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A study on management of fracture of tibia and fibula in dogs by bone plating and intramedullary pinning

Sukhpreet Singh[1†], Amit Kumar[2], S.P. Tyagi[3], Adarsh Kumar[4], Sukti Naryal[1] and Mansi Bajaj[1]

CSK Himachal Pradesh Agricultural University, Palampur-176 062 (Himachal Pradesh)

1MVSc Scholar, 2Assistant Professor, 3Professor and Head, 4Professor, Department of Veterinary Surgery and Radiology, Dr GC Negi College of Veterinary and Animal Sciences, Palampur.

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The present study was conducted on 18 dogs (age 1 m to 8 yr, body weight 2-44 kg) with fracture of tibia/fibula presented during Oct 2018 to Dec 2019 with the objective to repair/fix the tibia/fibula fractures in dogs by internal fixation techniques (bone plating and intramedullary pinning). The choice of technique was done on the basis of age of animal, type of fracture. Ten cases were treated by bone plating and 8 by intramedullary pinning. The average healing time of tibia/fibula fracture repaired by bone plating was 45.48±13.69 days. Bone plating provided good to excellent fracture reduction and fixation. Postoperatively there was bending of bone plate in two cases, in one case the distal part of the bone and screws got exposed and in another case there was osteomyelitis and plate induced osteopenia. The average healing time of fracture of tibia/fibula repaired by intramedullary pinning was 34.0±7.12 days without any postoperative complication. The mean weight bearing score was recorded as 8.89±1.11 and 10.0±0.0 out of 10 on final reappraisal day in fracture of tibia/fibula managed by bone plating and intramedullary pinning, respectively. The tibia/fibula fractures in dogs can be efficiently managed by both bone plating and intramedullary pinning but the extent of tissue manipulation and technical difficulty was higher in bone plating with better fracture fixation.

Key words: *Bone fracture, Bone plating, Dog, Intramedullary pinning, Tibia-fibula*

Fracture is a commonly encountered orthopaedic condition in veterinary practice. The incidence of fractures was recorded as 17.80 % among the total small animal surgery cases and the incidence of long bone fractures constituted about 84.48 % among the total number of fracture cases (Ali, 2013). Tibia/fibula is the second most commonly affected long bone with fracture after femur (Ali, 2013; Sran *et al.,* 2016). The method of fracture repair and the technique employed is normally dictated by type and location of fracture, size and age of the animal, the number of bones and limbs involved and other associated soft tissue injury (DeYoung *et al.,* 1993). The fracture of tibia/fibula can be effectively managed by internal fixation techniques (intramedullary pinning, cross-pinning, intramedullary interlocking nailing and bone plating etc.), external skeletal fixation and by external coaptation. The primary goal of any technique of fracture fixation is to achieve the healing without complication and allowing early mobility or ambulation. The present study describes the management of tibia/fibula fractures by internal fixation technique (bone plating, plate rod combination and intramedullary pinning) as per the need of the individual case (tailor made approach).

Materials and Methods

Eighteen cases of different types of tibia/fibula fractures were presented to the surgical OPD from October 2018 to December 2019 were treated by internal fixation; 10 by bone plating and 8 by intramedullary pinning. Open reduction and internal fixation (ORIF) technique was used for management of tibia/fibula fractures by intramedullary pinning and bone plating. Adequate exposure of tibial shaft was achieved by standard medial incision (Newton *et al.,* 1985; DeCamps *et al.,* 2016). The bone plate was applied on medial surface of tibia in all the cases. The bone plate was used in different modes as compression, neutralization or bridging mode depending upon the type of fracture. The intramedullary pin was inserted in normograde manner from the proximal end of the tibia, slightly cranial to the insertion footprint of the cranial cruciate ligament (DeCamps *et al.,* 2016).

Anamnesis, clinical examination, haemato-biochemical examination and orthopaedic examination (inflammation at fracture site, pain at fracture site, crepitus, status of weight bearing) was done in all cases. The radiographic examination (cranio-caudal and medio-lateral projections) was carried out in all the cases to diagnose the type and site of the fracture.

