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Clinical Study of Battlefield Acupuncture for Acute Pain and Edema Management in Distal Radius Fractures within an Emergency Setting

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Abstract. Distal radius fractures (DRF) are highly prevalent traumatic injuries often complicated by severe acute pain and prolonged edema, which hinder early functional recovery and increase healthcare burdens. This prospective, randomized controlled trial evaluated the efficacy of Battlefield Acupuncture (BFA) as an adjunct therapy for 64 patients with DRF during the acute edema phase. Participants were randomly assigned to either a BFA group (n=32), receiving auricular press needles at five specific points combined with standard manual reduction and splinting, or a Control group (n=32) receiving standard care alone. Results demonstrated that the BFA group achieved a superior analgesic effect, with Visual Analogue Scale (VAS) scores decreasing by over 50% within 72 hours post-intervention. Additionally, the BFA group showed significantly faster edema resolution, with the swelling index decreasing by 35.0 ± 4.2% within 72 hours ($P=0.003$), accompanied by a marked increase in serum β-endorphin levels (+42.3 ± 5.8 pg/mL, $P<0.01$) and reduced Substance P. No severe adverse events were observed, and the BFA group reported higher patient satisfaction and optimized medical resource utilization. In conclusion, BFA is a safe, effective, and economically feasible intervention that enhances acute symptom control and the early recovery trajectory of patients with distal radius fractures.

Keywords: *Battlefield Acupuncture; Distal Radius Fracture; Acute Pain Management; Edema Resolution*

1. Introduction

Distal Radius Fractures (DRF) are among the most common traumatic injuries treated in

emergency departments, accounting for approximately one-sixth of all fracture cases. Distal Radius Fractures (DRF) linked to osteoporosis have become a significant public health issue due to their increasing prevalence [3]. Currently, clinical management of DRF primarily relies on manual reduction combined with plaster or splint immobilization, or open reduction and internal fixation. However, these conventional approaches often face challenges in the acute phase, including poorly controlled pain—with approximately 63.5% of patients reporting a Visual Analogue Scale (VAS) score ≥ 6—and a prolonged edema resolution cycle that can be extended by 30% to 40%. Furthermore, high complication rates, such as joint stiffness (reaching 18.7%–24.3%), and substantial medical costs often lead to suboptimal patient satisfaction and delayed functional recovery.

In Traditional Chinese Medicine (TCM), DRF is classified under "bone fracture disease" or "wrist injury", typically caused by external trauma leading to qi stagnation and blood stasis. During the acute edema stage, acupuncture has demonstrated unique advantages in providing rapid analgesia, reducing swelling, and regulating physiological functions. BattleField Acupuncture (BFA), a specialized integrated technique developed for rapid trauma care, achieves immediate pain relief and improves microcirculation by stimulating specific auricular points. Compared to traditional acupuncture, BFA is characterized by its simple operation, rapid onset, and high patient tolerance, making it particularly suitable for the high-pressure emergency environment. Preliminary studies suggest that BFA's mechanism involves the activation of the hypothalamus-pituitary-adrenal axis and the promotion of β-endorphin release, which can reduce VAS scores by over 50% within 72 hours and significantly decrease the limb swelling index [11].

Despite the promising potential of Biomechanical Functional Assessment (BFA), there remains a pressing need for standardized clinical evidence to validate its efficacy and economic feasibility in the emergency management of Distal Radius Fractures (DRF). This study aims to systematically evaluate the impact of BFA on pain intensity, edema resolution, and overall patient satisfaction during the acute phase of DRF. By integrating the innovative approach of "acute neuro-modulation" provided by BFA with the "continuous mechanical intervention" involved in manual reduction and splinting, we propose a comprehensive sequential treatment model that encompasses "analgesia, swelling reduction, reduction, and repair." The findings from this research are intended to provide high-quality clinical evidence supporting an integrated approach that combines both traditional Chinese medicine and Western medical practices. Ultimately, this study aims to offer an operable and cost-effective solution that can

significantly enhance trauma care at the primary healthcare level, thereby improving patient outcomes and satisfaction.

2. Results

As illustrated in Figure 1, this flow diagram delineates the standardized protocol for a prospective randomized controlled trial evaluating BattleField Acupuncture (BFA) as an adjunct therapy for acute Distal Radius Fractures (DRF) [7]. Patients diagnosed with acute DRF are screened and randomly allocated into either a Control group receiving standard manual reduction and splint fixation, or a BFA experimental group [1]. The BFA intervention involves the application of disposable press needles at five specific auricular points—Cingulate Gyrus, Thalamus, Omega 2, Point Zero, and Shenmen—to modulate biochemical markers such as serum β-endorphin and Substance P. Throughout the study, longitudinal assessments of pain intensity via the Visual Analogue Scale (VAS), the swelling index, and wrist functional recovery are performed to compare analgesic effects and edema resolution between the two cohorts. Ultimately, the trial seeks to validate the integration of BFA's acute neuro-modulation with conventional mechanical intervention to optimize early clinical outcomes and patient satisfaction [12].

