

## Original Article

# Clinical application of homeopathic traction reduction techniques in traumatic fractures of lower extremities

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Received April 28, 2026; Accepted August 8, 2026; Epub October 15, 2026; Published October 30, 2026

**Abstract:** Objective: This study evaluates the clinical efficacy of homeopathic traction reduction techniques in traumatic fractures of the lower extremities (hereafter lower limb fractures). Methods: A total of 212 patients with lower limb fractures were enrolled. The control group (n = 100) received reduction using a traction table, and the research group (n = 112) received homeopathic traction reduction. Surgical parameters, perioperative indicators, serum inflammation, oxidative stress (superoxide dismutase (SOD), malondialdehyde (MDA)), complications, function recovery (Patient-Reported Outcomes Measurement Information System (PROMIS) - Physical Function (PROMIS PF), PROMIS - Mobility (PROMIS MOB)), pain intensity (Visual Analogue Scale (VAS): pain at rest, pain on movement), and quality of life (World Health Organization Quality of Life - BREF (WHOQOL-BREF)) were compared between the two groups. Results: Compared with the control group, the research group exhibited remarkably better surgical parameters and perioperative indicators, and lower postoperative serum inflammatory markers, MDA, overall complication rates, resting pain, and movement-evoked pain; while postoperative SOD, PROMIS PF scores, PROMIS MOB scores, and WHOQOL-BREF scores were notably higher. Conclusion: The homeopathic traction reduction technique has significant clinical efficacy in lower limb fractures.

**Keywords:** Homeopathic traction reduction, reduction using a traction table, traumatic fractures of lower extremities, clinical application, complications

## Introduction

Traumatic fractures of the lower extremities (hereafter lower limb fractures) is a major public health concern worldwide, imposing a significant socioeconomic burden [1]. It variably impairs patients' mobility and joint function, which may lead to serious complications, such as shock, lower-extremity deep vein thrombosis (DVT), systemic organ damage, and infection [2]. Lower limb fractures account for one-third (33.33%) of all fracture cases, primarily affecting the elderly population, and the prevalence is showing an upward trend as the population ages [3]. Intertrochanteric femoral fractures, femoral neck fractures, and femoral shaft fractures are representative types of lower limb fractures; as critical weight-bearing structures, they are characterized by high incidence, high disability rates, and complex pathophysiology [4, 5]. In particular, intertrochanteric femoral

fractures and femoral neck fractures are commonly observed in the elderly, and most of them are associated with falls. Femoral shaft fractures are more common in young people with high-energy trauma and in older people with low-energy trauma [6]. Previously, open reduction and internal fixation (ORIF) was mainly used for lower limb fractures, but this method has limitations, including the need for large incisions, significant surgical trauma, and high rates of infection and nonunion [7]. Closed reduction and internal fixation (CRIF) is a minimally invasive procedure, and intraoperative reduction can be achieved using a traction table or an AO reduction distractor [8]. The former, due to the misalignment between the traction line and the lower limb axis, is prone to causing soft tissue injury to the perineum, while the latter makes it more difficult to achieve ideal reduction and can hinder intraoperative fluoroscopy and the placement of internal fixa-

tion devices [9, 10]. The homeopathic traction reduction technique is a minimally invasive method based on the principle of direct bone-to-bone traction, which applies traction force directly to both fracture ends along the mechanical axis of the limb and achieves internal fixation while the reduction is continuously maintained. It maximizes the protection of the biological activity of the fracture ends and surrounding soft tissues; compared with traditional open reduction, it has clinical advantages like shorter operation time, reduced blood loss, reduced soft tissue trauma, and improved joint function recovery [11]. In the study by Zheng Z [12] et al., its application in the minimally invasive treatment of bilateral tibial plateau fractures has the advantages of minimal trauma, shorter operation time, precise reduction, and fewer complications; besides, it significantly promotes fracture healing and knee joint function recovery. For unstable intertrochanteric femoral fractures, homeopathic traction reduction technique has lower neck shaft angle and open reduction rate compared with reduction using a traction table, and has been proved to be clinically effective and safe [13]. This technique can also be applied to femoral shaft fractures treated with retrograde intramedullary nailing, which yields clinical outcomes comparable to manual traction, and offers significant clinical advantages including fewer surgical views required, fewer assistants, and a lower rate of open reduction [14].

