Evaluation of stainless steel positive profile end threaded intramedullary pins for management of long bones fractures in dogs

Ravi Kumar P, Devi Prasad V, Sreenu M, Venkata Naidu G and Raju NKB

Abstract
Six clients owned dogs (n=6) with fracture of long bones were included in the present study. Physical examination and radiography aided in the diagnosis of the condition. Steps were taken to stabilize the animal hemodynamically on the day of its presentation and stabilized the affected limb with application of modified Robert Jones bandage. Aseptic surgery was planned once the edema of the limb was reduced and open reduction and stabilization was performed under general anesthesia in all the dogs. All the fractures were stabilized with stainless steel positive profile end threaded intramedullary pins followed by application of modified Robert Jones bandage. Pin migration was noticed in two cases and the migrated pins were removed under general anesthesia. Mild osteomyelitis was noticed in one case and was resolved after administering antibiotics. Normal ambulation of the affected limb was seen in all the animals. Complications like malunion, non-union, limb shortening were not noticed in any of the cases.

Keywords: Positive profile, end threaded, intramedullary pinning, long bone fractures, Robert Jones bandage

Introduction
Management of long bone fractures with intramedullary pinning technique is a regularly followed technique in veterinary orthopaedics. Unthreaded intramedullary pins could only resist bending forces and cannot counteract shearing and rotational forces which act at the fracture site (Kumar & Gahlot, 2013) [1]. Stack pin application can partially overcome these disadvantages by opposing the horizontal crossing and bending forces (Lidbetter and Glyde, 2000) [2], whereas; combine plate-intramedullary pin application can overcome all the disadvantages by bringing increased axial and rotational stability at the fracture site (Hulse et al., 2000) [3]. Intramedullary interlocking nailing is one of the fracture fixation techniques which can counteract all the forces acting at the fracture site and achieve rigid repair (Kapler, 2015) [4]. End threaded intramedullary negative profile pins are the pins which can penetrate into the cancellous part of distal fragment and provide stability against the bending forces and also prevents migration of the pin, but the strength of this implant at the pin-thread junction is weak and prone to breakage if the junction is at the fracture site. This type of weak pin-thread junctions will not be seen in Positive profile end threaded intramedullary pins as the threads are raised above the core diameter of the pin (Chanana et al., 2018) [5]. The aim of the present study was to evaluate the stainless steel positive profile end threaded intramedullary pins for fixation of long bone fractures in dogs.

Materials and Methods
The study was conducted over six clients owned dogs (n=6) which were presented to the clinics of SVVU Super Speciality Veterinary Hospital, Visakhapatnam, with fracture of their long bones (Fig-1). The etiology and signalment of the animals were mentioned in Table No-1. Physical examination and radiography has been carried to diagnose the type of fracture. The bone involved and AO/AISF classification of the fracture were shown in Table No-2. All the dogs were stabilized hemodynamically by administration of intravenous fluids besides analgesics and antibiotics. The fracture site was temporarily immobilized with application of modified Robert Jones bandage and planned for aseptic surgery. All the dogs were given intramuscular injection of Butorphanol at the dose rate of 0.2mg per kg body weight, Acepromazine at the dose rate of 0.05mg per Kg body weight and Glycopyrrolate at the dose...
rate of 0.05mg per Kg body weight as preanesthetic medication. Anesthesia was induced by intravenous administration of Propofol at the dose rate of 4mg per kg body weight (Till effect). Anesthesia was maintained with the help of Isoflurane inhalant anesthesia using Boyel’s apparatus. The fracture site was approached from cranio-lateral aspect of the limb for humerus and femur fractures; and medial aspect of the limb for tibial fractures. Open reduction was performed and the fracture fragments were stabilized with retrograde application of stainless steel positive profile end threaded intramedullary pins (Fig-2). Ancillary support with cerclage wiring with orthopaedic wire was given in long oblique fractures. Mild bone loss at the fracture site with minimal cortex to cortex contact was noticed at the fracture site in all the animals after the reduction and stabilization of fracture. The fracture gap at the area of bone loss was left as such and the fracture site was closed as per the standard procedure. Postoperatively, the limb was supported with a modified Robert Jones bandage. Postoperatively, the dogs were given intramuscular injections of ceftriaxone sodium at the dose rate of 25mg per Kg bodyweight for seven days and meloxicam at the dose rate of 0.2mg per Kg bodyweight for 5 days. Oral administration of calcium syrup was advised for one month in all the operated dogs. All the operated dogs were evaluated on 0th, 7th, 15th, 30th, 60th and 90th postoperative days. In case5 and 6 migration of the intramedullary pin was noticed on 30th postoperative day and the pins was removed on the same day under general anesthesia and provided support with modified Robert Jones for one week.