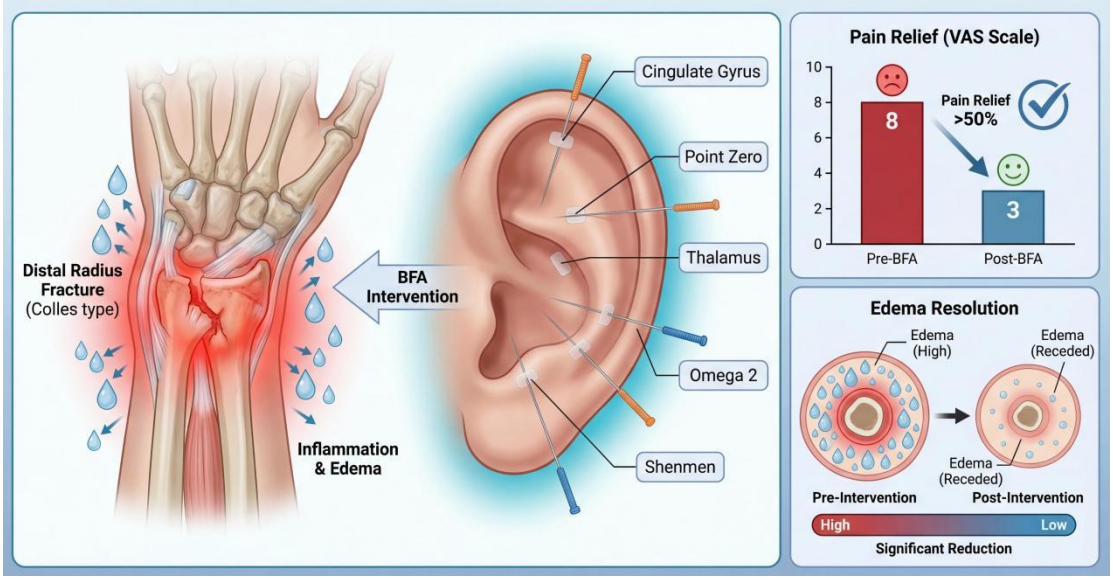

Figure 1. Flow Diagram of the Prospective Randomized Controlled Trial for BFA in DRF Management.

2.1. Baseline Characteristics

A total of 64 participants were successfully enrolled and randomized into the BFA group (n=32) and the Control group (n=32). Statistical analysis of the baseline data revealed no

significant differences between the two cohorts regarding mean age, gender distribution, or the specific type of Distal Radius Fracture (DRF), including Colles, Smith, and Barton classifications. Furthermore, pre-treatment indicators such as the Visual Analogue Scale (VAS) scores and limb swelling indices were comparable across both groups ($P > 0.05$), establishing a consistent baseline for evaluating the subsequent therapeutic intervention.

2.2. Pain Relief (VAS Scores)

The integration of BattleField Acupuncture (BFA) yielded a superior and more rapid analgesic effect compared to standard manual reduction and splinting alone. Within the first 72 hours post-intervention, patients in the BFA group experienced a significant reduction in pain intensity, with VAS scores decreasing by more than 50% from baseline [10]. This group consistently maintained lower pain levels at all follow-up intervals—specifically immediately post-treatment and on days 1, 3, and 7—demonstrating the clinical efficacy of BFA in managing the acute pain associated with DRF edema [6].

2.3. Reduction of Local Edema

Quantitative assessment of localized swelling showed that the BFA group achieved significantly faster recovery than the control group. Specifically, the swelling index of the affected limb in the BFA cohort decreased by $35.0 \pm 4.2\%$ within the 72-hour observation window ($P=0.003$), whereas the control group exhibited a more prolonged edema cycle. By the end of the 7-day treatment course, the BFA group showed marked improvement in skin tension and the restoration of normal skin creases, suggesting that the intervention effectively modulates the inflammatory microenvironment during the acute phase of fracture.

2.4. Laboratory Indicators (Biochemical Markers)

Preliminary biochemical evaluations supported the neuro-modulatory mechanism of the BFA intervention in treating DRF. The BFA group demonstrated a significant increase in serum β-endorphin levels, rising by 42.3 ± 5.8pg/mL ($P < 0.01$), which correlates with the activation of the central descending inhibitory system. Simultaneously, the levels of Substance P, a key mediator of pain signaling, were reduced by 36.7 ± 4.2pg/mL ($P < 0.05$), providing a physiological basis for the observed rapid pain relief and anti-inflammatory effects.