Current clinical applications of homeopathic traction reduction in lower limb fractures mainly focus on tibial plateau fractures. Research on its clinical application in other lower limb fractures such as intertrochanteric femoral fractures, femoral neck fractures, and femoral shaft fractures is limited. This study was conducted to conduct relevant clinical assessments to further validate its clinical efficacy.

### Materials and methods

#### *General data*

First, 212 patients with lower limb fractures admitted to North China Medical and Health Group Xingtai General Hospital from December 2023 to December 2025 were enrolled in this study. The control group (n = 100) received reduction using a traction table, and the

research group (n = 112) received homeopathic traction reduction. No remarkable intergroup differences were seen in general data ( $P > 0.05$ ), so the two groups were deemed comparable. This study has obtained approval from the North China Medical and Health Group Xingtai General Hospitals Ethics Committee.

#### *Inclusion and exclusion criteria*

Inclusion criteria: traumatic fractures of lower extremities confirmed by imaging (including intertrochanteric femoral fractures, femoral neck fractures, and femoral shaft fractures) [15]; indicated for surgery and scheduled for CRIF; aged 18 years or older; had normal bilateral lower extremity mobility prior to injury; time from injury to surgery  $\leq 14$  days; complete clinical data; normal communication and cognitive abilities.

Exclusion criteria: History of DVT or coagulation disorders in the lower extremities; severe heart, lung, liver, or kidney dysfunction, intolerable to surgery; pregnant or lactating women; preoperative lower extremity infection; comorbid mental illness; pathological fractures or old fractures; severe osteoporosis or other conditions that affect rehabilitation or joint surfaces.

CRIF is indicated in the following cases: for intertrochanteric femoral fractures, CRIF is indicated for stable fractures (Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification: 31-A1, A2), particularly those managed with minimally invasive techniques such as percutaneous compression plating; reverse intertrochanteric fractures and A3-type fractures are considered relative contraindications [16]. For femoral neck fractures, CRIF is applicable to cases without significant displacement or those in which anatomical or near-anatomical reduction can be achieved via closed reduction, thereby preserving the blood supply to the femoral head and reducing the risk of avascular necrosis [17]. For femoral shaft fractures, intramedullary nailing is the gold-standard procedure for CRIF, and its indication has been extended to comminuted fracture, provided that percutaneous reduction tools (e.g., blocking screws, Schanz pins) can effectively counteract the deforming forces of the surrounding musculature [18].

### *Treatment method*

All patients underwent preoperative examinations, and surgical treatment was performed after their key laboratory values had returned to normal.

The control group underwent reduction using a traction table. Surgical procedure: Prophylactic antibiotics were administered 30 minutes preoperatively, and general anesthesia was then induced. Position was chosen based on the type of fracture: patients with intertrochanteric femoral fractures and femoral neck fractures were placed in the supine position, with the affected limb secured in the foot restraints and the perineum positioned against the perineal support; patients with femoral shaft fractures were placed in the supine position, with the affected limb positioned on the traction table. After routine disinfection, the traction frame was adjusted under C-arm fluoroscopy to reduce the fracture ends. If good alignment was achieved, the reduction was deemed satisfactory. If the reduction was unsatisfactory, a compression rod can be inserted through a small incision to apply downward pressure for reduction, or a Hoffman retractor and periosteal elevator may be used to perform a lever reduction. After successful reduction, internal fixation was selected based on the fracture type: proximal femoral nail antirotation (PFNA) for intertrochanteric femoral fractures; 3 hollow cannulated compression screws or femoral neck system (FNS) for femoral neck fractures; and interlocking intramedullary nails for femoral shaft fractures.

The research group was given homeopathic traction reduction. Surgical procedure: Prophylactic antibiotics were administered 30 minutes preoperatively, and general anesthesia was then induced. The patient was placed in a supine position. After skin disinfection, reduction was performed with a homeopathic double-reverse traction reposer. The specific steps are as follows: The Steinmann pin was transversely inserted along the femoral condyle rotation line to connect the traction bow after it was placed along the femoral condyle rotation axis; the reposer traction frame was placed on the lower leg of the affected limb to connect it to the traction bow. The anterior superior iliac spine was cut about 3 cm to expose the anterior superior iliac spine and the inner and outer

cortex. After drilling the cortex with an electric drill, screws were implanted horizontally and fixed at the anterior superior iliac spine, and instruments were connected vertically. After selecting a suitable length of traction screw, the equipment and the reset frame were vertically connected. The position of the affected limb was adjusted according to the fracture type: For intertrochanteric femoral fractures and femoral neck fractures, an adduction and internal rotation position was maintained; for femoral shaft fractures, a neutral lower limb position was maintained. Under C-arm fluoroscopy, the reposer was rotated, and the traction bow was pulled to apply supracondylar femoral traction.