Different preoperative and postoperative observations were recorded at different intervals. Pain and inflammation were scored on a scale of 0-3 (Kumar *et al.,* 2020). Status of weight bearing on the fractured limb was recorded on implant fixation day (IFD) as well as on final reappraisal day (FRD), on the scale of 0-5 as: 0-test limb not touching the ground and 5 means-the paw of test limb touching the ground regularly. Net weight-bearing score (max. 10) was calculated by adding individual score of standing and walking phases (max. 5 in each) for a particular patient (Kumar *et al.,* 2020).

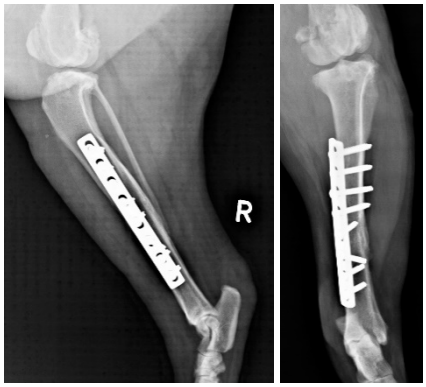
†Corresponding author; E-mail: sukhivets@gmail.com

During fracture fixation, various intraoperative observations like extent of manipulation/soft tissue damage, degree of technical difficulty, status of fracture reduction and fixation, intraoperative complications if any were also recorded. The extent of manipulation/soft tissue damage and degree of technical difficulty were recorded on scale of 1–3; as 1-slight, 2-moderate and 3-high (Kumar *et al.,* 2020). Whereas the status of fracture reduction and fracture fixation were recorded on scale of 1–4, as 1-poor, 2-fair, 3-good and 4-excellent (Kumar *et al.,* 2020).

Descriptive statistics, such as percentages, mean and standard error were calculated using SPSS ver. 21 software in order to describe the study.

Results and Discussion

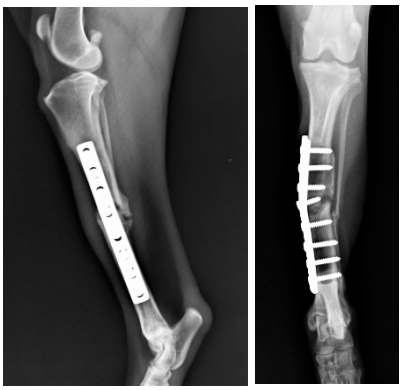
The age of the dogs with tibia/fibula fracture ranged from 1 m to 8 yr and weight ranged from 2-44 kg. The choice of the technique used was based on the age and temperament of the dog, type and location of the fracture, feasibility of the technique, owner's concern and the availability of the implant. The bone



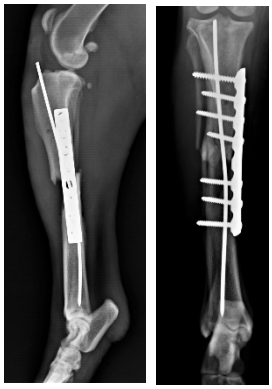
Case No. 1: On 120th postoperative day; fracture healing completed, cortical union achieved with obliteration of fracture line and callus remodelling.

Case No. 4: On 29th postoperative day, fracture healing was complete by primary bone healing, cortical union was achieved with obliteration of fracture line, with no periosteal callus.

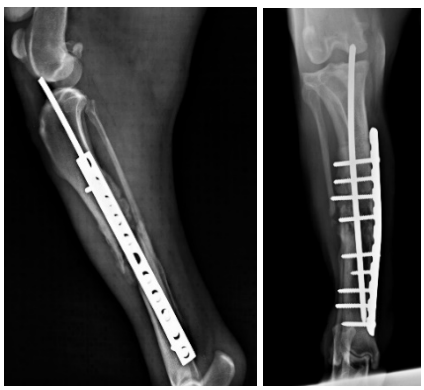
Case No. 7: On 45th postoperative day, large bridging callus formed at fracture site with obliteration of fracture line.



Case No. 8: On 52nd postoperative day, fracture healed with moderate amount of bridging callus at the fracture site. Bending of bone plate seen, but no screw breakage or loosening observed.



