RESEARCH ARTICLE

Evaluation of Physiological, Haemato-Biochemical Parameters in Tibial Shaft Fracture Repair by Supracutaneous Plating Technique in Cats

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Abstract

The present study investigated the variations in physiological and haemato-biochemical parameters during fracture healing in six cats with tibial shaft fracture, repaired using supra-cutaneous plating technique. During the study period, physiological parameters were recorded preoperatively and on days 0, 1, 3, 5, 7, 12 and 15 postoperatively, while haemato-biochemical changes were recorded preoperatively and on days 0, 1, 7, 15, 30, 45 and 60 post-operatively. Physiological parameters showed a significant decrease ($p<0.05$) during the post-operative period, while haematological parameters showed no significant variations during the study. Progressive increase in total erythrocyte count and haemoglobin level were recorded which indicate erythropoiesis. Biochemical evaluation revealed a statistically significant increase ($p<0.05$) in serum alkaline phosphatase levels on the 15th postoperative day, indicating active osteoblast proliferation during fracture healing. Serum calcium and phosphorus, on the other hand, showed no significant variations in all six cats. Monitoring of biochemical parameters, alongside physical and radiographic evaluations can provide valuable insights for assessing bone healing.

Keywords: Cat, Haemato-biochemical parameters, Physiological, Supracutaneous plating, Tibial fracture

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Introduction

Fractures in cats can occur because of traumatic incidents such as fall from heights, automobile accidents or injuries from bite wounds (Voss and Steffen, 2009). Tibial fractures are common in cats, ranking as the second most prevalent type among feline long bone fractures (5-14%). The majority of tibial fractures occur in the mid and distal diaphysis and are often open and comminuted. They tend to heal slowly, likely due to the limited surrounding soft tissue coverage on tibia which increases the risk of complications such as delayed union, non-union, and osteomyelitis compared to fractures of other bones (Scott, 2005). Careful tissue handling and preservation of blood supply are crucial for the success of fracture repair.

Supracutaneous plating is a technique of fracture repair where the bone plate is applied outside the skin to stabilize the fracture fragments in a minimally invasive fashion and this preserves fracture haematoma. Supracutaneous plating may be considered as an alternative to ESF for the treatment of long-bone fractures (Nicetto and Longo 2019). Bone healing is generally monitored through physical assessments and serial radiographic examinations of the fracture site. Numerous studies have documented variations in physiological and haemato-biochemical parameters in dogs during fracture repair (Chaurasia *et al*., 2019; Ojus *et al*., 2022) however, similar data for cats is lacking. Pre-operative physiological and haemato-biochemical assessments are essential to evaluate the animal's fitness for surgery, and observing post-operative changes may provide key insights into both fracture healing and complications. Therefore, the current study was conducted to investigate variations in physiological and haemato-biochemical parameters during fracture healing in six cats with tibial shaft fractures stabilized by the supracutaneous plating technique using a locking compression plate (LCP).

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Materials and Methods

The present study was carried out in six clinical cases of cats with tibial shaft fractures presented to the Department of Veterinary Surgery and Radiology, Hebbal, Bengaluru

(India). Detailed clinical examination followed by two orthogonal view radiographs were employed for diagnosis of the tibial fracture. All six cats were anaesthetized using Diazepam (Incalm-10 (10 mg/2 mL) 2 mL ampule, SBS Biotech., Simour) and Ketamine (Aneket® (50 mg/mL) 5 mL vial, Neon Laboratories Limited., Palghar) combination at the dose rate of 0.5 mg/kg and 20 mg/kg body weight, respectively, given intramuscularly. Hanging limb technique was employed for close reduction followed by supra-cutaneous fixation of the LCP plate on the medial side of the tibia to stabilize the fracture fragments without opening the surgical site.

Physiological parameters such as rectal temperature, respiratory rate and heart rate were monitored in all six cats preoperatively and on days 0, 1, 3, 5, 7, 12 and 15 post-operatively. Blood samples were collected in EDTA vacutainer and plain vacutainer (without anticoagulant) for evaluation of haematological parameters such as total erythrocyte count, haemoglobin, total leucocyte count and differential leucocyte count, and biochemical parameters such as serum calcium, phosphorus, alkaline phosphatase, alanine aminotransferase and serum creatinine prior to surgery and on days 0, 1, 7, 15, 30, 45 and 60 post-operatively. The data recorded were statistically analysed using one-way ANOVA using a computer software Graph Pad Prism.