Once satisfactory fracture reduction was confirmed, the reduction was maintained, and the bone was fixed. The internal fixation method was consistent with that of the control group.

Patients in both groups received a single intravenous infusion of 2.25 g of cefuroxime within 24 hours after surgery. Postoperatively, patients were instructed to perform functional exercises, including straight leg raise training on the affected limb starting 3 days post-surgery. A follow-up examination was conducted 3 months post-surgery.

### *Outcome measures*

**Surgical parameters.** The incidence of open reduction, operation time, and intraoperative blood loss were documented for patients in both groups. The incidence of open reduction was statistically analyzed by recording the number of cases where closed reduction failed and was converted to limited open reduction. Operation time is the total time from skin incision to suturing completion. Intraoperative blood loss was calculated based on the amount of blood in the suction bottle combined with the gauze weighing method.

**Perioperative indicators.** The fracture reduction time, radiation exposure time, and length of hospital stay were documented for patients in both groups. The fracture reduction time is the duration from the start of the reduction procedure until fluoroscopic confirmation of satisfactory reduction, which is a component of operation time and can be used to measure the efficiency of reduction techniques and to verify

whether the difference in surgical efficiency between two reduction techniques stems from reduction procedures or non-reduction procedures. The radiation exposure time is the cumulative exposure time of the C-arm during the surgery.

**Serum inflammation.** Before and 3 days after surgery, fasting venous blood samples (5 mL) were collected from each patient in the morning, followed by centrifugation to separate the serum.

Serum interleukin (IL)-6, C-reactive protein (CRP), and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) levels were measured by enzyme-linked immunosorbent assay (ELISA).

**Oxidative stress.** The levels of superoxide dismutase (SOD) and malondialdehyde (MDA) in patients' serum were measured using the colorimetric method before and 3 days after surgery.

**Complications.** The number of cases with adverse events, including fracture delayed union, femoral head necrosis, DVT, internal fixation failure, coxa vara, and fracture displacement, was observed and recorded, and the overall incidence rate was calculated.

**Function recovery [19].** The Patient-Reported Outcomes Measurement Information System - Physical Function (PROMIS PF) was used to assess patients' physical function before and 3 months after surgery. The scale was administered in a computerized adaptive testing (CAT) format. The item bank comprises 121 items, of which 4 to 12 are adaptively selected based on the patient's responses at each administration. A 5-point Likert scale (ranging from 1 to 5) was used for scoring. The PROMIS PF uses standardized T-scores, with scores ranging from 20 to 80. Higher scores represent better physical function, with the average score for the general population being 50. In patients with fractures, the T-score cutoff value of PROMIS PF is defined as follows:  $\geq 50$  points (normal), 40-50 points (mild impairment), and 25-30 points (moderate to severe impairment). The PROMIS - Mobility (PROMIS MOB) was used to assess patients' lower limb mobility. This scale focuses on lower limb-related functions such as walking, climbing stairs, and standing up from a chair. It also uses the CAT format and standardized T-scores, with higher scores indicating better mobility.

**Pain intensity [20].** Patients' pain intensity was assessed before and 3 months after surgery with the Visual Analogue Scale (VAS). Using a 10 cm straight line, where 0 on the left represents no pain and 10 on the right represents the most severe pain, the scores for pain at rest and pain on movement were separately recorded. The scores are positively correlated with pain intensity.

**Quality of life (QOL) [21].** The World Health Organization Quality of Life BREF (WHOQOL-BREF) was adopted to evaluate the QOL of patients before and 3 months after surgery. The scale contains 26 items, covering four domains: physical health, psychological health, social relationships, and environment. For each domain, the scores are calculated by multiplying the average score of the items within that domain by 4. Scores range from 4 to 20, with higher scores indicating a better QOL.

