

Whether Assisted Intramedullary Nail Implantation Without Traction Table is as Safe and Effective as Using Traction Table of Older Intertrochanteric Fracture Patients?

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Purpose: Despite promising clinical outcome proposals, there has been relatively little published regarding the use of traction table-assisted intramedullary nail implantation for intertrochanteric fractures. The purpose of this study is to further summarize and evaluate published clinical studies comparing the clinical outcomes of using traction table and without traction table in the management of intertrochanteric fracture.

Methods: A comprehensive literature search using PubMed, Cochrane Library, and Embase was systematically performed to evaluate all studies included in the literature up to May 2022. The search terms included “intertrochanteric fractures”, “hip fractures”, and “traction table” with Boolean operators “AND” and “OR”. The following information was extracted and summarized: demographic information, setup time, surgical time, amount of bleeding, fluoroscopy exposure time, reduction quality, and Harris Hip Score (HHS).

Results: A total of eight clinical controlled studies involving 620 patients were eligible for the review. The mean age at the time of injury was 75.3 years (traction table group 75.7 years, non-traction table group 74.9 years). The most common assisted intramedullary nail implantation method of non-traction table group included lateral decubitus position (4 studies), traction retractor, (3 studies) and manual traction (1 studies). Included studies results all support that there was no difference between the two groups in terms of reduction quality and Harris Hip Score, and the non-traction table group had an advantage in terms of setup time. However, there were still disputes in terms of surgical time, amount of bleeding and fluoroscopy exposure time.

Conclusion: For patients with intertrochanteric fractures, assisting intramedullary nail implantation without traction table is as safe and effective as using traction table and doing so without a traction table may be more advantageous in terms of setup time.

Keywords: intertrochanteric fractures, traction table, closed reduction, internal fixation, systematic review

Introduction

As the aging population and longer life expectancy rapidly increase. Intertrochanteric fractures due to osteoporosis are increasingly common.¹⁻³ While the treatment of intertrochanteric fractures has shown encouraging results with current technology and implants, the percentage of 20% of patients still fail the treatment.^{4,5} The management of intertrochanteric fractures remains a major challenge for orthopedic surgeons.

As the first choice for treatment of intertrochanteric fractures, compared with plates and screws, intramedullary devices have better biomechanical advantages, and minimal soft tissue injury.⁶⁻⁸ It has been well established that no matter what kind of devices are used, intraoperative traction reduction is an important part of successful surgery.^{9,10} In order to obtain better reduction quality, the currently preferred treatment method of intramedullary nailing for the treatment of intertrochanteric fractures is to take the supine position on the orthopedic surgery traction table.^{11,12}

Traction tables are commonly used to treat lesions around the hip joint (fracture fixation, hip arthroscopy, and minimally invasive arthroplasty) to achieve and maintain reduction.^{13,14} Previous studies have reported many

advantages of the traction table, including ease of surgical manipulation and imaging procedures, and can be done with fewer assistants or by the surgeon alone. Traction tables have gained wide acceptance and have shown good clinical outcomes. However, the reported possible complications remain numerous, including neurological injuries, soft tissue contusions, pressure ulcers, compartment syndrome, crush syndrome, and vascular injuries.^{15–17} Therefore, the exact indication for the use of a traction table still deserves further evaluation. Furthermore, traction tables have certain requirements for hospital surgical equipment, which limits the application and development of hospitals with limited resources.

To avoid traction table-related complications and dependence on the traction table, some researchers have used the lateral decubitus position and traction reposer to assist in the implantation of intramedullary nails.^{18–20} According to published articles, the lateral decubitus position and traction reposer are advantageous, but whether their use is as safe and efficient as the traction table is still unknown.

The aim of this study was to further summarize and evaluate published clinical studies comparing the clinical outcomes of using traction table and without traction table in the management of intertrochanteric fracture.

Methods and Materials

To conduct a comprehensive study of the evidence, we performed a systematic review of the literature. The review was conducted by searching the following databases: PubMed, Cochrane Library, and Embase. For the maximum range of potentially relevant literature, screening with keywords, including “intertrochanteric fractures”, “hip fractures”, and “traction table” with Boolean operators “AND” and “OR” was performed. The search period was from database creation to May 2022. All titles and abstracts were reviewed for relevance. Those considered consistent to the stated purposes of this review were read in full text and had their information extracted. At least two investigators evaluated each article. If there was a disagreement between the reviewers, then discrepancies were resolved by a third reviewer. Our search strategy is shown in [Figure 1](#).

