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RESEARCH ARTICLE

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Evaluation of Rush pinning for management of supracondylar femoral fractures in young dogs

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The present study was conducted to evaluate the clinical outcome of Rush pinning for the management of supracondylar femoral fractures in young dogs. A total of 11 supracondylar fractures in 10 dogs (one bilateral) were fixed using paired Rush pins. The age of dogs ranged from 1 to 9 months and the body weights from 3.2 to 19 kg. The technique was assessed on the basis of various perioperative observations. The technique was found to be relatively easy and provided good fixation leading to fracture healing within expected time period in all cases presented for postoperative examinations. The clinical outcome was also good to excellent in the majority of dogs. These findings suggest that though Rush pinning is an old technique, it is still an effective and viable method for the fixation of supracondylar femoral fractures in young dogs.

Keywords: Femur, Fracture, Rush pinning, Supracondylar fracture, Young dogs

Supracondylar femoral fractures are frequently encountered in young dogs and are difficult to stabilize using common internal fixation techniques like bone plating, standard intramedullary (IM) pinning or nailing. The small distal fracture fragment precludes placement of sufficient number of screws for bone plating or to provide requisite contact support for IM pins. The predominance of cancellous bone in the affected metaphyseal segment, relative softness of bone, presence of active growth plate and the proximity of stifle joint are other major factors that limit the use of bone plating in such cases.

The distal curvature of femur also limits fixation of distal fractures effectively by standard IM pinning. This is because the straight configuration of IM pin tends to fix the distal fracture segment in an abnormal extended angle relative to the proximal segment. This generally happens when active attempt is made to avoid the penetration of the cranial cortex of distal segment while seating the IM pin distally while at the same time effort is made to maximize engaging the metaphysis as deep as possible. As the fracture line passes through the curved portion of distal femur, the mobile distal segment straightens a bit resulting in eventual fixation of the straight IM pin slightly caudal than the ideal seating position cranially in distal segment. This often leads to fracture healing in an abnormal alignment of distal femur with respect to its shaft. Such 're-curvaturm' deformity has been reported with the use of different straight rigid IM fixation methods (Harish *et al*., 2020, Sakshi *et al*., 2022; Kaur *et al*., 2023).

Rush pins, however, when utilized in pairs to fix such fractures may provide an alternative option to overcome above challenges. It utilizes relatively elastic implants fixed in medullary cavity providing two-point fixation under spring-loaded fashion which does not loosen easily if properly applied. Further, such pins can be inserted with minimal soft tissue damage as compared to bone plating technique and also do not exert compressive forces on the growth plates (Campbell, 1976). Rush pinning also offer advantage over arrow-pin IM fixation as this technique does not require piercing the joint surfaces (Ramesh *et al*., 2018). The present study was undertaken to evaluate its efficacy for fixation of supracondylar femoral fractures in young dogs.

Materials and Methods

Paired Rush pinning technique was utilized to stabilize 11 supracondylar fractures of femur in 10 young dogs. The age of the dogs ranged from 1 to 9 months and the weight from 3.2-19 kg. The causes of fracture were either a fall from height or an automobile accident. The fractures were unilateral in 9 dogs and bilateral in one dog (Fig.1). The Rush pins measuring 1.2 and 1.5 mm in diameter and 60-110 mm in length were used to immobilize the fractures in this study.

A standard craniolateral parapatellar approach to the distal femur was used (Johnson, 2014). In some cases, pointed reduction forceps were applied to gently grasp the small distal fragment; however, their use was generally avoided because of the risk of penetrating the fragile cancellous bone and causing further fragmentation or complicating fracture reduction. Mostly, distal segment was held manually when inserting the pins in it. A pilot hole was created lateral to the distal end of trochlea using a K-wire of the same size as that of the Rush pin. The Rush pins were then inserted into the distal fragment at an angle of 20–30° to the long axis of the bone (Zargar, 2026). The fracture fragments were reduced and maintained in alignment using small Ferguson bone forceps. In cases with marked fracture overriding, the proximal fragment was carefully trimmed using a rongeur to facilitate reduction to minimize the risk of additional compressive damage to the fragile bone. The Rush pins were then alternately driven across the fracture line into the medullary canal of the proximal fragment. The length of the Rush pin was selected in such a way that it covered about 70% length of the femoral shaft (Fig. 1).

