

CASE REPORT

Companion or pet animals

Dowel pinning in phalangeal fractures

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Abstract

The objective of this case series was to report the outcome of a new technique for the surgical treatment of phalangeal fractures in cats and dogs. Medical records of cats and dogs presented with phalangeal fractures and treated with dowel pinning were retrospectively reviewed. Cases were included when a clinical examination and a radiographic follow-up evaluation of at least 6 months were available. Complications during the healing period and the final radiographic and functional outcome were analysed. Two cats and six dogs fulfilled the inclusion criteria. Closed fractures of a single phalanx predominated. All fractures were diaphyseal, transverse and displaced. Malunions occurred in two dogs. Complete functional union was achieved in all cases at the final follow-up. In conclusion, Dowel pinning was found to be an effective treatment for displaced, diaphyseal fractures of the proximal and the middle phalanx and a viable alternative to digit amputation.

BACKGROUND

Despite the fact that phalangeal fractures are common in veterinary practice, information regarding these injuries is sparse in the literature^{1,2} and treatment recommendations are not specific.^{3,4} Conservative or surgical therapy is recommended for shaft fractures of the first and second phalanges.^{3,4} Surgical treatment options are limited by the small size of these bones.^{3,4} Therefore, amputation is commonly performed due to practical reasons.^{3,4} However, short- and long-term complications in dogs after amputation are reported to be as high as 39% and 25%, respectively,⁵ and may require a second surgical intervention.^{5,6} This case series reports the results of dowel pinning in displaced, diaphyseal fractures of the first and second phalanges as a surgical alternative in a limited number of cases.

CASE PRESENTATION

All cases presented with a history of acute trauma and lameness to the Clinic for Small Animal Surgery and Reproduction, Ludwig Maximilian University of Munich, from 2000 to 2020. Causes of the injuries were being stepped on by a horse ($n = 2$), motor vehicle accidents ($n = 2$), high-rise syndrome ($n = 1$), being trapped in a door ($n = 2$) and in one case the cause was unknown.

INVESTIGATIONS

All cases underwent a general examination, followed by an orthopaedic evaluation. The latter revealed open and closed

injuries, swelling, pain and crepitus on one or two digits. Radiographs of the thorax and abdomen were performed as indicated by the general examination or the history of the cases. Orthogonal radiographs of the digits were performed and revealed phalangeal fractures, which were classified according to the fracture pattern, location and displacement (see Table 1). Concurrent injuries were not reported apart from a pneumothorax in a cat with high-rise syndrome, which was treated before any interventions or surgery. Bloodwork (complete blood count, chemistry panel) was performed before undergoing anaesthesia. Surgical treatment was indicated due to fracture displacement more than 50%, inability to reduce the fracture, or instability after reduction and external coaptation. Described surgical options to stabilise transverse phalangeal fractures are bone plates or amputation of the digits. The use of bone plates is commonly limited by the small size of these bones, and amputation of the digits may reportedly be associated with major complications requiring a second surgical treatment. Conversely, the dowel pinning technique offers possible digit preservation.

DIFFERENTIAL DIAGNOSIS

All dogs and cats presented with an acute lameness. According to the history of trauma and the results of the orthopaedic examination of the distal extremity (swelling, pain, crepitus), differential diagnoses were luxations or fractures of the phalanges.

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TREATMENT

Dowel pinning was performed to stabilise the phalangeal fractures. The surgical procedure was carried out in the same fashion as for stabilisation of metacarpal and metatarsal fractures in cats and dogs.^{7,8} Immediate postoperative orthogonal radiographs were obtained in all cases to assess fracture reduction and implant position. The animals were discharged with external coaptation, which consisted of a modified Robert Jones bandage reinforced with crepe paper or with a synthetic cast. External coaptation for 6 weeks until radiographic follow-up examination was recommended. Bandage changes were performed weekly at our clinic, or as per the referring veterinarian. During the first 6 weeks postoperatively, the owners were instructed to restrict the animals' activity (cage rest, indoors, leash walk).

