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Clinical and radiographic evaluation of closed and open methods of fracture management in dogs#

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Abstract

The study was aimed to compare open and closed methods of fracture management in dogs. Twelve adult dogs aged above 18 months, were selected and divided into two groups. Group I included dogs with stable, closed fractures treated with closed reduction and plaster of Paris cast immobilisation. Group II included dogs with unstable fractures requiring open reduction and internal fixation with intramedullary pinning. Fracture healing and clinical improvement were assessed through orthopaedic and radiographic examinations. Closed management was effective for simple fractures, while unstable fractures involving compression, shearing, or tensile forces required internal fixation. Healing and limb usage improvement were slower in Group I compared to Group II.

Keywords: *Dogs, fracture, healing, radiography*

Fracture of bones is characterised by a loss of bone integrity along with concurrent soft tissue injuries, such as periosteal laceration, rupture of blood vessels, contused nerves, either with or without fragment displacement (Mathai, 2015; Mathai *et al.,* 2016). Radiography of the affected site at two orthogonal views should be taken and interpreted for deciding treatment options (Dinesh *et al.,* 2018; Raouf *et al.,* 2019). Factors like age of the animal and size, number of involved limbs, type of fracture, location of fracture, soft tissue injuries, concurrent musculoskeletal injuries, financial resources of the client, surgeon's capabilities and facilities available were considered before selecting proper fixation method (Aron*,* 1998).

The study was conducted in 12 adult dogs presented over a period of 18 months with fracture of long bones to the University Veterinary Hospital, Kokkalai and Teaching Veterinary Clinical Complex, Mannuthy irrespective of breed and sex. All the animals under the study were subjected to detailed clinical and radiological investigations. Animals with simple, easily reducible fractures were included in Group I and those animals with unstable fractures which required open reduction and internal fixation were included in Group II. In Group I, fracture management included closed reduction and external coaptation using plaster of Paris cast and in Group II, open reduction and internal fixation using intramedullary

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pinning was done. Lameness evaluation was done in all the animals based on the scoring system proposed by Sumner and Smith (1993). Weight bearing was assessed by the grading system proposed by Carr and Dycus (2016) and functional outcome of the limb was assessed by the grading system developed by Clark (1986). Fracture healing and clinical improvement were assessed by orthopaedic and radiographic examinations done at weekly intervals for six weeks.

The current study used radiographical observation along with clinical and orthopaedic examination findings to compare and evaluate the fracture healing in open and closed method of fracture management. The signalment, fracture aetiology, bone involved, type of fracture and management of fracture of the animals are presented in Table 1. All the dogs under study were above one year of age. Nine (75%) of the animals observed were males and only three (25%) were females which was in accordance with the findings of Prabhukumar (2019) in his study on internal fixation in dogs. The major cause of fracture was road traffic accident. Similar findings were reported by Jain *et al*. (2018). In Group I, out of the six cases, five were radius ulna fracture. Simon *et al.* (2011) reported higher incidence of fracture in radius and ulna (65.25%), followed by the humerus (16.01%), metacarpal (10.2%), phalanges (5.43%) and scapula (3.02%). In group II, five cases of femur fracture (83.33%) were recorded which was in accordance with Sran *et al.* (2016) who reported that the incidence of long bone fractures was highest in femur.

In both groups, all the dogs exhibited severe non-weight bearing lameness at presentation. Group I (managed with a plaster of Paris cast) showed slow and inconsistent improvement, with some dogs exhibiting complications such as self-mutilation and oedema. These findings aligned with Deveci *et al.* (2022), who reported underlying tissue trauma in radius and ulna fractures in toy and miniature breeds. By the sixth week, only few dogs achieved sound gait, while others continued to show varying degrees of lameness. Similar delayed healing was reported by Divya (2003) in her study on polyvinyl chloride external splints for long bone fractures in dogs. In contrast, Group II animals, treated with open reduction and internal fixation using intramedullary pinning, demonstrated a more consistent recovery pattern. Most dogs began weight-bearing earlier, although some experienced complications like pin migration. By the sixth week, the majority of dogs in Group II had restored functional limb usage, whereas one dog (B2) continued to show significant lameness. Overall, surgical management led to a more predictable and favourable outcome in terms of lameness resolution and functional recovery. The clinical improvement based on lameness evaluation is summarised in Table 2.