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Table 1: Assessment of the degree of inflammation and pain at the fracture site

Score	Degree of inflammation	Degree of pain	Degree of muscle atrophy
0	Nil	No pain on moderate digital pressure at the fracture site (Nil)	Nil
1	Mild	Pain on moderate digital pressure at the fracture site (Mild)	Mild
2	Moderate	Pain on slight digital pressure at the fracture site (Moderate)	Moderate
3	Severe	Pain on just touching the fracture site (Severe)	Severe

Table 2: Assessment of the status of lameness in the affected limb of dogs.

Weight-bearing score	During standing phase	During walking phase
0	Test limb not touching the ground	
1	Toe of the test limb touching the ground occasionally	
2	Toe of the test limb touching the ground frequently	
3	The paw of the test limb touching the ground occasionally	
4	The paw of the test limb touching the ground frequently	
5	The paw of the test limb touching the ground regularly	
Net weight-bearing score	Score in standing + Score in walking	

Table 3: Intraoperative observations.

	Description and score			
	1	**2**	**3**	**4**
The extent of soft tissue damage	Low	Moderate	High	Very high
Degree of technical difficulty	Low	Moderate	High	Very high
Status of fracture reduction	Poor	Fair	Good	Excellent
Status of fracture fixation	Poor	Fair	Good	Excellent

The assessment of the degree of technical difficulty, utility and the efficacy of the technique was evaluated on the basis of perioperative observations based on clinical, orthopaedic, goniometric and radiological examinations at different postoperative intervals. The status of inflammation, pain and muscle atrophy were scored as described by Tyagi (1997) as detailed in table 1.

The weight-bearing score of the fractured limb was evaluated in both standing and walking phases, as per Kumar *et al*. (2020) as detailed in table 2.

Intraoperatively, the extent of soft tissue manipulation, technical difficulty, duration of surgery, status of fracture reduction and fixation were recorded as per Kumar *et al*. (2020) as detailed in table 3.

Results and Discussion

Preoperatively, the clinical examination of the dogs revealed non-weight-bearing lameness in 8 dogs and partial weight-bearing in 2 dogs. The pain and inflammation ranged from mild to moderate with a mean score of 1.94±0.14 and 1.68±0.15, respectively. The muscle atrophy was minimal (0.21±0.12) due to recent injury. As per AO fracture classification, 9 fractures were categorized as 33A1 (distal extra-articular simple fracture) and 1 as 33C2 (distal complete, simple articular, metaphyseal complex fracture) (Table 4).

The length of distal fracture fragment ranged from 10-28 mm with a mean of 22.31±1.76 mm (Table 5). The duration of surgery ranged from 43 to 60 min, with a

Table 4: Fracture description and details of fixation implant used for the repair of supracondylar femoral fractures.

Case No.	Breed	Age (m)	Weight (kg)	Type of fracture	Implant size
1.	Labrador Retriever	4	15.0	33A1	1.5x90 mm
2.	ND	8	5.4	33A1	1.5x80 mm
3.	ND	4	9	33A1	1.5x90 mm
4.	ND	3	4.2	33A1	1.5x60 mm (plus 1 full cerclage wiring, 24G)
5.	ND	4	3.2	33A1	1.2x60 mm
6.	ND	4	3.2	33A1	1.2x60 mm
7.	ND	5	11.0	33A1	1.5 x 100mm (plus 1 full cerclage wiring, 22G)
8.	ND	2	6.0	33A1	1.5x70 mm
9.	Labrador Retriever	4	14.5	33C2	1.5x90 mm
10.	ND	6	15.0	33A1	1.5x90 mm
11.	Labrador Retriever	9	19.0	33A1	1.5x100 mm

mean of 48.27±1.83 min (Table 6). The degree of technical difficulty was assessed to be low with a mean score of 1.90±0.01. The soft tissue manipulation was moderate (2.00±0.00) but it was mainly related to the exposure of surgical site and the fracture reduction rather than on account of fixation technique. The status of fracture reduction and fixation was considered fair to good with a mean of 1.90±0.23 and 2.18±0.10, respectively.