Case No. 9: On 14th postoperative day, fracture healing in progress, with minimal callus formation



Case No. 10: On 37th *postoperative day, f*racture healed with moderate callus formation

Fig. 1: Radiographs of tibia/fibula fractures repaired by bone plating on final reappraisal day in different cases.

plating was used for repairing of 10 tibia/fibula fractures (in 8 cases bone plate was used as sole implant for fixation of fracture, whereas in 2 cases plate rod combination was used) and intramedullary pinning in 8 cases.

Out of these 10 cases, 9 cases were presented for postoperative follow-up. The mean score of technical difficulty was recorded as 2.6±0.16 (moderate to high) and mean score of extent of manipulation and soft tissue was calculated as 2.4±0.16 (moderate to high).

Table 1: Intraoperative observations in dogs with tibia/fibula fracture repaired by different fixation techniques (Mean±SE).

Fixation technique	Extent of manipulation and soft tissue damage	Degree of technical difficulty	Status of fracture reduction	Status of fracture fixation
Intramedullary pinning	2.0±0.19	2.0±0.19	3.63±0.52	3.25±0.16
Bone plating	2.4±0.16	2.6±0.16	3.3±0.21	3.7±0.15

Table 2: Clinical and orthopaedic observations (IFD and FRD) in dogs with tibia/fibula fracture repaired by internal fixation (Mean±SE)

Fixation technique	Inflammation		Pain		Weight bearing		Muscle atrophy FRD
	IFD	FRD	IFD	FRD	IFD	FRD	
Intramedullary pinning	2.25± 0.25	0.0±0.0	2.25±0.25	0.25±0.25	1.5± 0.86	10.0±0.0	1.0±0.4
Bone plating	2.44±0.17	0.33±0.23	2.11± 0.2	0.44± 0.33	0.66± 0.37	8.89±1.11	0.55±0.38

Table 3: Patient signalment, fracture description, implant size, final radiographic and clinical outcome of tibia/fibula fractures repaired by bone plating.

Case No.	Case detail	AO/ASIF Code	Implant size	Mode of application of bone plate	Radiographic observation Size of callus	Outcome in days	Final clinical outcome
1.	F; Labrador, 45 kg; 8 yr	42A1	8 hole 3.5 mm LC-DCP	Bridging mode	Moderate	Healing completed (120)	Excellent
2.	M; ND; 18.5 kg; 6 yr	42A3	8 hole 3.5 mm LC-DCP	Compression mode	–	–	–
3.	M; Labrador; 41 kg; 3 yr	42C3	8 hole 3.5 mm LC-DCP	Neutralization mode	Minimal	Bending of bone plate; healing in progress (28)	Excellent
4.	M; ND; 13.5 kg; 4 m	42A3	12 hole 3.5 mm reconstruction plate	Bridging mode	Minimal	Healing completed (29)	Excellent
5.	M; Great Dane; 45 kg; 7 yr	–	14-hole 4.5 mm	Broad LC-DCP Neutralization mode	–	Osteomyelitis, absorption of bone (120)	Poor
6.	F; Pomeranian; 9 kg; 8 yr	42A1	8 hole 2.7 mm	Neutralization LC-DCP	Minimal mode	Healing in progress (14)	Excellent Excellent
7.	M; ND, 9.5 kg; 7 m	43A1	9 hole 2.7 mm reconstruction plate	Bridging mode	Large	Healing completed (87)	
8.	F; ND; 19 kg; 2 yr	42B2	8 hole 3.5 mm LC-DCP	Bridging mode	Moderate	Bending of bone plate; healing completed (52)	Excellent
9.	M; Rottweiler; 38 kg; 4 yr	42B2	8 hole 3.5 mm LC-DCP + 2.5 mm Steinmann pin	Bridging mode (PRC)	Minimal	Healing in progress (14)	Excellent
10.	M; Rottweiler; 44 kg; 3 yr	42A1	8 hole 3.5 mm LC-DCP + 4 mm Steinmann pin	Bridging mode (PRC)	Moderate	Healing in progress (37)	Excellent

Status of fracture reduction and fixation was good to excellent with mean score of 3.3±0.21 and 3.7±0.15, respectively. Guiot *et al.* (2011) and Kumar *et al.* (2019) stated that the bone plating (bone plating and plate rod combination) provided rigid and stable fixation to the reconstructed tibia/fibula fractures in dogs by neutralizing all type of forces acting upon the fracture. The mean score of inflammation at implant fixation day (IFD) was 2.44±0.17 and on final reappraisal day (FRD) was 0.33±0.23. Mean pain score on IFD was 2.11±0.2, which reduced to 0.44± 0.33 on FRD.