Orthogonal radiographic examination, as reported by Divya (2003), assessed apposition, alignment, and angulation weekly for up to six weeks. In Group I, fracture fragments generally maintained good apposition, except in two cases, with cranio-caudal angulation noted in one dog from the fourth week. Yu *et al.* (2011) found that carpal and digital flexor muscles could displace the distal radial segment, complicating reduction. A slight lateral angulation was seen in one case of distal humerus fracture and Perry and Woods (2017) confirmed them challenging for external coaptation. However, rapid healing was observed in a case reported by Remya (2008) in the management of fracture of extremities of long bones in dogs managed with external coaptation. Wraighte and Scammell (2006) suggested that rapid bone healing in metaphyseal and physeal fractures could be due to the abundant cancellous bone with rich blood supply. By the third week, four dogs showed periosteal reaction, with significant callus formation by fourth week. The fracture line was faintly visible by sixth week. Delayed union occurred in two dogs with distal radius and ulna fractures, while another showed rapid healing, likely due to minimal soft tissue trauma and good owner compliance, as reported by Joyner *et al.* (2004).

In Group II, good alignment and apposition of bone fragments were achieved immediate postoperative and maintained throughout the observation period, with no angular deformity observed. Callus formation was less evident in Group II animals compared to Group I, likely due to the more stable fixation. Allen (1990) noted that stable fixation produced minimal radiographic callus formation. Periosteal reaction was observed at the fracture site by the third week in three dogs, and by week four in two dogs, possibly due to periosteum sensitisation, as reported by Julie (2005), Venkateswaralu (2006) and Syam *et al*. (2012). Periosteal and endosteal callus formation occurred by week four in three cases and by week five in two. Beale (2004) suggested that intramedullary pins may inhibit endosteal callus formation. One dog had osteopenia and no callus formation, and by week six, extensive necrosis was observed at both fracture ends, likely due to cerclage wire interference and disrupted blood supply, as noted by Jackson and Pacchiana (2004). Radiographic evaluation is summarised in Table 3.

Group II, managed with open reduction and internal fixation, exhibited early recovery, with intact alignment and stability of fracture fragments, resulting in reduced lameness and improved weight-bearing from third week onwards. In contrast, Group I, treated with external coaptation, showed a slower and more variable recovery, with some cases experiencing delayed union and persistent lameness. Radiographically, Group I animals exhibited significant callus formation, indicative of secondary bone healing, whereas Group II animals displayed minimal callus formation due to stable fixation (Aron, 1998). Despite this, one case in Group II developed osteopenia and necrosis, likely due to cerclage wire interference. Overall, internal fixation provided superior functional outcomes and faster recovery, while external coaptation, though effective in

Table 1. Signalment, fracture aetiology, bone involved, type of fracture and management of fracture

CASES	AGE	SEX	BODY WEIGHT	BREED	AETIOLOGY	BONE INVOLVED	TYPE OF FRACTURE	MANAGEMENT
A1	1 year 6 months	Female	5.3 kg	Spitz	Fall from height	Left radius and ulna	Transverse-Distal third	Immobilisation using Plaster of Paris cast
A2	1 year	Male	20 kg	Boxer	Fall from height	Left radius and ulna	Short oblique-Distal third	Immobilisation using Plaster of Paris cast
A3	1 year	Male	16.8 kg	Non-descript	Fall from height	Right distal humerus	Short oblique-Distal third short oblique	Immobilisation using Plaster of Paris cast
A4	1 year	Male	8.3 kg	Non-descript	Road traffic accident	Right radius and ulna	Transverse-Distal third	Immobilisation using Plaster of Paris cast
A5	1 year	Male	18.7 kg	Siberian husky	Fall from height	Right radius and ulna	Long oblique-Proximal	Immobilisation using Plaster of Paris cast
A6	2 years	Male	13 kg	Non-descript	Fall from height	Left radius and ulna	Short oblique-Proximal	Immobilisation using Plaster of Paris cast
B1	1 year	Female	22.5 kg	German shepherd dog	Road Traffic Accident	Right femur	Mid diaphyseal long oblique	Intramedullary pinning and cerclage wiring
B2	1 year	Female	26.5 kg	German shepherd dog	Road Traffic Accident	Right femur	Short oblique-Mid diaphyseal	Intramedullary pinning and cerclage wiring
B3	1 year	Male	13 kg	Rajapalayam	Road Traffic Accident	Right humerus	Short oblique-Mid diaphyseal	Intramedullary pinning and cerclage wiring
B4	1 year	Male	31 kg	Doberman pinscher	Road Traffic Accident	Right femur	Short oblique-Mid diaphyseal	Intramedullary pinning and cerclage wiring
B5	6 years	Male	26 kg	Labrador retriever	Road Traffic Accident	Right tibia	Short oblique-Mid diaphyseal	Intramedullary pinning and cerclage wiring
B6	1 year	Male	18 kg	Non-descript	Road Traffic Accident	Left femur	Short oblique-Mid diaphyseal	Intramedullary pinning and cerclage wiring