The inclusion criteria were as follows: 1) clinical control studies comparing the clinical outcomes of using traction table and without traction table in the management of intertrochanteric fracture; 2) a minimum means radiological and clinical follow-up period of 6 months; 3) postoperative surgical data, and functional and radiological outcome data are available.

The exclusion criteria were biomechanical studies, computational and finite element analyses, and other nonclinical applications. Moreover, case reports and gray literature were also excluded.

From the included studies, we extracted and analyzed the following data: demographic information, setup time, surgical time, amount of bleeding, fluoroscopy exposure time, reduction quality, and HHS. Continuous variable data were reported as mean and standard deviations from the mean. Categorical variable data were reported as frequency with percentages. The primary outcomes were surgical time, reduction quality, and HHS. The secondary outcomes were setup time, amount of bleeding, fluoroscopy exposure time. Most of the literature applied different evaluation criteria, or the data reports were incomplete. We could not conduct a meta-analysis because of high heterogeneity. We only conducted a descriptive analysis of these data.

Results

In total, eight clinical studies, including three randomized controlled trials (RCTs) and five case-control studies, were eligible for our research and met the inclusion criteria. Of these eight studies, four studies comparing the radiographic and clinical outcomes of traction table versus lateral decubitus in the treatment of intertrochanteric fractures.^{21–24} Three studies compared the clinical outcomes of intertrochanteric fractures treated with traction repositors (without a traction table) with those treated using a traction table.^{25–27} One study compared the final outcomes of a traction table versus manual traction for the treatment of unstable intertrochanteric fractures.⁴ The general information of the included studies is illustrated in [Table 1](#). A total of 620 patients were included at the baseline; at study completion, only 603 patients were included in the data analysis (295 patients treated with a traction table and 308 without a traction table). The mean age at the time of injury was 75.3 years (traction table group 75.7 years, non-traction table group 74.9 years).