### *Statistical analysis*

In this study, the SPSS 21.0 software package was employed for statistical analysis. Count data are presented as frequency/percentage (n/%); measurement data are presented as mean  $\pm$  standard deviation (SD). The comparison of count data was conducted with the  $\chi^2$ . The intergroup comparison of measurement data was performed by the independent sample t-test, and the intragroup comparison of measurement data before and after treatment was conducted using the paired t-test. When  $P < 0.05$ , there is a statistically significant difference.

## **Results**

### *General data*

No statistically significant differences were observed in baseline characteristics between the two groups in terms of age, gender, body mass index (BMI), time from injury to surgery, fracture site, AO classification of each fracture segment, cause of injury, fracture type, smoking history, presence of concurrent hypertension, and presence of concurrent diabetes ( $P > 0.05$ ) (**Table 1**).

### *Surgical parameters*

Compared to the control group, the research group had a significantly lower incidence of

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**Table 1.** General data

| Item                               | Control group (n = 100) | Research Group (n = 112) | $\chi^2/t/Z$ | P     |
|------------------------------------|-------------------------|--------------------------|--------------|-------|
| Age (years)                        | 58.12±10.95             | 56.64±13.46              | 0.872        | 0.384 |
| Gender                             |                         |                          | 0.603        | 0.437 |
| Male                               | 65 (65.00)              | 67 (59.82)               |              |       |
| Female                             | 35 (35.00)              | 45 (40.18)               |              |       |
| BMI (kg/m <sup>2</sup> )           | 23.24±2.34              | 23.43±2.14               | 0.617        | 0.538 |
| Time from injury to surgery (d)    | 5.00 (3.00, 6.00)       | 5.00 (3.00, 6.00)        | -0.490       | 0.624 |
| Fracture site                      |                         |                          | 0.584        | 0.747 |
| Femoral neck fracture              | 40 (40.00)              | 48 (42.86)               |              |       |
| Intertrochanteric femoral fracture | 38 (38.00)              | 44 (39.29)               |              |       |
| Femur shaft fracture               | 22 (22.00)              | 20 (17.86)               |              |       |
| AO classification                  |                         |                          |              |       |
| Femoral neck fracture              |                         |                          | 1.155        | 0.561 |
| B1                                 | 12 (30.00)              | 10 (20.83)               |              |       |
| B2                                 | 17 (42.50)              | 25 (52.08)               |              |       |
| B3                                 | 11 (27.50)              | 13 (27.08)               |              |       |
| Intertrochanteric femoral fracture |                         |                          | 1.327        | 0.515 |
| A1                                 | 11 (28.95)              | 8 (18.18)                |              |       |
| A2                                 | 18 (47.37)              | 24 (54.55)               |              |       |
| A3                                 | 9 (23.68)               | 12 (27.27)               |              |       |
| Femur shaft fracture               |                         |                          | 0.313        | 0.855 |
| Type A                             | 7 (31.82)               | 8 (40.00)                |              |       |
| Type B                             | 9 (40.91)               | 7 (35.00)                |              |       |
| Type C                             | 6 (27.27)               | 5 (25.00)                |              |       |
| Cause of injury                    |                         |                          | 2.630        | 0.268 |
| Fall Injury                        | 56 (56.00)              | 71 (63.39)               |              |       |
| Traffic injury                     | 33 (33.00)              | 35 (31.25)               |              |       |
| Injuries from falls from height    | 11 (11.00)              | 6 (5.36)                 |              |       |
| Types of fracture                  |                         |                          | 0.248        | 0.619 |
| Closed fracture                    | 93 (93.00)              | 106 (94.64)              |              |       |
| Open fracture                      | 7 (7.00)                | 6 (5.36)                 |              |       |
| Smoking history                    | 25 (25.00)              | 32 (28.57)               | 0.343        | 0.558 |
| Concurrent hypertension            | 40 (40.00)              | 50 (44.64)               | 0.466        | 0.495 |
| Concurrent diabetes                | 22 (22.00)              | 29 (25.89)               | 0.438        | 0.508 |

Note: BMI, body mass index; AO, Arbeitsgemeinschaft für Osteosynthesefragen.

open reduction, shorter operation time, and less intraoperative blood loss, with statistically significant differences ( $P < 0.001$ ) (**Table 2**).