Results and Discussion

Physiological Evaluation

The mean values of rectal temperature, and respiration rate during the preoperative period were higher than the normal range. Postoperatively, rectal temperature returned to normal physiological limit, showing significant decrease ($p<0.05$) on 0, 3rd, 5th, 7th, 12th and 15th postoperative days, while heart rate decreased ($p<0.05$) on the 5th, 7th, 12th and 15th day and respiration rate decreased ($p<0.05$) on the 5th, 7th and 12th postoperative day. The higher values during the preoperative period could be attributed to pain and inflammatory reaction at the fracture site as well as stress due to fracture and anxious nature of cats when exposed to new environment. This was in accordance with Shreeveni (2023). Patil *et al.* (2017) also observed elevated rectal temperature on the pre-operative day, which returned to normal physiological range in the days following surgery. However, El-shafey *et al.* (2022) and Radha (2023) reported non-significant variations in rectal temperature. Abbott (2005) monitored heart rate in cats using telemetry at the hospital and home environment, revealing a statistically significant increase in heart rate in a hospital setting. Ojus *et al.* (2022) reported non-significant decrease in respiratory rate up to 15th postoperative days in dogs with femur fracture, repaired using locking compression plate (LCP).

Table 1: Mean ± SE values of physiological parameters pre- and post-operatively in cats (Mean ± SE)

Days	Rectal Temperature (°F)	Heart rate (Beats/min)	Respiratory rate (Breaths/min)
Pre operative	102.57±0.17^{a}	159.50±4.60^{a}	63±7.86^{a}
0	101.47±0.17^{b}	148.83±5.15^{a}	49.83±1.89^{a}
1	101.83±0.13^{a}	156.83±7.15^{a}	50.83±2.29^{a}
3	101.32±0.22^{b}	143.33±3.84^{a}	56.83±6.12^{a}
5	100.85±0.17^{b}	130.67±5.63^{b}	40±2.35^{b}
7	100.90±0.21^{b}	129.00±7.24^{b}	41±4.12^{b}
12	100.93±0.33^{b}	120.17±6.75^{b}	37.5±3.89^{b}
15	101.48±0.28^{b}	124.67±6.80^{b}	46.17±4.35^{a}

Means with different superscripts (a,b) within a column indicates significant difference at $p<0.05$.

Haematological Parameters

The variations in total erythrocyte count, haemoglobin, total leucocyte count, and differential leukocyte count were statistically insignificant and remained within normal physiological ranges. A slight, non-significant decrease in total erythrocyte count and haemoglobin levels was observed immediately and one day post-surgery, followed by a progressive increase throughout the postoperative period. This initial decline may be attributed to medullary artery injury due to the fracture, resulting in haemorrhage and mild

Table 2: Mean ± S.E values of haematological parameters before and after surgery in cats (Mean ± SE)

Days	TEC (10^6/cmm)	Haemoglobin (g/ dL)	TLC (10^3 /cmm)	Neutrophils (%)	Lymphocyte (%)	Monocytes (%)	Eosinophils (%)
BS	8.53±0.72	11.55±0.62	15.25±2.72	63.38±2.70	25.17±3.67	2.70±0.48	3.82±1.07
0	8.34±0.86	11.43±0.55	15.64±2.43	65.48±5.64	25.30±3.75	4.08±1.75	3.95±1.20
1	8.30±0.78	11.40±0.49	14.91±2.68	62.36±3.29	29.34±2.93	3.22±0.76	3.60±0.94
7	8.38±0.44	11.78±0.37	13.07±1.50	59.62±2.95	32.25±2.84	3.70±0.59	3.48±0.52
15	8.78±0.31	12.00±0.45	11.51±0.74	57.75±1.79	34.82±1.44	3.32±0.16	3.60±0.99
30	9.03±0.32	12.44±1.05	14.33±2.73	59.97±2.72	32.32±2.33	3.27±0.25	3.40±0.66
45	9.01±0.32	12.48±0.64	11.73±2.02	56.75±2.28	35.72±2.13	3.35±0.24	3.32±0.23
60	9.04±0.69	12.55±0.44	9.57±0.63	60.90±2.66	30.37±3.03	3.45±0.16	4.07±0.71

Table 3: Mean ± SE values of serum biochemical parameters before and after surgery in cats (Mean ± SE)

Days	Calcium (mg/dL)	phosphorus (mg/dL)	Alkaline Phosphatase (IU/L)	Alanine Amino Transferase (IU/L)	Creatinine (mg/dL)
BS	9.01±0.32 [a]	3.97±0.92 [a]	161.40±28.29 [a]	78.77±23.54 [a]	0.85±0.08 [a]
0	8.91±0.33 [a]	4.06±0.31 [a]	176.12±18.37 [a]	72.93±15.20 [a]	0.88±0.08 [a]
1	8.80±0.33 [a]	4.08±0.86 [a]	179.73±35.84 [a]	68±11.10 [a]	0.92±0.12 [a]
7	8.73±0.13 [a]	4.12±0.75 [a]	250.67±19.64 [a]	58.67±8.36 [a]	0.95±0.14 [a]
15	8.68±0.28 [a]	4.13±0.48 [a]	301.67±27.68 [b]	70.83±10.57 [a]	0.90±0.07 [a]
30	8.60±0.30 [a]	4.14±0.36 [a]	179.33±35.36 [a]	59.83±10.74 [a]	0.95±0.15 [a]
45	8.79±0.40 [a]	4.03±0.57 [a]	119.67±26.62 [a]	51.17±6.87 [a]	0.92±0.13 [a]
60	9.03±0.91 [a]	4.01±0.55 [a]	66.47±9.39 [a]	58±8.62 [a]	0.87±0.07 [a]

