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Radiofrequency ablation in acute post-operative orthopedic trauma pain: A prospective cohort study from India

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Abstract
Background: Post-operative pain management in orthopedic trauma remains challenging. Conventional reliance on opioids and NSAIDs is limited by side effects, risk of dependence, and delayed rehabilitation. Radiofrequency ablation (RFA), traditionally used in chronic musculoskeletal pain, has recently emerged as a potential modality in acute post-surgical settings. This study evaluates the effectiveness of thermal continuous-mode RFA in reducing pain and facilitating early recovery in patients with peri-articular and periprosthetic fractures.
Methods: A prospective cohort study was conducted at Amandeep Hospital, Amritsar (March 2024-March 2025). A total of 754 adult patients with peri-articular or periprosthetic fractures underwent ultrasound or fluoroscopy-guided thermal RFA at 48 hours post-surgery. Pain relief was assessed using the Numerical Rating Scale (NRS). Secondary outcomes included opioid consumption, time to physiotherapy initiation, ambulation milestones, and hospital stay duration.
Results: The mean age was 36 years, with 56% males. Fracture distribution included knee (27%), elbow (21%), and periprosthetic fractures (9%). Mean pre-RFA NRS was 8.2, reduced significantly to 3.1 at 48 hours (p<0.001). Opioid requirement decreased by over 60%. Physiotherapy was initiated within 3-5 days, and 65-68% of patients achieved ambulation by day 3. Mean hospital stay was reduced to 5-7 days. No major complications from RFA were reported.
Conclusion: Thermal RFA is a safe and effective adjunct for acute post-operative pain management in orthopedic trauma, reducing opioid dependence, accelerating rehabilitation, and enhancing patient outcomes. Incorporating RFA into multimodal protocols may represent a paradigm shift in acute pain management.

Keywords: Radiofrequency ablation, orthopedic trauma, post-operative pain, peri-articular fractures, periprosthetic fractures, opioid-sparing, rehabilitation

Introduction
Orthopedic trauma surgery is frequently associated with severe postoperative pain, especially in complex periarticular and polytrauma cases. Despite advances in multimodal analgesia, a large proportion of patients continue to report high pain intensity in the immediate postoperative period [1-4].
Poorly controlled pain delays mobilization, prolongs hospitalization, and may contribute to persistent postsurgical pain [5].
Opioids remain widely used but carry important limitations, including tolerance, dependence, constipation, and other adverse events [6-11]. Contemporary guidelines recommend multimodal, opioid sparing strategies; however, even optimized regimens may not adequately address severe early pain after fracture fixation [7, 8].
Radiofrequency ablation (RFA) provides targeted neuromodulation by lesioning sensory branches while preserving motor function. Robust evidence supports RFA in chronic musculoskeletal pain, particularly knee osteoarthritis and facet mediated pain [12-15]. By extension, periarticular sensory RFA may offer a focused, opioids paring option in the acute postoperative setting following orthopedic trauma. To our knowledge, large clinical cohorts evaluating this indication remain scarce. We therefore conducted a prospective cohort study at a tertiary care teaching institute to evaluate RFA performed at 48 hours after surgery as an adjunct to multimodal analgesia in patients undergoing fracture fixation.

Primary outcomes were pain intensity and opioid use; secondary outcomes addressed early rehabilitation milestones and length of hospital stay.

Materials and Methods

Study Design and Setting: This was a prospective cohort study conducted in the Department of Orthopaedics, Amandeep Hospital, Amritsar, India, a tertiary care center of excellence and a recognized teaching institute, catering to a large volume of complex trauma and polytrauma cases. The study was carried out over a one-year period (March 2024-March 2025).

Patient Population: A total of 754 adult patients (≥ 18 years) undergoing operative fixation of peri-articular and intra-articular fractures of the upper limb, lower limb, shoulder, elbow, wrist, ankle, foot, and periprosthetic fracture fixation were enrolled.

- **Inclusion criteria:** Adult trauma patients with surgically managed peri-articular fractures who developed significant postoperative pain despite standard multimodal analgesia.
- **Exclusion criteria:** Patients with primary arthroplasty procedures, known peripheral neuropathies, local infection at the ablation site, coagulopathy, or refusal to participate.

Study Protocol: All patients underwent routine postoperative care, including standardized analgesia, physiotherapy, and wound management. Radiofrequency ablation (RFA) of sensory nerves was performed at 48±6 hours postoperatively, concurrent with the first dressing change. The procedure was carried out in the operating theatre under sterile precautions.