OUTCOME AND FOLLOW-UP

Follow-up radiographs after 6 weeks were performed and repeated approximately every 6–8 weeks until complete healing was documented. Radiographs were evaluated for fracture healing, delayed union (>3 months), malunion, osteomyelitis and implant failure (pin migration, bending, breakage). Clinical outcome was evaluated after a minimum of 6 months postoperatively. Radiographs from the last follow-up examination were assessed for signs of malunion and osteoarthritis. The functional outcome was based on the last clinical examination. Lameness was graded as present or absent. Complications were rated as minor (conservative therapy) or major (surgical therapy).

From 2000 to 2020, a total of three cats and seven dogs with phalangeal fractures were treated with dowel pinning. One cat and one dog were lost to follow-up. A total of two cats and six dogs fulfilled the inclusion criteria.

The signalments of the patients are listed in Table 1. Four dogs had fractures of the proximal and two had fractures of the middle phalanx. All fractures were unilateral, a single toe was affected in four dogs and two toes in two dogs (No. 1 and 5). The fractures were closed in four and grade 1 open in

LEARNING POINTS/TAKE HOME MESSAGES

- Previously reported major complications after amputation of the digit may occur.
- Displaced phalangeal fractures, which are not reducible or stable with external coaptation, are not amenable for conservative treatment.
- Dowel pinning may be an effective treatment for displaced transverse diaphyseal fractures of the proximal and the middle phalanx, providing an alternative to digit amputation in these small bones.
- External coaptation is required until bone healing is confirmed radiographically.

two dogs. All fractures were diaphyseal, transverse with severe displacement. In the two dogs (No. 4 and 5) with open fractures, dowel pinning was performed by the owner's request to attempt preserving the digit. In one dog with two fractured phalanges (No. 1), one phalanx was left unpinned due to minimal displacement. In one dog (No. 5) with an open fracture, the distal phalanx of another digit of the same foot was amputated due to severe soft tissue trauma and luxation. The size of the Kirschner wires used for dowel pinning ranged from 0.6 to 2.0 mm (median: 1.2 mm). Axial alignment was correct in all but one dog (No. 4). The pin could not be seated deeply enough in the distal fragment due to narrowing of the medullary canal. The distal fragment showed slight rotation and malalignment in the dorsopalmar direction. The toe was manually realigned under fluoroscopy and splinted. External coaptation was used for 6–8 weeks (median: 6 weeks). Short-term complications such as infection and/or incisional dehiscence did not occur. During the healing period, malunion occurred in the two dogs (33%) with fractures of the middle phalanx. In Case 6, a distal diaphyseal fracture was present and the distal fragment slightly tilted in a dorsopalmar direction. The distal end of the pin appeared to have resulted in atrophy of the caudal cortex but did not protrude, migrate or affect

TABLE 1 Fracture data, treatment and outcome in six dogs and two cats with diaphyseal fractures of phalangeal bones

Case	Signalment	Fracture				Treatment			Outcome			
		Limb	Bone	Type	Displ.	Method	Pin	Bandage	Compl.	Follow-up	Radio-graphy	Lame-ness
1	MB, fs, 1 y, 13.1 kg	LH	P/P 4/5	t/t	1/3	c/Dp	1.4	CP, 6 w	–	6.8 y	0	–
2	IG, m, 1.4 y, 5.8 kg	RF	P 4	t	3	Dp	1	CP, 6 w	–	3.3 y	0	–
3	MB, f, 9.1 y, 37.7 kg	LF	P 5	t	2	Dp	2	PS, 8 w	–	1.1 y	0	–
4	JRT, fs, 2.2 y, 7.5 kg	LH	M 4	t*	2	Dp	0.8	CP, 6 w	M	2.8 y	M	–
5	MB, fs, 9.5 y, 5.6 kg	RH	P 5	t*	3	Dp	0.6	CP, 6 w	–	6 m	0	–
6	BS, fs, 3.3 y, 25.4 kg	RF	M 3	t	3	Dp	1.4	PS, 7 w	M	7 m	M	–
7	Siamese, fs, 9.8 y, 4.2 kg	RH	P/P 4/5	t/t	3	dp/dp	0.8/0.8	CP, 6 w	–	4.8 y	0	–
8	ESH, fs, unknown, 3.7 kg	RF	P 3	t	3	Dp	0.8	CP, 2 w	D	7 m	0	–