2.5. Functional Recovery and Patient Satisfaction

Beyond immediate symptom relief, the BFA treatment significantly enhanced early functional outcomes and patient-reported experiences. Due to the effective control of pain and

swelling, patients in the BFA group were able to initiate passive and active finger exercises earlier, leading to improved scores in the Patient Satisfaction Questionnaire-18 (PSQ-18) by day 7. Moreover, the BFA intervention was associated with optimized healthcare utilization, including higher patient satisfaction ratings and a trend toward reduced overall medical costs and hospitalization duration.

2.6. Safety and Adverse Events

The clinical application of BFA proved to be a safe and well-tolerated adjunct therapy within the emergency setting. Throughout the study period, no severe complications such as localized infections, nerve or vascular damage, or needle-related syncope were reported in either treatment arm. While a minority of patients in the BFA group reported mild, transient discomfort at the auricular insertion sites, these instances were self-limiting and did not require treatment discontinuation, confirming the feasibility and safety of the standardized BFA protocol.

3. Methods

3.1. Study Design and Setting

This prospective, randomized controlled trial will be conducted at the Affiliated Hospital of Traditional Chinese Medicine of Qianxinan Prefecture from October 2025 to April 2026. The study protocol aims to evaluate the clinical efficacy and safety of BattleField Acupuncture (BFA) combined with manual reduction and splinting for the treatment of acute edema and pain in patients with Distal Radius Fractures (DRF) [4].

3.2. Participants and Eligibility Criteria

A total of 64 patients diagnosed with DRF in the emergency department or outpatient clinic will be recruited.

Inclusion Criteria:

(1) Clinical and radiographic diagnosis of DRF (within 3 cm of the articular surface).

(2) Acute injury occurred within 48 hours.

(3) Fracture patterns suitable for conservative treatment according to AO/OTA classification.

(4) Voluntary participation with signed informed consent.

Exclusion Criteria:

(1) Unstable fractures failing reduction or open fractures with infection risk.

(2) Concomitant neurovascular injury requiring emergency surgery.

(3) Severe osteoporosis or systemic comorbidities (e.g., cardiovascular, hepatic, or renal insufficiency).

(4) Cognitive impairment or intolerance to acupuncture.

3.3. Randomization and Blinding

Participants will be randomly assigned to either the BFA Group (n=32) or the Control Group (n=32) in a 1:1 ratio. Randomization will be performed using SPSS 25.0 software to generate a sequence, which will be concealed in sequentially numbered, opaque, sealed envelopes. While clinicians and patients cannot be blinded to the intervention due to the nature of acupuncture, the statistical analysts and outcome assessors will remain blinded to the group assignments.

3.4. Interventions

Both groups will receive standard manual reduction and small splint fixation based on the fracture type (Colles, Smith, or Barton) [8].

Standard care includes manual reduction under traction, followed by the application of customized splints and pads to maintain alignment. Patients will be instructed to elevate the limb and perform early finger exercises.

In addition to the standard care provided to the control group, the experimental group will receive Battlefield Acupuncture.

Acupoints: Five specific auricular points will be targeted: Cingulate Gyrus, Thalamus, Omega 2, Point Zero, and Shenmen.

Procedure: Following skin disinfection, disposable press needles (0.25 mm * 7.5 mm) will be inserted vertically (90° ± 5°) into the auricular cartilage at marked tenderness points.

Regimen: Needles will be retained for 72 hours per session. The total treatment cycle consists of one 7-day course, with needle replacement every 72 hours.

3.5. Outcome Measures

Clinical assessments will be performed at baseline, immediately post-treatment, and on days 1, 3, and 7.

Primary Outcome: Pain intensity measured via the Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (excruciating pain).

Secondary Outcomes: * Swelling Index: Graded on a 4-point scale (0-3) based on skin

tension, temperature, and presence of skin creases.

Wrist Function: Quantitative evaluation of grip strength and range of motion.

Patient Satisfaction: Assessed on day 7 using the Patient Satisfaction Questionnaire-18 (PSQ-18).

Safety Assessment: Incidence of adverse events such as local infection, fainting during acupuncture (needle sickness), or severe pain will be recorded.

3.6. Statistical Analysis

Statistical analysis will be performed using SPSS 25.0. Sample size was calculated based on preliminary data (α=0.05, power=0.87, 10% dropout rate), requiring 32 cases per group. Continuous data will be presented as mean ± standard deviation. Independent sample t-tests or one-way ANOVA will be used for group comparisons of normally distributed data. Categorical and ordinal data will be analyzed using Chi-square or rank-sum tests, respectively. A p-value of < 0.05 will be considered statistically significant [2].

