragments in all the seven dogs. The plate length, size and position were appropriate in all cases. Screw length, size and position were considered appropriate in all cases. Post-operatively no screw loosening was observed in any of the cases. Radiographs obtained on the 7th post-operative day revealed proper apposition and alignment of the fracture fragments in all the seven dogs. The radiolucent fracture line was observed.

Table 2: Post-operative lameness score in SOP plating for femoral fractures in dogs

Case No	Pre-operative	Post-operative weight bearing at the end of				
		Day 1	**Day 7**	**Day 15**	**Day 30**	**Day 45**
1	Grade V	Grade III	Grade III	Grade II	Grade III	Grade II
2	Grade V	Grade III	Grade I	Grade I	Grade I	Grade I
3	Grade V	Grade III	Grade III	Grade II	Grade III	Grade II
4	Grade V	Grade IV	Grade III	Grade II	Grade II	Grade I
5	Grade V	Grade III	Grade III	Grade I	Grade I	Grade I
6	Grade V	Grade III	Grade II	Grade I	Grade I	Grade I
7	Grade V	Grade III	Grade III	Grade I	Grade I	Grade I

Follow-up radiographs obtained on the 15th post-operative day depicted proper position and good alignment of the fracture fragments in all the dogs. The radiographs revealed good callus formation, bridging the fracture site in all the dogs. However, the radiolucent fracture line was still discernible in all the cases. Radiographs obtained on the 30th post-operative day revealed bridging callus considerably reduced in size. In two dogs, radiographs revealed plate breakage at the fracture site. The callus was smoother and more opaque. The radiolucent fracture line was faintly visible. On the 45th post-operative day, the radiographs revealed, gradual obliteration of the bridging callus at the fracture area. Callus looked as opaque as the normal bone (Fig. 3).

Figure 3: Progressive radiographic changes in a dog with femur fracture

Complications

No intraoperative complications were observed. Plate breakage was noticed in two dogs at 30th post-operative radiographical evaluation. The etiology for the implant failure was reported as subsequent fall from height. Revision of surgery was not performed due to owner's noncompliance. However, intermittent weight bearing was observed by 45th post-operative day in both the dogs. In none of the cases, implant removal was taken up as the owners were reluctant for the second surgery and no other complications were clinically observed.

The SOP consists of series of cylindrical sections (internodes) and spherical components (pearls). The cylindrical component, or internode, has an area moment of inertia greater than the corresponding DCP's. The SOP differs from other locking plate systems; in that the SOP can be contoured in six degrees of freedom; medial to lateral bending, cranial to caudal bending and torsion; using specially designed bending irons without compromising the locking function. Properly performed, contouring results in bending or torsion at the internode, preserving the locking function of pearl absolutely. The design of the SOP plate achieved an inherently greater AMI at the screw hole than an equivalent sized conventional plate or LC-DCP making it suitable choice for buttress function (DeTora and Kraus, 2008). Use of SOP plates had been reported for the repair of Y-T humeral fractures (Ness, 2009), stabilization of vertebral bodies in thoracolumbar disc protrusions (Mc Kee and Down, 2008), as a transilial plate stabilization of a sacral fracture (Mills, 2009) and distal femoral fractures (Kumar *et al*. 2018). The lameness grading followed in the present study was reported Vasseur *et al.* (1995)

Conclusion

It was concluded from the results of the present study that SOP plates were found to be effective in treatment of femoral fractures since they are replete with features like their ability to lend themselves to contouring to any shape of bone, high bending strength and maintaining limited contact with bone. It was also felt that SOP plates, because of the features mentioned above, have a good potential for use in fractures of not only the long bones but also flat bones in dogs.

Conflict of Interests

There is no conflict of interest.

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References

1. DeTora, M. and Kraus, K. (2008). Mechanical testing of 3.5 mm locking and non-locking bone plates. *Veterinary and Comparitive Orthopaedics and Traumatology 21*(4): 318–322.
2. Gahlod, B. M., Dhakate, M. S., Patil, S. N., Gawande, P. S. and Kamble, M. V. (2004). Retrospective study of fractures in canines- A report of 109 cases. *Indian Journal of Veterinary Surgery*. *25*(2): 122-142 Abstracts, XXVIII Annual Congress of Indian Society for Veterinary Surgery 2004.
3. Kallianpur, N., Singh, K., Gopinathan, A., Sarangom, S. B., John, C., Sowbharenya, C. and Sharma, P. (2018). Investigation on relation between factors affecting occurrence and outcome of repair of long bone fractures in 216 dogs. *International Journal of Livestock Research*, *8*(2), 225-234. http://dx.doi.org/10.5455/ijlr.20170823024229.
4. Kraus, K. H. and Ness, M. G. (2014). *The SOP Locking Plate System*. In Current Techniques in Small Animal Surgery, Bojrab M J, V Ed., Williams and Wilkins, Baltimore. Pp. 792-796.
5. McKee, W. M. and Downes, C. J., (2008). Vertebral stabilisation and selective decompression for the management of triple thoracolumbar disc protrusions. *Journal of small animal practice*, *49*(10), pp.536-539.
6. Kumar, K. M., Prasad, V. D., Lakshmi, N. D., and Raju, N. K. B. (2018). Management of distal femoral diaphyseal fractures with string of pearls locking plate in dogs. *Indian Journal of Animal Research.* DOI: 10.18805/ijar. B-3447.

7. Mills, J. (2009). Transilial interlocking plate stabilization of a sacral fracture and an ilial fracture in a dog. *Veterinary and Comparitive Orthopaedics and Traumatology 22*(1): 70-73.
8. Ness, M. G. (2009). The effect of bending and twisting on the stiffness and strength of 3.5mm SOP implant. *Veterinary and Comparitive Orthopaedics and Traumatology 22*(2): 132-135.
9. Piermattei, D. L. and Johnson, K. A. (2014). *The hind limb in an atlas of surgical approaches to the bones and joints of the dog and cat.* 5th Ed. Saunders WB, Philadelphia. pp. 369.
10. Vasseur, P. B., Johnson, A. L., Buder berg, S. C., Linwin, J. B., Toombs, J. P., Whitebain, J. G. and Lentz, E. L. (1995). Randomized, controlled trials of the efficacy of carprofen, a non-steroidal anti-inflammatory drug in the treatment of osteoarthritis in dog. *Journal of American Veterinary medical Association.* 206: 807-811.

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