Means with different superscripts (a,b) within a column indicates significant difference at $p<0.05$

anaemia, as suggested by Newton and Nunamaker (1985). The subsequent increase reflects erythropoiesis, consistent with findings of Patil *et al.* (2017), Raj (2022), Vidiastuti and Purwatiningsih (2022), and Pooja *et al.* (2023).

The variations in total leucocyte count and differential leukocyte counts could be linked to stress responses and inflammatory changes during the fracture healing. Similar observations were reported by Chaurasia *et al.* (2019), Raj (2022), Vidiastuti and Purwatiningsih (2022), and Radha (2023).

Biochemical Parameters

The fluctuations in mean serum calcium and phosphorus levels were statistically insignificant. Serum calcium showed a non-significant decline up to the 30th postoperative day, likely due to increased alkaline phosphatase (ALP) secretion by osteoblasts, which promotes calcium salt deposition at the fracture site, reducing the extracellular calcium levels. Concurrently, phosphorus levels rose up to the 30th post-operative day, possibly due to increase in bone resorption during the initial stages of bone healing, leading to release of phosphorus from bone into the bloodstream. Post-operative 30th day, calcium levels increased, and phosphorus levels decreased as osteoblast-driven bone formation exceeded bone resorption, leading to formation of new bone and restoring the normal levels. These findings aligned with Komnenou *et al*. (2005), Einhorn and Gerstenfeld (2015) and Shreeveni (2023). Tembhurne *et al*. (2010) and Chaurasia *et al*. (2019) observed statistically nonsignificant fall in serum calcium up to the 20th and 15th post-operative day, respectively. Contrarily, Kumar *et al.* (2018) recorded serum calcium value peaking at the 14th post-operative day, followed by a gradual decrease and returned to normal levels by the 60th day. Patil *et al*. (2017) reported significant increase in serum phosphorus levels on 30th, 60th and 90th post-operative days when compared to pre-operative day. The variation in mean serum creatinine levels was also statistically non-significant and within the normal physiological range suggesting that the surgical procedure and patient management had no adverse affect on the Kidney function.

Enzymatic Profile

The mean serum alkaline phosphatase (ALP) level was above the normal physiological range during the preoperative period and showed a statistically significant increase ($p<0.05$) on the 15th post-operative day, followed by a gradual decline during the remaining post-operative period. This increase in ALP activity is likely due to enhanced osteoblast proliferation, particularly from the periosteum of the damaged bone, a rich source of ALP. Fernandez and Kidney (2007) also observed that ALP activity typically rises during fracture healing, while Muljačić *et al.* (2013) suggested a strong correlation between ALP activity and callus formation. Similar findings were reported by Tembhurne *et al.* (2010), Phaneendra *et al.* (2016), Chaurasia *et al.* (2019), and Vidiastuti and Purwatiningsih (2022). In contrast, Ojus *et al*. (2022) found that the mean values were highest on the pre-operative day, after which a gradual decrease in concentration was observed up to the 30th post-operative day. Shreeveni (2023) reported elevated serum alkaline phosphatase levels in cats with femur fracture on pre-operative day and a significant decrease on 0, 15th and 30th post-operative day.

The variation in mean serum alanine aminotransferase levels was statistically non-significant and within the normal physiological range. The non-significant variations suggest that the supra-cutaneous plating procedure, antibiotics, anaesthetic protocols and analgesics might not have adversely affected the liver. This aligned with the findings of Tembhurne *et al.* (2010) and Radha (2023).

Conclusion

All physiological parameters showed statistically significant ($p<0.05$) decline post-operatively within normal physiological range compared to their elevated preoperative values. Haematological parameters showed no significant changes and remained within the normal range, indicating minimal surgical stress and low blood loss during surgery. Biochemical

parameters such as serum calcium and phosphorus showed non-significant decrease and increase, respectively, up to the 30th postoperative day. Serum alkaline phosphatase levels showed statistically significant rise ($p<0.05$) on the 15th postoperative day, followed by a gradual decline during the rest of the postoperative period due to active osteoblastic activity and callus formation. Therefore, monitoring these biochemical parameters alongside physical examinatons and radiographic evaluations can provide valuable insights for assessing bone healing.

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