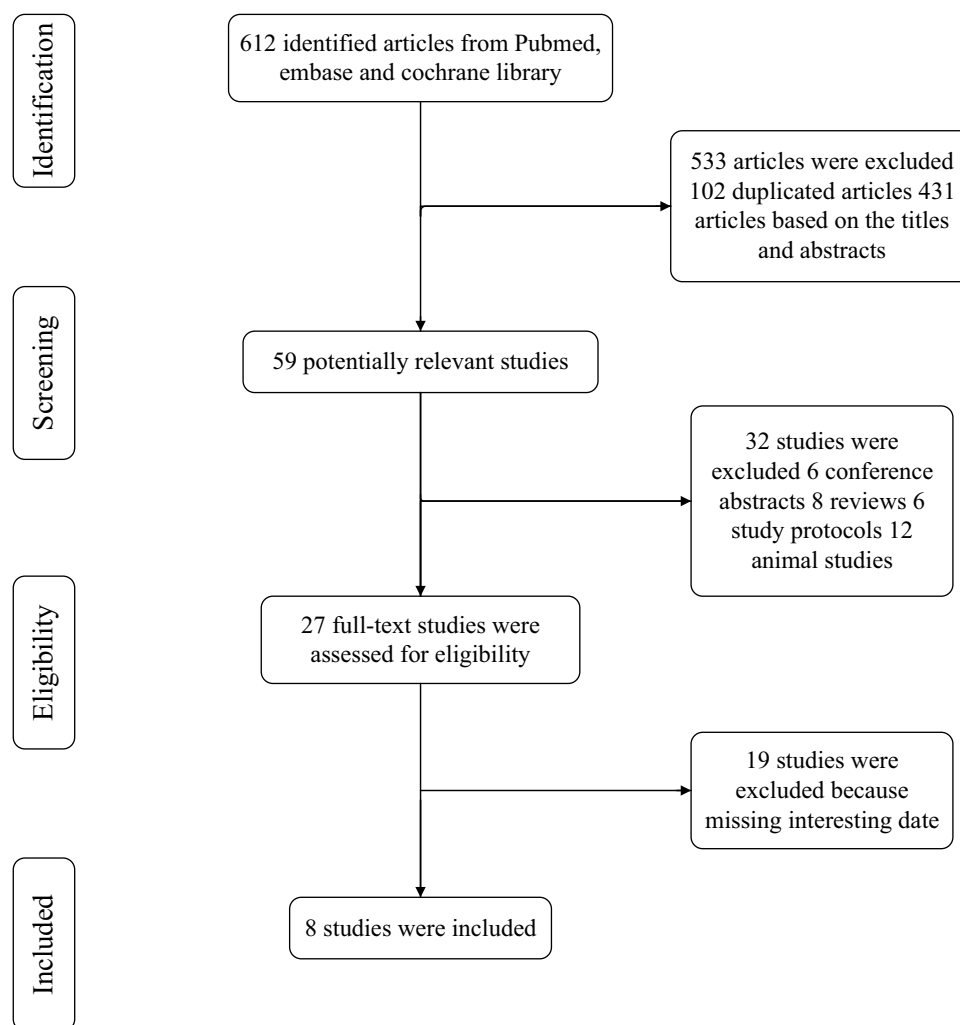


Figure 1 Flowchart of included studies.

Primary Outcomes

Surgical Time

Surgical time was the important outcome analyzed in this systematic review. Seven of the eight studies reported surgical time. In the non-traction table group, three studies reported the use of the lateral decubitus position,^{22–24} three studies reported the use of a traction repositr,^{25–27} and one study reported the use of manual traction.⁴ As enumerated in Table 2, four studies reported that surgical time was shorter in the non-traction table group than in the traction table group. No difference was found in three studies.

Table 1 Baseline Information of the Included Studies

Author	Years	Type of Study	Grouping	Sample Size	Age	Type of Implant	Observation Index	AO Classification
Souza EF ²¹	2016	Retrospective comparative study	Traction table Lateral decubitus	18 19	65.9 60.0	Gamma nail and TFN	Radiographic index	A1=6 A2=7 A3=5 A1=1 A2=11 A3=7
Şahin E ⁴	2016	Prospective randomized controlled study	Traction table Manual traction	36 36	74.8 76.5	InterTAN	Setup time, surgical time, fluoroscopic exposure time, blood loss, reduction quality HHS	A1=0 A2=16 A3=18 A1=0 A2=9 A3=21

(Continued)

Table 1 (Continued).

Author	Years	Type of Study	Grouping	Sample Size	Age	Type of Implant	Observation Index	AO Classification
Sonmez MM ²³	2017	Prospective randomized controlled study	Traction table Lateral decubitus	40 42	78.0 78.0	PFNA	Setup time, surgical time, fluoroscopic exposure time, reduction quality	A1=7 A2=18 A3=11 A1=4 A2=20 A3=13
Du G ²⁷	2020	Retrospective comparative study	Traction table skeletal tractor	42 44	72.2 70.8	PFNA	Setup time, surgical time, fluoroscopic exposure, blood loss, HHS	A1=7 A2=25 A3=10 A1=6 A2=27 A3=11
Li M ²⁴	2020	Retrospective comparative study	Traction table Lateral decubitus	50 52	72.9 73.1	PFNA	Setup time, surgical time, fluoroscopic exposure, blood loss, HHS	A1=21 A2=24 A3=5 A1=25 A2=21 A3=6
Yan M ²⁶	2021	Retrospective comparative study	Traction table double reverse traction repositr	39 56	78.8 74.2	PFNA	Setup time, surgical time, blood loss, reduction quality, HHS	A1=0 A2=30 A3=9 A1=0 A2=50 A3=6
Zhao K ²⁵	2021	Retrospective comparative study	Traction table double reverse traction repositr	36 30	79.2 79.5	PFNA	Setup time, surgical time, blood loss, reduction quality, HHS	A1=0 A2=23 A3=13 A1=0 A2=24 A3=6
Doğan N ²²	2021	Prospective randomized controlled study	Traction table Lateral decubitus	40 40	79.9 81.4	PFN	Setup time, surgical time, fluoroscopy exposure time, blood loss, reduction quality, HHS	A1=0 A2=33 A3=7 A1=0 A2=37 A3=3

Table 2 Mean Surgical Time in Min (Mean \pm SD)

Study	Traction Table	Non-Traction Table	Grouping	Conclusion
Doğan ²²	45.2 \pm 8.31	47.95 \pm 12.5	Traction table/Lateral decubitus	No difference
Sonmez ²³	32.08 \pm 7.33	28.7 \pm 7.11	Traction table/Lateral decubitus	Non-Traction table better
Şahin ⁴	49.8 \pm 4.9	55.1 \pm 13.4	Traction table/Manual traction	No difference
Zhao ²⁵	88.5 \pm 30.59	95.8 \pm 34.5	Traction table/Traction repositr	No difference
Yan ²⁶	72.5 \pm 6.1	63 \pm 4.1	Traction table/Traction repositr	Non-Traction table better
Du ²⁷	60.33 \pm 7.59	48.64 \pm 5.7	Traction table/Traction repositr	Non-Traction table better
Li ²⁴	53.5 \pm 7.1	42.3 \pm 5.7	Traction table/Lateral decubitus	Non-Traction table better