Results
The dogs presented with the fracture of long bones in the present study belong to non-descriptive breed. The mean age of the dogs in the present study was 23.33±16.9 months and the mean weight of them was 10.27 ± 1.15 Kg. The etiology responsible for fracture is fall from height in three cases, automobile accident in two cases, dog bite in one case and sudden blow with a wood in one case. In the present study the fracture was noticed in femur in three cases, tibia in 2 cases and humerus in one case. Immediate postoperative radiographs showed good reduction in all the animals with minor fracture gaps (Fig-3). Partial weight bearing of the affected limb was noticed on 7th postoperative day (Fig-4). Normal function of the limb was restored by 30th postoperative day in cases 1, 2, 3 and 4 (Fig-5) whereas; in cases 5 and 6 mild lameness was noticed which was due to migration of the pin. By 90th postoperative day all the animals showed normal amputation of the affected limb. Radiographic evaluation of the fractured limb on 7th postoperative day revealed initiation of callus at the fracture site in two dogs (case-1 & 3) (Fig-6), whereas; in the remaining dogs it is not evident. On 14th postoperative day, all the dogs showed periosteal calls at the fracture site. Complete bridging periosteal callus was noticed in case 1, 2, 3 and 4; on 30th postoperative day, by which time the complete function of the limb, was appeared to be restored. whereas; In case 4 and 5 migration of intramedullary pin was noticed in addition to exuberant callus at the fracture site (Fig-7), resulting in mild lameness. Mild osteomyelitis was noticed in case 4 during 30th postoperative day and was subsided by administration of antibiotics for one week. Complete radiographic healing was noticed in all the cases by 60th postoperative day. Lamellar bone formation with medullary canal continuity was noticed in cases 1, 2, 3 and 4 by 90th postoperative day (Fig-8). Whereas; in the remaining two cases excessive bridging callus was noticed at the site of fracture. Complications like non-union, mal union, bone shortening etc., were not noticed in any of the case under study.

Discussion
In the present study, the incidence of fractures was noticed in dogs belonging to non-descriptive breed which could be attributed to their higher population in the surrounding localities. Similarly, Aithal et al., (1999) [6]; Thilagar and Balasubramanian (1988) [7]; and Manjunatha and Ranganath (2012) [8] also reported the higher incidence of fractures in non-descriptive breeds. In contrary to this Balagopolan et al. (1995) [9] reported higher incidence of fractures in German shepherd dogs and Kushwaha et al. (2011) [10] reported higher incidence of fractures in Spitz dogs. Manjunatha and Ranganath (2012) [8] opined that, the higher incidence of fractures in non-descriptive dogs might be due to higher population of non-descriptive breed in and around the area, over the streets where they are more likely to come across external trauma. The mean age of the animals in the present study was less than 2 years, suggesting that, the fracture incidence was more in young animals. Similar findings were also reported by Aithal et al., (1999) [6]; Thilagar and Balasubramanian (1988) [7], Kushwaha et al. (2011) [10].

In the present study, the etiological factor responsible for the fracture was Fall from height in three animals, Automobile accident in one animal, Trauma due to blow by a log in one animal and dog bite in one animal. The present findings were in concomitance with Kumar et al., (2007) [11]; and Kushwaha et al. (2011) [10] who reported fall from height as a major etiological factor responsible for fracture in dogs, but Priyanka et al., (2019) [12] reported Automobile accidents as a major etiological factor responsible for fracture in dogs. Libardoni et al. (2018) [13] reported both automobile accidents and fall from height as the frequent causes of fractures in dogs.