### *Perioperative indicators*

The fracture reduction time, radiation exposure time, and length of hospital stay were all significantly better in the research group than in the control group, with statistically significant differences ( $P < 0.001$ ) (**Table 3**).

### *Serum inflammation*

No statistically significant differences were observed in any serum inflammatory markers

between the two groups before surgery ( $P > 0.05$ ). Postoperatively, serum inflammatory markers were considerably elevated in both groups ( $P < 0.05$ ), with the research group showing lower IL-6, CRP, and TNF- $\alpha$  levels ( $P < 0.001$ ) (**Table 4**).

### *Oxidative stress*

No statistically significant intergroup differences were seen in preoperative SOD and MDA levels ( $P > 0.05$ ). Postoperatively, SOD levels decreased notably in both groups and were higher in the research group ( $P < 0.001$ ); MDA levels increased significantly in both groups

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**Table 2.** Surgical parameters

| Item                           | Control group (n = 100) | Research Group (n = 112) | $\chi^2/t$ | P       |
|--------------------------------|-------------------------|--------------------------|------------|---------|
| Incidence of open reduction    | 36 (36.00)              | 18 (16.07)               | 11.052     | < 0.001 |
| Surgery duration (min)         | 83.18±12.81             | 73.32±10.89              | 6.056      | < 0.001 |
| Intraoperative blood loss (mL) | 191.39±44.86            | 138.90±32.11             | 9.872      | < 0.001 |

**Table 3.** Perioperative indicators

| Item                           | Control group (n = 100) | Research Group (n = 112) | t/Z    | P       |
|--------------------------------|-------------------------|--------------------------|--------|---------|
| Fracture reduction time (min)  | 12.00 (10.00, 14.75)    | 9.00 (8.00, 11.00)       | -6.598 | < 0.001 |
| Radiation exposure time (s)    | 63.30±14.64             | 47.38±9.38               | 9.526  | < 0.001 |
| Length of hospital stay (days) | 14.00 (12.00, 16.00)    | 12.00 (10.00, 13.00)     | -5.809 | < 0.001 |

**Table 4.** Serum inflammation

| Item                                 | Control group (n = 100) | Research Group (n = 112) | t      | P       |
|--------------------------------------|-------------------------|--------------------------|--------|---------|
| IL-6 (pg/mL; preoperative)           | 9.05±1.96               | 9.11±2.12                | 0.831  | 0.213   |
| IL-6 (pg/mL; postoperative)          | 39.94±10.01             | 21.58±5.54               | 16.752 | < 0.001 |
| CRP (mg/L; preoperative)             | 7.14±1.58               | 7.08±1.68                | 0.790  | 0.267   |
| CRP (mg/L; postoperative)            | 28.02±9.70              | 19.34±7.71               | 14.746 | < 0.001 |
| TNF- $\alpha$ (pg/mL; preoperative)  | 10.49±3.03              | 10.34±3.06               | 0.358  | 0.721   |
| TNF- $\alpha$ (pg/mL; postoperative) | 24.74±6.69              | 16.54±4.70               | 10.411 | < 0.001 |

Note: IL-6, interleukin-6; CRP, C-reactive protein; TNF- $\alpha$ , tumor necrosis factor- $\alpha$ .

**Table 5.** Serum inflammation

| Item                      | Control group (n = 100) | Research Group (n = 112) | t     | P       |
|---------------------------|-------------------------|--------------------------|-------|---------|
| SOD (U/mL; preoperative)  | 82.48±9.95              | 81.12±10.81              | 0.949 | 0.344   |
| SOD (U/mL; postoperative) | 61.17±6.44              | 70.52±9.80               | 8.105 | < 0.001 |
| MDA (U/mL; preoperative)  | 5.05±1.01               | 5.10±1.21                | 0.324 | 0.746   |
| MDA (U/mL; postoperative) | 7.40±1.82               | 6.33±1.79                | 4.311 | < 0.001 |

Note: SOD, superoxide dismutase; MDA, malondialdehyde.

and were lower in the research group ( $P < 0.001$ ) (**Table 5**).