Reduction Quality

Reduction quality was the most important primary outcome of this study. We extracted and analyzed the relevant data of five studies. Two studies used the Baumgaertner system to evaluate reduction quality.^{22,23,28} Two studies evaluated reduction quality according to the criteria of Schipper.^{4,25,29} One study assessed reduction quality using the Garden alignment index,^{26,30} as enumerated in Table 3. While different authors used different criteria, the conclusions they reached were consistent.

Harris Hip Score

Function, as the most important prognostic criterion, was our primary outcome. A total of 6 articles reported the HHS of patients at different times. Five articles recorded specific scores, as enumerated in Table 4. All studies found no difference between the two groups. In Yan's study, with at least one year of follow-up, the HHS in the non-traction table group was excellent in 10 patients (17.9%), good in 36 (64.3%), fair in 8 (14.3%), and poor in 2 (3.6%). Similar

Table 3 Reduction Quality

Study	Traction Table	Non-Traction Table	Conclusion
Doğan ²²	Good (31) Acceptable (9) Poor (0)	Good (35) Acceptable (5) Poor (0)	No difference
Sonmez ²³	Good (25) Acceptable (9) Poor (2)	Good (15) Acceptable (18) Poor (4)	No difference
Şahin ⁴	Good (25) Acceptable (8) Poor (1)	Good (18) Acceptable (10) Poor (2)	No difference
Zhao ²⁵	Good (24) Acceptable (10) Poor (2)	Good (25) Acceptable (5) Poor (0)	No difference
Yan ²⁶	Good (19) Acceptable (16) Poor (4)	Good (39) Acceptable (14) Poor (3)	No difference

Table 4 Mean Harris Hip Score (Mean \pm SD)

Study	Traction Table	Non-Traction Table	Follow Up	Conclusion
Doğan ²²	77.62 \pm 16.55	76.95 \pm 17.6	At least 1 year	No difference
Şahin ⁴	71.7 \pm 8.4	69.6 \pm 6.7	6 months	No difference
Zhao ²⁵	79.03 \pm 9.38	77.4 \pm 9.81	At least 1 year	No difference
Du ²⁷	84.1 \pm 6.1	86.2 \pm 5.9	At least 1 year	No difference
Li ²⁴	88.1 \pm 5.2	87.2 \pm 6.4	At least 1 year	No difference

Table 5 Mean Setup Time in Min (Mean \pm SD)

Study	Traction Table	Non-Traction Table	Grouping	Conclusion
Doğan ²²	17.85 \pm 3.52	9.4 \pm 2.24	Traction table/Lateral decubitus	Non-Traction table better
Sonmez ²³	21.69 \pm 5.4	17.65 \pm 4.16	Traction table/Lateral decubitus	Non-Traction table better
Şahin ⁴	29.0 \pm 2.4	18.0 \pm 1.6	Traction table/Manual traction	Non-Traction table better
Li ²⁴	45.2 \pm 4.1	14.6 \pm 1.5	Traction table/Lateral decubitus	Non-Traction table better

results were obtained with the traction table group, which were excellent in 8 patients (20.5%), good in 24 (61.5%), fair in 6 (15.4%), and poor in 1 (2.6%).²⁶

Secondary Outcomes

Setup Time

The period from the transfer of patients from the anesthesia group to the surgery group until the skin incision was defined as the setup time. Four of the eight studies reported the setup time as we defined it. As enumerated in Table 5, there was a significant difference between the groups in all the studies. The non-traction table group has a clear advantage in terms of setup time.

Amount of Bleeding

Six of the eight studies reported the amount of bleeding. The amount of bleeding reported by different studies varied greatly, which may be mainly due to the different types of implants used in the different studies or differences in surgical proficiency. As enumerated in Table 6, most studies concluded that there was no difference in the amount of bleeding between the traction table group and the non-traction table group.

Fluoroscopy Exposure Time

Five of the eight studies reported fluoroscopy exposure, three of the studies reported the fluoroscopy exposure time^{4,22,23} and two studies reported the frequency of fluoroscopy exposure.^{24,27} As enumerated in Table 7, Although studies are similar, reports have reached different conclusions, fluoroscopy time remaining the same,⁴ decreasing,^{23,24,27} or increasing.²² Fluoroscopy exposure time may vary depending on surgical technique or fracture types.