Standard Analgesia Protocol: All patients received a uniform multimodal analgesic regimen, consisting of-Paracetamol (intravenous)-NSAIDs (intravenous or oral, unless contraindicated)-Opioid analgesics (restricted to tramadol or morphine as rescue)-Nefopam (used in selected cases requiring additional non-opioid support)-Gabapentinoids (administered selectively as adjuvants). This regimen was administered to all patients in addition to RFA.

RFA Intervention Protocol

- **Equipment:** RFA was performed using the Radiofrequency Lesion Generator RFE2-A, 1-Channel RF Generator (Beijing Neo Science Co., Ltd., China; Model WR1010B, Software Version V1.0).
- **Electrodes and cannulas:** A 22G × 100 mm curved RF needle (Suru International Pvt. Ltd., India; active tip 10 mm) was used in conjunction with a Beijing Neo Science Co., Ltd. RF Electrode (Spec 4-100; OD 0.4 mm, Length 100 mm; REF CN2202). Both were sterile, single-use devices.
- **Guidance:** Either ultrasound or fluoroscopy was used to localize target nerves.
- **Placement confirmation:** Sensory and motor stimulation were employed to ensure accurate positioning and to avoid motor deficits.
- **Lesioning protocol:** Continuous mode thermal RFA was performed using a standardized lesioning protocol (80 °C for 60-90 seconds, repeated 2-3 times per target nerve).
- **Target Nerves:** Sensory nerves corresponding to the operated joint were targeted:
- **Knee:** Anterior femoral cutaneous nerve (AFCN), infrapatellar branch of saphenous nerve (IPBSN), and genicular branches (superior medial, superior lateral, inferior medial).
- **Ankle/Foot:** Superficial peroneal, saphenous, sural, and deep peroneal nerves.
- **Wrist/Hand:** Superficial radial nerve and dorsal branch of the ulnar nerve.
- **Elbow:** Posterior antebrachial cutaneous, lateral antebrachial cutaneous, and posterior cutaneous nerve of forearm.
- **Shoulder:** Articular branches of suprascapular, axillary, and lateral pectoral nerves.

Since only sensory branches were ablated, motor impairment was not expected.

Results

Baseline Characteristics

The study cohort comprised 754 patients with a mean age of 36.2 years; 56% were male. Fracture distribution is detailed in Table 1 and illustrated in Figure 1.

Table 1: Baseline characteristics of the study cohort

Characteristic	Value
Mean Age (years)	36.2 ± 11.4
Male (%)	56% (422/754)
Female (%)	44% (332/754)
Common Comorbidities	Hypertension (18%), Diabetes (14%)
Fracture Distribution	knee 27%, Elbow 21%, Periprosthetic 9%, Others 4

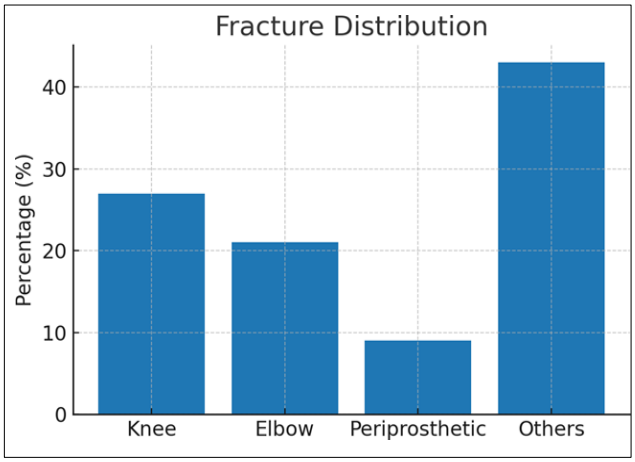

Fig 1: Distribution of fracture types among study participants

Pain Outcomes

Pain intensity significantly decreased following RFA. Mean NRS pain scores reduced from 8.1 preoperatively to 3.9 at 24 hours, 2.7 at 48 hours, and 2.1 at 1 week ($p<0.001$). Figure 2 demonstrates this downward trend.

Opioid Consumption

Opioid use declined markedly following RFA. The mean daily opioid consumption decreased from 180 mg to 85 mg morphine equivalents (53% reduction, $p<0.001$). Details are provided in Table 2.