### Complications

The incidence of fracture delayed union, femoral head necrosis, DVT of lower extremities, internal fixation failure, coxa vara, and fracture displacement was statistically analyzed. The overall total incidence was 6.25% in the research group, remarkably lower than the 26.00% in the control group ( $P < 0.001$ ) (**Table 6**).

### Function recovery

Functional recovery was assessed using the PROMIS PF and PROMIS MOB and compared between the two groups. Preoperatively, no remarkable intergroup differences were seen in

scores on any scale ( $P > 0.05$ ). The scores in the two groups increased notably after surgery, and the research group had higher scores of PROMIS PF and PROMIS MOB than the control group ( $P < 0.001$ ) (**Table 7**).

### Pain intensity

Pain at rest and on movement were assessed with the VAS scale, which revealed no remarkable intergroup differences preoperatively ( $P > 0.05$ ). Postoperatively, significant decreases were observed in both groups in these two scores, with lower scores in the research group ( $P < 0.05$ ) (**Figure 1**).

### Quality of life

Using the WHOQOL-BREF scale, patients' QOL was assessed. Preoperatively, there were no

**Table 6.** Complications

| Item                      | Control group<br>(n = 100) | Research Group<br>(n = 112) | $\chi^2$ | P       |
|---------------------------|----------------------------|-----------------------------|----------|---------|
| Fracture delayed union    | 8 (8.00)                   | 2 (1.79)                    |          |         |
| Femoral head necrosis     | 6 (6.00)                   | 2 (1.79)                    |          |         |
| DVT                       | 8 (8.00)                   | 3 (2.68)                    |          |         |
| Internal fixation failure | 3 (3.00)                   | 1 (0.89)                    |          |         |
| Coxa vara                 | 2 (2.00)                   | 0 (0.00)                    |          |         |
| Fracture displacement     | 3 (3.00)                   | 1 (0.89)                    |          |         |
| Total ( $\geq 1$ item)    | 26 (26.00)                 | 7 (6.25)                    | 15.679   | < 0.001 |

Note: DVT, deep vein thrombosis.

remarkable intergroup differences in WHOQOL-BREF scores in physical function, psychological function, social relationships, and environment ( $P > 0.05$ ). Postoperatively, WHOQOL-BREF scores significantly increased across all domains in both groups ( $P < 0.05$ ), with the research group showing notably higher WHOQOL-BREF scores in all domains ( $P < 0.05$ ) (Figure 2).

### Discussion

The findings of this study demonstrate that the homeopathic traction reduction technique effectively improved the reduction quality and surgical efficiency, while maintaining an adequate safety profile, in patients with lower limb fractures (including intertrochanteric femoral fractures, femoral neck fractures, and femoral shaft fractures). Second, the application of homeopathic traction reduction in lower limb fractures ensured patient and physician safety and promoted faster recovery. Under the operation of homeopathic traction reduction technique, the double-reverse traction retractor achieves high-quality reduction of overriding fragments by generating a traction line aligned with the axis of the lower limb, while utilizing the tension of surrounding tissues and auxiliary fixation to correct fracture displacements in different planes; additionally, its design, which moves with the affected limb and allows for unobstructed fluoroscopic visualization, facilitates intraoperative manipulation and the placement of internal fixation devices, thus promoting faster recovery of patients on the basis of improving reduction quality and surgical efficiency and ensuring safety [22]. In a study by Cao F et al. [23], the use of homeopathic traction reduction for unstable intertrochanteric fractures, compared with traction table reduc-

tion, effectively reduced the average intraoperative reduction time and average operation time; however, there were no remarkable differences in incision length, intraoperative blood loss, or fracture union time. This differs from the results of this study, possibly due to differences in patient selection. The study by Cao F et al. only focused on unstable intertrochanteric fractures with sig-

nificant muscle traction and bleeding, while this study also included femoral neck fractures with intra-articular procedures and less bleeding. According to Yan M et al. [24], in patients with unstable intertrochanteric fractures, homeopathic traction reduction offered advantages over reduction using a traction table in terms of operation time and the duration of patient positioning, which complements the findings of this study.