Table 6 Mean Amount of Bleeding in ml (Mean \pm SD)

Study	Traction Table	Non-Traction Table	Type of Implant	Conclusion
Doğan ²²	120.0 \pm 35.44	138.46 \pm 50.6	PFN	No difference
Şahin ⁴	195.2 \pm 11.3	202.3 \pm 23.7	Inter-TAN	No difference
Zhao ²⁵	274.2 \pm 178.64	225.0 \pm 127.14	PFNA	No difference
Yan ²⁶	154.1 \pm 38.9	168.9 \pm 49.7	PFNA	No difference
Du ²⁷	215.81 \pm 27.17	178.68 \pm 28.69	PFNA	Non-Traction table better
Li ²⁴	121.2 \pm 24.8	74.2 \pm 12.3	PFNA	Non-Traction table better

Table 7 Mean Fluoroscopy Exposure Time or Times in Sec (Mean \pm SD)

Study	Traction Table	Non-Traction Table	Type of Implant	Conclusion
Doğan [time] ²²	70.63 \pm 29.07	84.23 \pm 26.12	PFN	Traction table better
Sonmez [time] ²³	41.83 \pm 14.31	35.19 \pm 12.0	PFNA	Non-Traction table better
Şahin [time] ⁴	204.0 \pm 30.0	216.0 \pm 60.0	InterTAN	No difference
Du [times] ²⁷	49.32 \pm 6.35	41.14 \pm 5.29	PFNA	Non-Traction table better
Li [times] ²⁴	12.4 \pm 1.4	6.1 \pm 0.3	PFNA	Non-Traction table better

Discussion

The traction table, lateral decubitus position, and traction repositrator can be used to assist reduction and implant intramedullary nails for intertrochanteric hip fractures. Fixation of these fractures with intramedullary nails is generally considered to be best performed on a traction table. The traction table has the advantages of a large axial traction force, which is conducive to correcting limb shortening and maintaining fracture reduction. However, it also has other shortcomings, such as the use of traction table during the treatment is inconvenient to readjust the reduction of fracture end during the operation. For obese patients, the operation must be ensured by enlarging the surgical incision, and some elderly and frail patients are difficult to tolerate lying on the traction table.^{31,32} Lateral decubitus position and traction repositrator techniques can avoid these shortcomings, so it has attracted more and more attention.

Is nonuse of a traction table-assisted intramedullary nailing of intertrochanteric fractures as safe and effective as a traction table-assisted intramedullary nailing? Our study included eight papers published between 2016 and 2021 that evaluated the radiographic and clinical outcomes of 620 patients with intertrochanteric fractures. The major findings of this systematic review are as follows: 1) no significant differences in the reduction quality or the HHS were observed between the two groups; 2) nonuse of a traction table is advantageous in terms of setup time compared to the use of a traction table; and 3) in terms of surgical time, the amount of bleeding and fluoroscopy exposure time remain controversial.

Intertrochanteric fractures are especially common in elderly patients, and decreasing the setup time and surgical time is an important step in the surgical treatment of high-risk elderly patients. Prolonged anesthesia in elderly patients with additional comorbidities can contribute to increased mortality.^{33,34} We compiled the setup time data of all the studies. The results showed that the non-traction table group could significantly reduce the operation setup time compared with the traction table group. Setup time includes placing the patient on the traction table or surgical table, adjusting the patient's position and sterile covering until the skin is incised. For patients treated with a traction table-assisted intramedullary nailing, the reduction phase and use of fluoroscopy during the reduction were included within the setup time, and the reduction of patients without a traction table-assisted treatment is completed during the operation.³⁵ Therefore, theoretically, patients with a traction table-assisted intramedullary nailing always need more setup time for surgery, while patients without a traction table-assisted treatment will lose some surgical time due to the fracture reduction needs to be completed during surgery.⁴ However, this theory did not translate to surgical data, and we found. Compared with the traction table group, the non-traction table group significantly reduced the operation preparation time, but did not prolong the operation time.