In the present study, the fracture fixation was done with intramedullary pinning technique using positive profile end threaded stainless steel intramedullary pins. Chanana et al., (2018) [5] used similar type of intramedullary pins for management of long bone fractures in dogs. Ozsoy (2004); and Altunatmaz et al., (2012) [14] used negative, fully threaded stainless steel implants for management of long bone fractures. The pin migration noticed in the present study was due to sudden fall of the dogs from height during the postoperative period. Hence, this could not be attributed to the implant failure and it was resulted from poor management of the pet owner and aggressive temperament of the pet. Ozsoy (2004) stated that, the threaded pins prevent migration by gripping the cancellous bone and this statement was strengthened by the findings of Altunatmaz et al. (2012) [15] and Chanana et al., (2018) [5]. Pin removal was performed in two cases where pin migration was observed, to prevent soft tissue damage due to migrated pin. Large amount of external callus was noticed in only two animals and this could be attributed to lack of rigid fixation at the fracture site due to pin migration. Piermattei et al. (2006) [16] stated that, the amount of callus formed at the fracture site is inversely proportional to degree of stability at the fracture site. However, young animals show excess callus at the fracture site though the fracture fixation was rigid. In the present study, early fracture healing was noticed in majority of the
cases, and this could be attributed to rigid fixation achieved with the implant. Chanana et al. (2018) [5] opined that, use of positive profile end threaded pins provide 30-40% unoccupied medullary cavity at the fracture site, which allow the medullary circulation to regenerate and might aid in early healing.

Table 1: Table showing the signalment of the dogs included in the present study

<table>
<thead>
<tr>
<th>Dog no</th>
<th>Age</th>
<th>Sex</th>
<th>Breed</th>
<th>Weight(kg)</th>
<th>Etiology</th>
<th>Limb involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5M</td>
<td>Male</td>
<td>ND</td>
<td>7.4</td>
<td>Blow injury by a log</td>
<td>LHL</td>
</tr>
<tr>
<td>2</td>
<td>8M</td>
<td>Female</td>
<td>ND</td>
<td>13</td>
<td>Fall from height</td>
<td>RHL</td>
</tr>
<tr>
<td>3</td>
<td>6M</td>
<td>Male</td>
<td>ND</td>
<td>12</td>
<td>Fall from height</td>
<td>RHL</td>
</tr>
<tr>
<td>4</td>
<td>5M</td>
<td>Male</td>
<td>ND</td>
<td>9</td>
<td>Fall from height</td>
<td>RHL</td>
</tr>
<tr>
<td>5</td>
<td>9Y</td>
<td>Female</td>
<td>ND</td>
<td>7.2</td>
<td>Dog bite</td>
<td>LFL</td>
</tr>
<tr>
<td>6</td>
<td>8M</td>
<td>Female</td>
<td>ND</td>
<td>13</td>
<td>Automobile accident</td>
<td>RHL</td>
</tr>
</tbody>
</table>

M: Months, Y: Years, ND: Non-descript, LFL: Left fore limb, RHL: Right hind limb

Table 2: Table showing the bone involved and AO/AISF classification of the fracture

<table>
<thead>
<tr>
<th>S. No</th>
<th>Bone involved</th>
<th>Type of fracture</th>
<th>AO/ASIF classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tibia</td>
<td>Closed, Complete, Distal, Simple, Oblique fracture with displaced fragments.</td>
<td>43A1</td>
</tr>
<tr>
<td>2.</td>
<td>Tibia</td>
<td>Closed, complete, Diaphyseal, Simple, long oblique fracture with displaced fragments</td>
<td>42A2</td>
</tr>
<tr>
<td>3.</td>
<td>Femur</td>
<td>Closed, Complete, Diaphyseal, Simple, Oblique fracture with displaced fragments</td>
<td>32A2</td>
</tr>
<tr>
<td>4.</td>
<td>Femur</td>
<td>Closed, Complete, Diaphyseal, Simple, Transverse fracture with displaced fragments</td>
<td>32A3</td>
</tr>
<tr>
<td>5.</td>
<td>Humerus</td>
<td>Closed, Complete, Diaphyseal, Simple, Oblique fracture with displaced fragments</td>
<td>12A2</td>
</tr>
<tr>
<td>6.</td>
<td>Femur</td>
<td>Closed, complete, Diaphyseal, wedge fracture with a reducible wedge and displaced fragments.</td>
<td>32B1</td>
</tr>
</tbody>
</table>

Fig 1: Photograph showing non-weight bearing lameness on left hind leg in case-1

Fig 2: Intraoperative photograph showing open reduction and stabilization with intramedullary pinning in case-4

Fig 3: Photograph showing the preoperative and immediate postoperative radiographs in case-1

Fig 4: Photograph showing partial weight bearing on 7th postoperative day in case-1
Conclusion
The positive profile end threaded stainless steel intramedullary pin used in the present study provided rigid fixation and early fracture healing in majority of the cases with an exception in two cases where it was failed due to improper management by the pet owners.

Acknowledgements
The authors wish to thank the university authorities for their help and support during the research programme and this particular paper is part of PhD research programme.

References
15. Altunatmaz K, Ozsoy S, Mutlu Z, Devecioglu Y, Guzel