By 15 days most of the dogs showed full weight bearing on the affected limb. Similar observation was recorded by Schwandt *et al.* (2005), Guiot *et al.* (2011) and Kumar *et al.* (2019). The mean weight bearing score was 8.89±1.11 on FRD as compared to 0.66±0.37 on IFD. Eight out of nine dogs showed full weight bearing on FRD. In Case No. 3 and 8, although there was bending of bone plate on 14th and 26th postoperative days, respectively, both the dogs showed full weight bearing with good functional recovery of the limb with mild changes in gait. In Case No. 5, weight bearing score was 0 (out of 10), in this case, there was severe muscular atrophy and pain on the whole tibial region due to osteomyelitis and plate related osteopenia.

In Case No. 7, on 3rd postoperative day there was dehiscence of the skin sutures, the bone plate and 4 distal screws were exposed. There was open fracture with avulsion of soft tissue. In this case, on 45th postoperative day, the bone plate was removed after formation of bridging callus at the fracture site. Plate bending was probably due to fatigue failure of the plate in the fracture zone, due to inadequate postoperative care, indicating that the plate was not strong enough to resist the bending forces (Sharma *et al.*, 2006). Similar complications (self-mutilated wound, bone plate bending with or without fracture of bone plate, loosening and breakage of screws, exposure of distal plate and screws, osteomyelitis and stress protection syndrome) were observed by Rahn *et al.* (1971), Das *et al.* (2012), Sahu *et al.* (2017) and Slunsky (2017) in tibia/fibula fractures repaired by bone plating. The complication rate in the tibia/fibula fracture repaired by bone plating was about 10 %.

In most of the cases uneventful 'bridging osteosynthesis' was recorded characterized by classical radiographic features of 'secondary fracture-healing' with visible periosteal callus. In some cases, the repaired fractures showed primary bone healing, showing gradual disappearance of fracture line without the evidence of periosteal callus. The average healing time of fractures repaired by bone plating was 45.48±13.69 days (14-120 days). Rahn *et al.* (1971), Guiot *et al.* (2011) and Sahu *et al.* (2017) observed that the tibia/fibula fractures repaired by bone plating either healed by primary or secondary bone healing within 60-90 days. The size of callus formed at the fracture site depended upon the size of implant and degree of fixation of fracture.

Out of the 8 cases repaired by intramedullary (IM) pinning, only 4 cases were presented for postoperative follow-up, therefore these 4 cases were included in results and discussion. The extent of manipulation and soft tissue damage as well as technical difficulty ranged from 1-3 (low-high) with mean score of 2.0±0.19 (moderate). According to Fossum (2007) and Priyanka *et al.* (2019), IM pinning for repairing of tibia/fibula fractures was the most common technique due to its simplicity and requirement of less exposure of tibial shaft for the repair of fracture. The status of fracture reduction and fixation was recorded good to excellent with mean score of 3.63±0.52 and 3.25±0.16, respectively.

Inflammation score at FRD was 0.0±0.0, as compared to the inflammation score at IFD (2.25±0.25). The mean score of pain on fracture site was 0.25±0.25 on FRD, which was comparatively much lower than pain on fracture site on IFD (2.25±0.25). Slight pain was observed in Case No.8, in which the fracture healing was in progress.

The mean weight wearing score at FRD was 10.0±0.0, wihich was greatly improved from the weight bearing score at IFD of 1.5±0.86.

Bending of bone plate in case no. 3, on 14thpostoperative day

Exposure of bone plate and distal screws in case no. 7

Osteomyelitis and sclerotic activity observed in case no.5 on 90th postoperative day

Fig. 2: Different postoperative complications encountered in tibia/fibula fractures repaired by bone plating.