Additional fluoroscopic exposure can cause serious health problems for both the surgical team and the patient, and reducing fluoroscopic exposure time is a topic of concern for surgeons.³⁶ Some studies reported the amount of fluoroscopy as time, and some studies reported it as "shoots".^{4,22,23,27} It is difficult to interpret and comparison of the previous studies' outcomes due to such a discrepancy. One study showed that the duration of fluoroscopy exposure in the non-traction table group was prolonged because it was more difficult to achieve reduction and obtain lateral views without the use of a traction table.²² However, most studies have shown no difference between the two groups or that the non-traction table group had an advantage over the traction table group.^{4,23,24,27} It is worth noting that there is a strong correlation between the amount of fluoroscopy and the degree of comminution of the fracture, and fluoroscopy exposure time may vary depending on skill of the surgical team. In view of the above controversies, we believe that this issue deserves further study. In the operation of hip fractures in the elderly, the amount of bleeding is of great significance to

the incidence of complications and mortality.³⁷ We compiled the amount of bleeding data of all the studies and obtained encouraging results that showed that a traction table was not superior to a non-traction table in terms of the amount of bleeding.

High-quality reduction is critical for attaining the ideal position of the implant and achieving a good clinical outcome.^{8,38} For patients in the non-traction table group, the surgeon can adjust the reduction at each stage of the procedure, the quality of the reduction can be more precisely controlled. For the patients in the traction table group, the adjustment of the reduction was completed during the setup time at the beginning of the operation, and it was difficult to finely adjust the reduction during the operation, as the fine adjustment is made with a nonsterile device.²¹ All of the studies we included found no difference between the two groups in reduction quality, and the good and acceptable rates of the two groups were basically the same (the traction table group was 95.1% and the non-traction table group was 95.3%). Tip-apex distance (TAD) and cervicodiaphyseal angle (CDA) are widely accepted parameters used to evaluate whether the reduction and positioning of the cephalic element in both positioning methods were equivalent. TAD is the distance of subchondral bone in the central portion of the femoral head to the end of the cephalic pin of the nail, shorter than 25 mm are ideal.³⁹ CDA values between 130° and 135° were considered as normal.⁴⁰ In the studies we included, a total of 4 articles reported these two parameter indicators. All studies concluded that there was no difference in TAD between the two groups. The CDA is still controversial (3 studies reported that the CDA of traction table group is significantly smaller than that of non-traction Table 1 study found no difference between the two groups.). In conclusion, the time spent to achieve better reduction may lead to a slightly longer surgical time and increased use of fluoroscopy, but better reduction also leads to better outcomes. The results of all the studies also showed that there was no significant difference in the HHS between the two groups, which fully showed that implanting intramedullary nails for a femoral intertrochanteric fracture without the assistance of a traction table did not affect postoperative rehabilitation. However, it is important to note that the different intramedullary nail designs might be a confounder while comparing different parameters as surgical time, fluoroscopy time and blood loss.

The available data support the effectiveness of the lateral decubitus position and traction repositioner, which seems to be reproducible and safe when compared with conventional traction table techniques. Finally, the traction repositioner is more cost-effective than the traction table, which makes it an ideal substitute for the traction table in primary hospitals.

Limitations

First, this review was limited by the clinical and methodological heterogeneity of included studies and inconsistent outcome reporting. Variability in baseline data, intervention data, and outcome data did not permit the quantitative synthesis of data into a meta-analysis. Second, the relatively few included studies ultimately made it difficult to provide a comprehensive and accurate review. Third, the complication rate is an important indicator in the evaluation of surgical efficacy. Unfortunately, we did not analyze complication rate. Due to the limitations of included studies, we were not able to obtain data of complication rate. Fourth, our paper indicating that implantation without a traction table is safe and reliable was intended to provide clinicians with an overview; however, it does not provide exhaustive detail about any one surgical technique to guide administration or training in any specific surgical technique. Clinicians need to refer directly to the cited article and more widely in the published literature for this information.

Conclusion

Regarding proximal femoral intramedullary nailing for elderly intertrochanteric fractures, treatment without a traction table is equally as safe and reliable as treatment with a traction table, and it may be more advantageous in terms of setup time.

Abbreviations

HHS, Harris Hip Score; RCT, randomized controlled trial; TFN, trochanteric fixation nail; PFN, proximal femoral nail; PFNA, proximal femoral nail antirotation; MD, mean difference; CI, confidence interval.

Data Sharing Statement

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

Ethical Approval

The study was waived by the Ethics Committee of the Honghui Hospital, Xi'an Jiaotong University.

Consent

The work described has not been previously published; it is not under consideration for publication elsewhere; and its publication has been approved by all the co-authors.

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Disclosure

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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