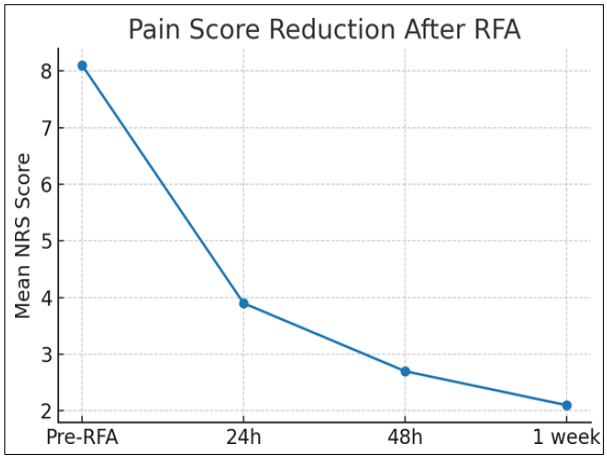

Fig 2: Reduction in mean NRS pain scores following RFA.

Table 2: Comparison of opioid consumption before and after RFA

Metric	Pre-RFA	Post-RFA	P-Value
Mean Daily Dose (mg morphine equivalent	80±38	85±22	<0.001
% Reduction	–	53% reduction	<0.001

Rehabilitation Outcomes

Postoperative recovery was favorable. The mean time to initiation of physiotherapy was 4.2±1.1 days. Ambulation was achieved by 65% of patients by Day 3, and by 100% by Day 7. Median hospital stay was 6 days (IQR 5-7). Figure 3 illustrates ambulation trends.

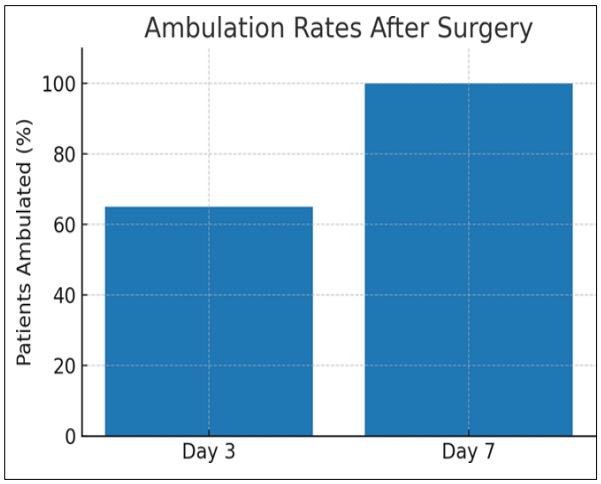

Fig 3: Ambulation rates achieved by Day 3 and Day 7.

Safety Outcomes

No major RFA-related complications such as neurovascular injury, infection, or prolonged numbness were observed. Minor transient numbness occurred in 2 patients (0.3%), which resolved spontaneously.

Discussion

Effective postoperative analgesia is fundamental to recovery in orthopedic trauma, yet remains challenging in routine practice. Opioids, although effective, are limited by dependency risk, withdrawal symptoms (e.g., insomnia, anxiety), gastrointestinal intolerance, and constipation factors that impede rehabilitation and long term outcomes [9-11]. NSAID based approaches, while valuable within multimodal protocols, can be constrained by gastrointestinal and renal adverse effects and by patient specific risk profiles, necessitating opioid sparing alternatives [6-8].

In this context, radiofrequency ablation (RFA) offers a localized, opioid sparing approach. Our cohort applying peri articular sensory RFA at 48 hours postoperatively demonstrated clinically meaningful reductions in pain scores alongside lower opioid consumption and earlier initiation of physiotherapy, translating to faster ambulation and shorter hospital stay. These findings are directionally consistent with the robust evidence base for RFA in chronic musculoskeletal pain, including randomized trials and meta analyses in knee osteoarthritis and spine related pain [16-22, 24].

Importantly, the integration of RFA within a tertiary teaching institute's multimodal pathway provided additional educational value: trainees gained hands on exposure to interventional pain techniques and multidisciplinary perioperative care skills likely to influence future practice patterns [25-28].

Strengths

This is among the first large scale cohorts to assess RFA for acute postoperative pain after fracture fixation, with standardized technique and comprehensive inpatient outcomes.

Limitations

Single center design and absence of a randomized comparator limit generalizability; longer term outcomes were beyond the study's scope.

Future directions

Randomized trials comparing RFA augmented multimodal care versus standard protocols are warranted, alongside cost effectiveness analyses and longer term functional follow up.

Conclusion

Thermal RFA of peri articular sensory nerves performed ~48 hours after fracture fixation provided effective acute analgesia, reduced opioid requirement, and facilitated earlier rehabilitation without systemic drug related adverse effects. Within a multimodal framework, RFA appears to be a safe, targeted, and scalable adjunct for high volume orthopedic trauma care [16, 20, 21, 24].

Conflict of Interest

Not available

Financial Support

Not available

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