The length of Rush pin was selected to be approximately 3/4th of the femoral bone length to ensure effective two-point fixation (Zargar *et al*., 2026). As per postoperative radiographs, the exact length of used Rush pins was calculated as 61–81% of bone length with a mean pin-to-bone ratio of 0.68±0.01. These lengths matched with a recommended range (Decamp *et al*., 2016). Two-point fixation was achieved in 9 cases, while in 2 cases three-point fixation was observed due to the use of slightly longer pins.

Table 5: Length of fractured femoral bone and the Rush pins utilized for fracture fixation in dogs.

Case No.	Length of distal segment (mm)	Bone length (mm)	Rush pin length (mm)	Pin to bone ratio	Point of fixation
1.	20.5	147.0	90.0	0.61	2
2.	26.0	98.0	80.0	0.81	3
3.	18.0	117.0	90.0	0.78	3
4.	24.0	88.0	60.0	0.68	2
5.	14.0	88.0	60.0	0.68	2
6.	10.0	95.0	60.0	0.63	2
7.	27.0	126.0	90.0	0.71	2
8.	24.0	98.0	70.0	0.71	2
9.	28.0	136.0	90.0	0.66	2
10.	28.0	22.7	90.0	0.65	2
11.	26.0	155.0	100.0	0.64	2
Mean± SE	22.31±1.76	10.60±7.3	89.0±4.2	0.68±0.01	2.18±0.01

Table 6: Various intra-operative observations in dogs with supracondylar fracture fixation by Rush pinning.

Case No.	Extent of soft tissue manipulation (max=4)	Degree of technical difficulty (max=4)	Duration of surgery (min)	Status of fracture reduction (max=4)	Status of fracture fixation (max=4)
1.	2	2	48	1	2
2.	2	2	45	2	2
3.	2	2	45	1	2
4.	2	2	43	1	2
5.	2	2	55	4	4
6.	2	1	40	3	3
7.	2	2	45	2	2
8.	2	2	50	2	2
9.	2	2	60	2	2
10.	2	2	55	1	1
11.	2	2	45	2	2
Mean± SE	2.00±0.00	1.90±0.01	48.27±1.83	1.90±0.23	2.18±0.10

Postoperatively, one case was lost to reappraisal (case No. 4); two cases could be followed up only telephonically and thus only 7 dogs were presented for appraisals physically. As the study was on clinical cases where patients were not presented for postoperative examinations at uniform intervals, the data has been presented as per the individual status on final appraisal day (FRD). The mean FRD was 75.41±9.61 days (range 32-150 days). The pain and inflammation were absent at FRD in all cases except in case No. 8.

On implant fixation day (IFD), the range of joint motions of the affected limb was compromised significantly in all dogs, while on FRD, these were near normal in most cases (Table 7).

An excellent clinical outcome was observed in seven cases, good in one and poor in two cases (Table 8). The findings were in line with Zargar *et al*. (2026), who stated that supracondylar femoral fractures of dogs can be easily fixed with the Rush pinning technique to provide satisfactory fixation and outcome in most cases (Fig. 1).

Poor clinical outcome was observed in case No. 9 & 10 as variable degree of lameness persisted well beyond the expected time till the FRD. The case 9 was a supracondylar fracture of femur with multiple

Table 7: Pre- and post-operative degree of joint angles of dogs subjected to Rush pinning for fixation of supracondylar femoral fractures.

	Stifle (Extension)	Stifle (Flexion)	Hock (Extension)	Hock (Flexion)
IFD (n=11)	140.71±6.17	42.85±2.87	147.00±2.67	43.50±3.28
FRD (n=7)	148.55±4.15	47.00±4.76	144.24±2.13	45.27±0.40
Contra-lateral limb at FRD	150.28±3.34	49.92±6.68	155.58±1.27	51.16±1.24

Table 8: Outcome of supracondylar femur fracture fixation by Rush pinning in young dogs.