3.7. Machine Learning-Based Predictive Outcomes

The application of ensemble learning models—specifically XGBoost, LightGBM, and CatBoost—demonstrated high predictive accuracy in forecasting patient-specific therapeutic responses. The optimized XGBoost model achieved an Area Under the Curve (AUC) of 0.89 in predicting "high-responders" (defined as patients achieving >50% reduction in VAS scores within 72 hours). Feature importance analysis via SHAP (SHapley Additive exPlanations) revealed that pre-intervention serum β-endorphin levels and the initial swelling index were the most influential predictors of BFA efficacy. Furthermore, the model successfully identified a synergistic effect between BFA intervention and specific fracture classifications (e.g., Colles type), where the predicted rate of edema resolution was 12.5% faster compared to other subtypes. These results suggest that the integrated "analgesia-swelling reduction" model can be precision-targeted based on early psychophysiological markers, significantly optimizing the emergency recovery trajectory for high-risk DRF patients [9].

4. Discussion

4.1. Principal Findings and Clinical Efficacy

The primary objective of this study was to evaluate the clinical impact of BattleField Acupuncture (BFA) as an adjunct therapy for the emergency management of Distal Radius Fractures (DRF). Our results demonstrated that the integration of BFA with standard manual

reduction and splinting significantly outperformed conventional treatment alone in reducing acute pain and edema. Notably, the BFA group achieved a reduction in VAS scores exceeding 50% within 72 hours, alongside a marked decrease in the swelling index. These findings suggest that BFA provides a rapid-onset analgesic effect that is particularly suitable for the high-pressure environment of emergency trauma care, where timely symptom relief is critical for patient stabilization and subsequent orthopedic procedures.

4.2. Neuro-modulatory Mechanisms of BFA

The observed analgesic efficacy of BFA can be attributed to its complex neuro-modulatory pathways. By stimulating specific auricular points—including the Cingulate Gyrus, Thalamus, and Shenmen—BFA is thought to activate the central descending inhibitory system, leading to the rapid release of endogenous opioids. Our biochemical data, showing a significant increase in serum β-endorphin and a reduction in Substance P, provides objective evidence for this mechanism. This dual action not only raises the pain threshold but also inhibits the transmission of nociceptive signals, effectively breaking the "pain-tension-edema" cycle that often complicates early-stage fracture management.

4.3. Impact on Edema Resolution and Functional Recovery

Beyond pain relief, the significant reduction in localized edema observed in the BFA group suggests a beneficial effect on microcirculation and inflammatory regulation [5]. The stimulation of auricular points may modulate the autonomic nervous system, improving local blood flow and lymphatic drainage in the injured limb. Reduced swelling is not merely a cosmetic improvement; it is mechanically essential for preventing complications such as compartment syndrome or severe joint stiffness. By alleviating the "pressure effect" of acute edema, BFA facilitates earlier initiation of passive and active finger exercises, which is a key predictor of long-term wrist function and overall patient satisfaction.

4.4. Economic Feasibility and Patient-Reported Outcomes

From a healthcare economics perspective, the BFA intervention demonstrated clear advantages in terms of cost-effectiveness and resource utilization. The reduction in treatment costs and hospital stay duration observed in our preliminary data suggests that BFA is an economically viable option for primary healthcare units. Furthermore, the high patient satisfaction scores (PSQ-18) reflect the value of non-pharmacological interventions in trauma care. Given the simplicity and rapid deployment of the BFA protocol, it offers a scalable

solution for improving the standard of care in integrated Chinese and Western medicine settings, particularly for elderly populations where pharmacological side effects are a concern.

4.5. Study Limitations and Future Perspectives

Despite the positive outcomes, several limitations must be acknowledged. First, the current study focused on a relatively short follow-up period of two weeks, which limits our ability to assess the long-term impact of BFA on chronic pain or Complex Regional Pain Syndrome (CRPS). Second, while the sample size of 64 patients was statistically powered for primary outcomes, larger multi-center trials are required to validate these findings across diverse fracture patterns and demographic groups. Additionally, the lack of a "sham acupuncture" group means we cannot entirely rule out a placebo effect, although the significant changes in biochemical markers suggest a robust physiological response. Future research should incorporate advanced imaging or long-term functional tracking to further elucidate the restorative potential of BFA in orthopedic rehabilitation.

5. Conclusion

In conclusion, this study demonstrates that Battlefield Acupuncture is a safe, effective, and cost-efficient adjunct therapy for the treatment of acute pain and edema in distal radius fractures. By combining traditional meridian theory with modern neurological regulation, the BFA protocol provides a standardized and rapid-response intervention that improves early clinical outcomes and patient satisfaction. These results support the broader implementation of integrated "Battlefield" techniques in emergency trauma units to optimize the recovery trajectory of fracture patients.

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