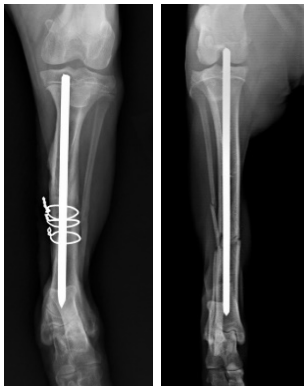
Table 4: Patient signalment, fracture description, implant size, final radiographic and clinical outcome of tibia/fibula fractures repaired by intramedullary pinning.

Case No.	Case detail	AO/ASIF Code	Implant size (Diameter of pin)	Radiographic observation		Final clinical outcome
				Size of callus	Outcome in days	
1.	M; ND; 13.3 kg; 4 m	42A2	Steinmann pin (3 mm)	–	–	–
2.	M; ND; 13.3 kg; 4 m	42C2	Steinmann pin (3 mm)	–	–	–
3.	M; ND; 20 kg; 3 yr	42B1	Steinmann pin (5 mm) with 2 cerclage wires (22 G)	–	–	–
4.	F; ND; 5.25 kg; 3 m	42A3	Steinmann pin (3 mm)	Minimal	Complete union (50)	Excellent
5.	M; ND; 13 kg; 5 m	42A1	Steinmann pin (4 mm) with 3 cerclage wires (20 G)	Moderate	Healing in progress (21)	Excellent
6.	F; ND; 11 kg; 1.5 yr	42C3	Steinmann pin (4 mm) with 3 cerclage wires (20 G)	–	–	–
7.	M; Pointer; 19 kg; 10 m	42A3	Steinmann pin (5 mm) + 2 cerclage wires (20 G) + PU cast	Minimal	Complete union (42)	Excellent
8.	M; Pitbull; 30 kg; 11 m	42A3	Steinmann pin (5 mm)	Minimal	Healing in progress (23)	Excellent

Case No. 4: On 50th postoperative day, fracture healed with cortical union and callus remodeling and obliteration of fracture line

Case No. 5: On 21st postoperative day bridging callus seen. The caudal side of tibia showing cortical union and bridging callus formed on cranial side along with fracture line visible on cranial aspect

Case No. 7: On 42nd postoperative day, radiographic cortical union was evident with minimal amount of callus at the fracture site



Case No. 8: On 23rd postoperative day minimal amount of callus formed/ periosteal reaction at caudal side at distal segment of fracture, fracture line visible.

Fig. 3: Radiographs of tibia/fibula fractures repaired by intramedullary pinning on final reappraisal day in different cases.

All the cases healed by minimal to moderate amount of callus formation at the fracture site without any postoperative complication like pin migration, collapse of fracture and osteomyelitis etc. The mean healing time of tibia/fibula fractures repaired by IM pinning was 34±7.12 days. In earlier

reports, the healing time in tibia/fibula fractures repaired by IM pin ranged from 21-60 days with small to moderate amount of callus formation at the fracture site (Umeshwori *et al.*, 2015; Lalzawmliana *et al*,. 2019). The tibia/fibula fractures repaired by IM pin healed by formation of periosteal callus. Fractures treated by IM pinning must unite by peripheral callus because the pin blocks the endosteal callus and new bone does not develop from the vascular cortical ends (Beale, 2004). Moreover, the insertion of intramedullary pin promotes bone healing even by bringing in contact with the bone fragments, pluripotent cells derived from bone marrow (Fossum, 2007).

The degree of soft tissue manipulation and technical difficulty was more in bone plating. Bone plating also provided the rigid and more stable fixation to the reconstructed tibia/fibula fractures. The mean healing time of tibia/fibula fractures was 45.48±13.69 days and 34±7.12 days bone plating and IM pinning, respectively. Postoperative complications were seen only in tibia/fibula fracture repaired by bone plating (bending of bone plates, exposure of distal plate and screws, osteomyelitis and plate induced osteopenia). No postoperative complication was found in tibia/fibula fractures repaired by intramedullary pinning. The mean weight bearing score was 8.89±1.11 and 10.0±0.0 out of 10 on FRD in tibia/fibula fractures managed by bone plating and intramedullary pinning, respectively. The tibia/fibula fractures in dogs can be efficiently managed by both bone plating and intramedullary pinning but the extent of tissue manipulation and technical difficulty was higher in bone plating with better fracture fixation.

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