Note: Signalment: MB, mixed breed; IG, Italian greyhound; JRT, Jack Russel terrier; BS, Belgian Shepherd; ESH, European shorthair; f, female; s, spayed; m, male; y, years (rounded); kg, bodyweight at follow-up. Fracture - limb: R, right; L, left; F, forelimb; H, hindlimb. Bone: P, proximal phalanx; M, middle phalanx. Type: t, transverse; *, open fracture. Displ, displacement: 1 <50%; 2, 50%–100%; 3, >100% of bone diameter. Treatment: c, conservative; Dp, Dowel pinning; Pin, size in mm. Bandage: CP, crepe paper; PS, plastic splint; w, duration in weeks. Outcome: D, delayed union; if, implant failure; M, malunion. Follow-up: y, years; m, months. Radiography: 0, no abnormalities; M, malunion. Lameness: +, lame; –, not lame.



FIGURE 1 Dorsopalmar and mediolateral radiographic views of the left front paw in a 9.1-year-old mixed breed dog (No. 3) preoperatively (a), postoperatively (b) and 1.1 years (c) after dowel pinning of the fractured fifth proximal phalanx. The dog was not lame

the joint. Long-term outcome was evaluated after a median observation time of 2.6 years (6 months to 6.8 years). On the last follow-up, healing was complete in all cases, although a mild degree of malunion was still present in dogs 4 and 6. No other complications occurred (Figure 1). On the final clinical examination, none of the dogs were lame or showed pain on palpation. All complications were minor.

The two cats included in this study (No. 7 and 8) had fractures of the proximal phalanx. One cat had two digits fractured. All fractures were unilateral and closed. All fractures were transverse diaphyseal with severe displacement. The size of the Kirschner wires used for dowel pinning was 0.8 mm. Axial alignment was accurate in both cats. External coaptation was used for 6 weeks in Case 7 and 2 weeks in Case 8. Short-term complications such as infection and/or incisional dehiscence did not occur. During the healing period, delayed union was noted in one of the cats (Case 8). Long-term outcome was evaluated after a median observation time of 2.7 years (7 months to 4.8 years). On the last follow-up, healing was complete in both cases and no further complications were detected (Figure 2). During the final clinical examination, both cats were lameness free and comfortable on palpation. All complications were minor.

DISCUSSION

Dowel pinning was reported to be an effective treatment for metacarpal and metatarsal fractures in cats and dogs.^{7–9} The same technique was applied in this reported cohort of cats and dogs for stabilising diaphyseal phalangeal fractures with severe displacement not amenable for conservative treatment. The results in this small number of cases are encouraging.

Conservative treatment of markedly displaced fractures resulted in a high incidence of complications and unsatisfactory outcomes in the distal extremity.¹ Therefore, conservative treatment of phalangeal fractures may be considered when apposition can be achieved and maintained with external coaptation. Because this was not possible in the dogs and cats

of this case series, surgical therapy was recommended to the owners. Bones plates represent a potential fixation technique for transverse shaft fractures of the phalanges. The size of the bones may exclude this option due to the inability to place at least two screws in each fragment.^{3,4} Amputation of the digits was postulated as an alternative to surgical therapy in order to achieve a timely and predictable result.⁴ However, Muir and Peard reported lameness after digit amputation in three dogs (1998) and Kaufman and Mann (2013) in one dog. Remodeling of the distal bone end and rotation of the remnant due to adhesions of the flexor tendons caused continued lameness.⁶ In this report, all dogs were free of lameness after revision surgery at a more proximal level.^{5,6} These results suggest that amputation may be associated with possible major complications, rather than being purely a salvage procedure.

Dowel pinning offers a simple and cost-effective fixation method. However, this technique does not obviate external coaptation for successful fracture healing. Prolonged external coaptation can be associated with complications ranging from mild to severe including pressure sores to necrosis of an extremity. According to the limited number of cases and the retrospective nature of this study, we cannot make recommendations about the duration of postoperative external coaptation. Prospective studies are necessary to establish recommendations. In any case, diligent technique and regular assessments are paramount when using any form of external coaptation. Malunion, being the main complication in this case series, occurred in two dogs in which the middle phalanx was affected. In the first dog, the pin could not be seated at a sufficient depth in the distal fragment due to narrowing of the medullary canal. Pre-drilling of the medullary cavity with a K-wire might be helpful in such cases but carries the risk of fracturing of the bone.