Table 2. Clinical improvement based on lameness evaluation

WEEKS	GROUP I			GROUP II		
	Degree of lameness	**Weight Bearing**	**Functional outcome**	**Degree of lameness**	**Weight Bearing**	**Functionaal outcome**
WEEK 1	All dogs were unable to place foot on the ground (Grade 10)					
WEEK 2	A3, A4 still unable to place foot (Grade 10); others improved	A3, A4 still non-weight bearing (Grade VI); others showed slight improvement	A3, A4 unable to use limb; others placed foot occasionally	B1, B2, B3 unable to place foot (Grade 10); others improved slightly	B1, B2, B3 non-weight bearing (Grade VI); others toe touching (Grade V)	B1, B2, B3 unable to use limb; others placed foot occasionally
WEEK 3	A6 self-mutilated, unable to place foot (Grade 10); A2, A3 improved (Grade 7)	A6 non-weight bearing (Grade VI); A2, A3 significant lameness (Grade IV)	A6 unable to use limb; A2, A3 weight bearing while walking	B1, B2 toe touching (Grade 9); B3, B4 severe lameness (Grade 7)	B1, B2, B3 weight bearing lameness (Grade III-IV)	B1, B2 placed toe; others used limb for walking
WEEK 4	A6 unable to place foot (Grade 10); A2, A3 mild lameness (Grade 3)	A6 non-weight bearing (Grade VI); A2, A3 mild lameness (Grade III)	A6 unable to use limb; others weight bearing at walk	B1, B2, B4 placed toes but carried limb (Grade 9)	B1, B4, B5 weight bearing lameness (Grade III-IV)	B2 unable to use limb; others weight bearing at walk
WEEK 5	A6 still unable to place foot (Grade 10); A3 shifting-weight lameness (Grade 1)	A6 non-weight bearing (Grade VI); A3 mild lameness (Grade II)	A6 unable to use limb; others bearing weight at walk	B1, B2 severe lameness (Grade 8-9); B3, B5 mild lameness (Grade 3)	B1, B2 weight bearing lameness (Grade III-IV); others mild (Grade II)	B1, B2 limping; others weight bearing at walk
WEEK 6	A6 placed toe but carried limb (Grade 9); A2, A3 sound gait (Grade 0)	A6 mild weight bearing lameness (Grade I); A2, A3 normal	A6 shifting lameness; others full weight bearing	B1, B2 severe lameness (Grade 9); B3, B5 sound gait (Grade 0)	B1, B2 weight bearing lameness (Grade III-IV); others mild (Grade I-II)	B3, B5 fully weight bearing; others mild shifting lameness

Table 3. Summary of radiographic evaluation

Parameter	Group I	Group II
Apposition of fragments	Good except A4	Maintained in all cases
Alignment and angulation	Good alignment except in A3, A4; angulation in A5 from week 4	Good alignment maintained in all cases
Implant Stability	Not applicable	Stable in most cases; pin migration in B1, B4, B6 (week 4)
Callus	Progressive periosteal & endosteal callus; good fracture line obliteration by week 6	Minimal callus; one case showed necrosis and implant failure
Healing Pattern	Consistent callus formation; fracture line gradually obliterated	One case showed delayed healing, necrosis, and implant issues

some cases, was associated with prolonged healing and complications.

Summary

Internal fixation with intramedullary pinning resulted in more stable fracture healing, reduced lameness, and better early functional recovery compared to external coaptation. While both methods were effective, internal fixation proved superior for managing unstable fractures, whereas external coaptation remained a viable option for simple, reducible fractures.

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Conflict of interest

The authors declare that they have no conflict of interest.

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