Fracture ends can trigger inflammatory reactions by inducing inflammatory factors, leading to cell damage and oxidative stress, disrupting the balance of bone metabolism and causing abnormal bone formation, which is not conducive to fracture union and prognosis in patients [25]. Homeopathic traction reduction significantly attenuated surgery-related inflammatory responses and reduced the abnormally elevated levels of IL-6, CRP, and TNF- $\alpha$  after surgery in patients with lower limb fractures. This technique also significantly reduces surgery-related oxidative stress damage in this population, increasing abnormally low SOD levels and inhibiting abnormally high MDA levels. This may be attributed to the use of direct osseous countertraction by the double-reverse traction retractor, which avoids soft tissue irritation and iatrogenic injury, reduces surgical trauma, effectively mitigates the postoperative inflammatory reactions, and protects the endogenous antioxidant system [26].

In terms of safety, the overall incidence of fracture delayed union, femoral head necrosis, DVT of lower extremities, internal fixation failure, coxa vara, and fracture displacement in patients with lower limb fractures treated with homeopathic traction reduction was only 6.25%, remarkably lower than the 26.00% rate

**Table 7.** Function recovery

| Item                              | Control group (n = 100) | Research Group (n = 112) | t     | P       |
|-----------------------------------|-------------------------|--------------------------|-------|---------|
| PROMIS PF (score; preoperative)   | 29.95±5.69              | 31.42±6.83               | 1.691 | 0.092   |
| PROMIS PF (points; postoperative) | 35.18±7.65              | 40.04±7.93               | 4.529 | < 0.001 |
| PROMIS MOB (score; preoperative)  | 37.21±4.45              | 37.68±5.10               | 0.711 | 0.478   |
| PROMIS MOB (score; postoperative) | 41.97±4.72              | 43.53±4.83               | 9.613 | < 0.001 |

Note: PROMIS PF, Patient-Reported Outcomes Measurement Information System Physical Function; PROMIS MOB, Patient-Reported Outcomes Measurement Information System Mobility.

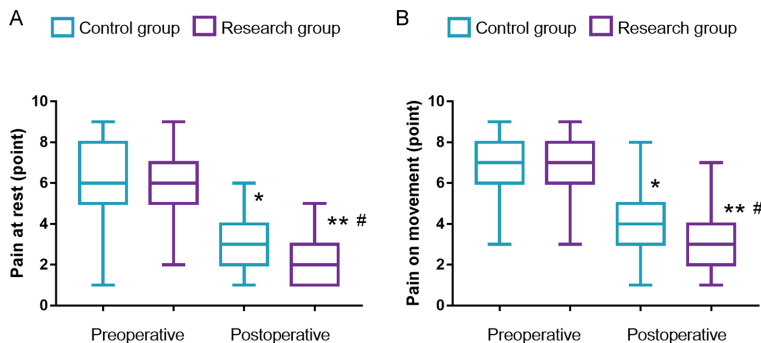


**Figure 1.** Pain intensity. A. Pain at rest before and after surgery. B. Pain on movement before and after surgery. Note: \*P < 0.05, \*\*P < 0.01, compared with preoperative results; #P < 0.05, compared with the control group.