In the second dog, a distal diaphyseal fracture was present, suggesting dowel pinning may be indicated only in mid-diaphyseal fractures of the middle phalanx. However, similar K-wire positioning in distal fragments in the case with proximal phalangeal fractures did not lead to malunion. This may imply that intramedullary pinning might not be stable enough

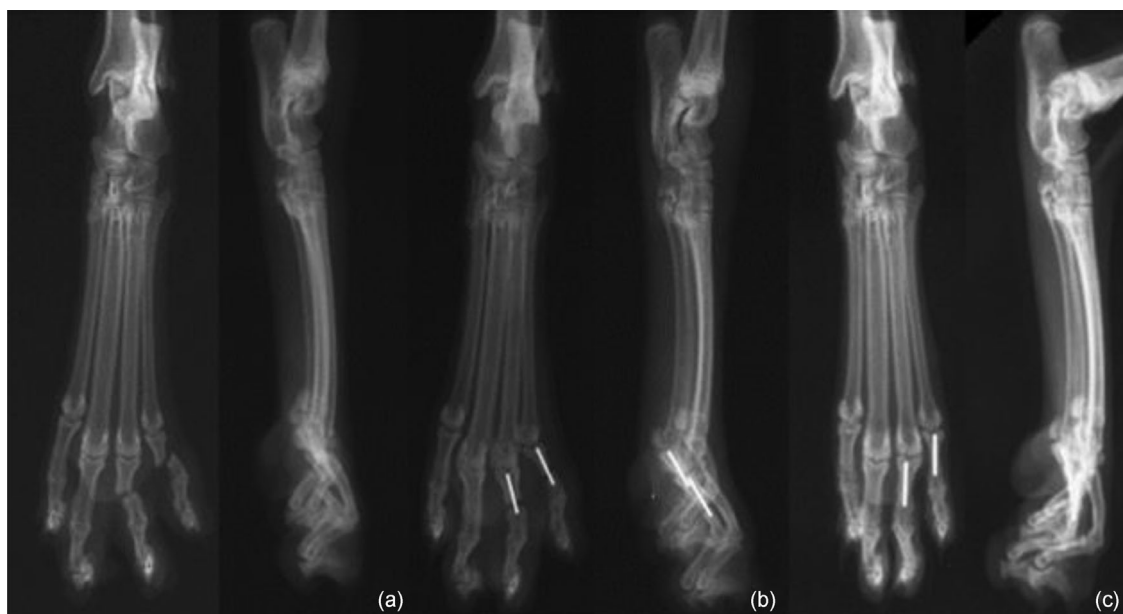


FIGURE 2 Dorsoplantar and mediolateral radiographic views of the left hind paw in a 9.8-year-old Siamese cat (No. 7) preoperatively (a), postoperatively (b) and 4.8 years (c) after dowel pinning of the fractured fourth and fifth proximal phalanx. The cat was not lame

in the middle phalanx due to the smaller size of the K-wires in the middle compared to the proximal phalanges, leading to malunion in the dorsopalmar/-plantar plane during weight bearing.

The major limitation of this report is the low number of cases and that the results cannot be compared to other treatments. However, our intention was to introduce an alternative treatment option for these fractures considering the lack of clinical studies and the common practice of amputation.

Despite these limitations, dowel pinning may offer a simple, inexpensive and effective treatment option for displaced, diaphyseal fractures of the first and second phalanges in cats and dogs. It offers a valuable alternative to amputation for these small bones in which other surgical options are often not feasible. Considering the short- and long-term complications after amputation,⁵ preserving the digits with Dowel pinning may be a favourable option. However, further studies are required comparing treatment groups (surgical techniques, external coaptation or amputation) with similar injuries to support our results before offering definitive recommendations.

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CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

ETHICS STATEMENT

There is no ethical issue associated with this manuscript, because the presented data were obtained during routine treatment in the dogs and cats. They were not involved in any kind of animal experiment. According to competent authori-

ties, this kind of research does not require ethics approval or general approval with respect to German law.

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