Case No.	FRD	Weight bearing		Clinical Outcome
		IFD	FRD	
1.	32	0	10	Excellent
2.	40	0	10	Good
3.	60	1	10	Excellent
4.	Lost to PO reappraisal			
5.	90	0	10	Excellent
6.	90	0	10	Excellent
7.	51	0	10	Excellent
8.	84	4	10	Excellent
9.	150	0	10	Poor
10.	60	0	0	Poor
11.	66	0	10	Excellent

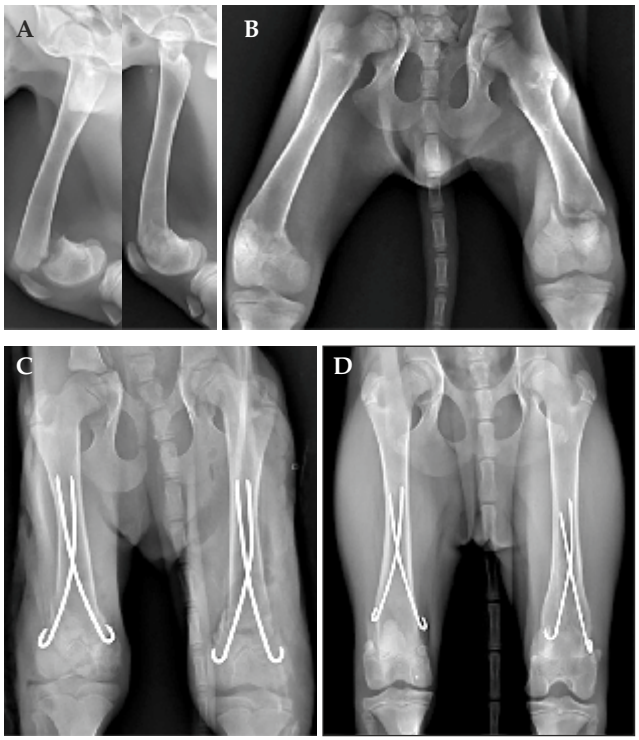

Fig. 1: Perioperative radiographs of a young dog with bilateral supracondylar femur fracture fixed with paired Rush pinning technique: Preoperative radiographs-lateral view (A), ventrodorsal view (B), immediate postoperative (C) and 90th PO day (D) radiographs showing good fracture reduction and maintenance of fixation leading to excellent healing.

fissures. One fissure was extending to the stifle joint and another to trochlea. In this case, the fracture could not be reduced satisfactorily during surgery. Due to substantial overriding of fracture fragments, softness of metaphyseal area and fracture complexity, the reduction was attempted by trimming of proximal fragment rather than attempting toggling of fragments lest fissures may extend further. This led to gross mismatch in the widths of primary bone fragments. Hence, anatomical alignment of these fragments could not be achieved and the medial side of distal bone remained deviated medially in relation to proximal shaft. This patient was not presented for reappraisal but subjected to radiographic examinations locally on 30th and 150th day. However, the shared radiographs were not of good quality to assess the bone completely. The 30th day radiograph revealed slight gap in between trochlear fracture fragments just caudal to patella with evidence of new bone formation around it. Additionally, exuberant osseous callus was observed towards the proximal shaft of bone away from the original fracture site. The 150th day radiographs revealed complete healing of original fracture and substantial remodelling of proximal callus but an osseous union was also found in between patella and trochlea. Additionally, the femoral shaft showed deviation and the femoral head was found luxated. The implants, however, remained at the site throughout the period.

The case No. 10 was presented with a complete femoral physeal separation (SH type 1) and postoperative radiograph revealed a gap in between fracture fragments just caudal to patella. Later new bone formed around the patella and restricted its movement. On 60th day, radiographs revealed that though fracture healed, there was arrest of physeal growth plate leading to significant shortening of bone and thus animal was not able to touch its paw during standing or moving phase though no pain was observed.

Hence, the poor clinical outcomes observed in both cases were attributable to multifactorial factors rather than to any inherent limitation of the fixation technique employed.

In conclusion, the Rush pinning technique provided stable fixation for supracondylar femoral fractures in young dogs to bring about uneventful healing in expected time frame in majority of cases. Early weight bearing and satisfactory joint mobility indicated good functional recovery. The findings of the present study validate the previous reports describing the suitability of Rush pinning for supracondylar femoral fractures in young dogs.

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