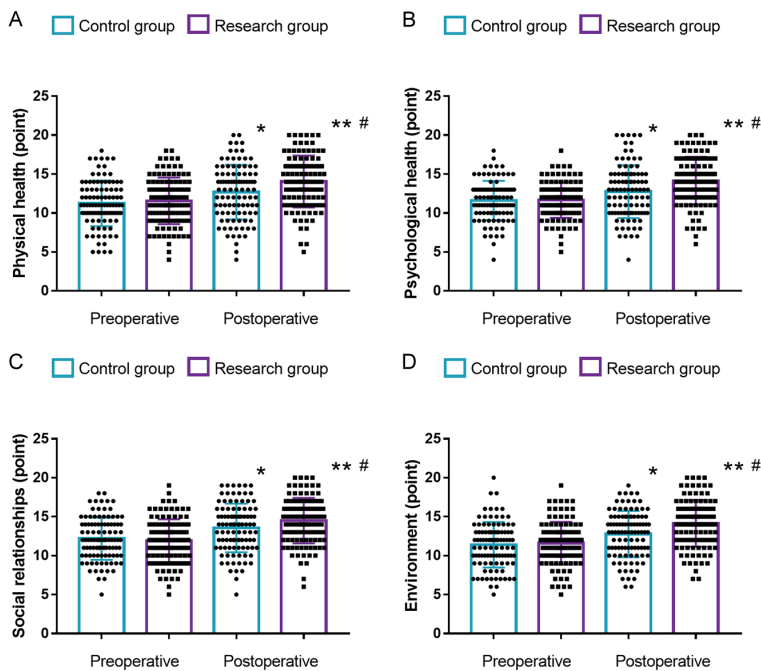


**Figure 2.** Quality of life. A. WHOQOL-BREF scores (physical function) before and after surgery. B. WHOQOL-BREF scores (psychological function) before and after surgery. C. WHOQOL-BREF scores (social relationships) before and after surgery. D. WHOQOL-BREF scores (environment) before and after surgery. Note: \*P < 0.05, \*\*P < 0.01, compared with preoperative results; #P < 0.05, compared with the control group. WHOQOL-BREF, World Health Organization Quality of Life - BREF.

observed in the traction table group. The double-reverse traction retractor eliminates the need for foot boots and perineal braces, avoiding contusion, compression, and traction injuries to the perineum, ankles, and lower limbs, and minimizing the risk of infection caused by traction, which significantly reduces the incidence of postoperative complications. In the report by Zhao Z et al. [27], compared with traditional manual closed reduction, the homeopathic traction reduction resulted in a shorter fracture reduction time and a lower incidence of complications in open tibial shaft fractures, which is similar to the finding of this study.

Regarding function recovery, patients with lower limb fractures who underwent homeopathic traction reduction achieved better functional outcomes. Furthermore, the double-reverse traction retractor effectively improves the reduction quality of long bone fractures of the limbs (including intertrochanteric femoral fractures, femoral neck fractures, and femoral shaft fractures), reduces surgical trauma, and effectively maintains fracture reduction, thereby ensuring favorable functional recovery. According to Wang Y et al. [28], the use of homeopathic traction reduction combined with CRIF for lateral tibial pla-

teau fractures in the elderly yielded favorable radiographic outcomes and restoration of knee function, consistent with the findings of this study.

The VAS scale assessment revealed that the use of the homeopathic traction reduction resulted in a more significant reduction in both rest pain and pain on movement in patients with lower limb fractures. This may be attributed to the direct bone-to-bone traction employed by the homeopathic double reverse traction, which avoids complications such as joint damage caused by the transmission of traction force through the knee joint and perineal contusion; besides, the natural compartments formed by the musculofascial structures provide uniform reduction forces through tension compression, reducing soft tissue irritation and thereby helping to alleviate postoperative pain [29].

Last, the QOL assessment revealed that homeopathic traction reduction resulted in more significant improvements in QOL across the physical, psychological, social, and environmental domains in patients with lower limb fractures. The homeopathic double reverse traction, by providing sufficient direct bone-to-bone traction, achieves a higher rate of successful closed reduction (with a reduction difficulty rate of 0% in this study) and allows for flexible adjustment of rotational and angular deformities according to the surgeon's needs. It also avoids the complex reduction procedures caused by eccentricity issues with traction tables, thereby comprehensively improving patients' QOL with less trauma and better reduction outcomes.

This study has several limitations. First, the sample size is from a single region, which may result in insufficient representativeness. Samples from multiple regions should be included in future studies to improve representativeness. Second, the impact of the two reduction techniques on patients' negative emotions and sleep quality were not assessed. The potential clinical advantages of homeopathic traction reduction techniques should be further confirmed by supplementary prospective correlation analyses. Last, the levels of inflammatory and oxidative stress markers were only determined at a single time point, without dynamic monitoring of perioperative trends (e.g., preop-

eratively, immediately postoperatively, 1 day postoperatively, and 3 days postoperatively). Future studies should prospectively collect data at all relevant time points to evaluate the temporal effects of homeopathic traction reduction on inflammatory and stress responses.

To sum up, for patients with traumatic fractures of the lower extremities, the use of homeopathic traction reduction demonstrates significant clinical advantages over reduction using a traction table. It significantly improves reduction quality, surgical efficiency, and patient and physician safety, promotes recovery, reduces surgery-related inflammation and oxidative stress, lowers overall adverse reaction rates, facilitates function recovery, alleviates pain at rest and on movement, and helps improve patients' QOL.

### Acknowledgements

This work was supported by Application of the reverse traction reduction technique in lower limb fractures, Project No.: 2023ZC160.

### Disclosure of conflict of interest

None.

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