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Review Article

Lateral vs. Supine Positioning for Femoral Intramedullary Nailing: A Systematic Review of Comparative Studies

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Abstract

Femoral shaft fractures are devastating injuries, often resultant from high-energy mechanisms in victims of poly-trauma. Reamed and statically locked intramedullary nailing (IMN) is the definitive treatment modality for femoral shaft fractures. Patients are most commonly positioned either supine or lateral decubitus. There remains considerable concern regarding the safety of lateral positioning in the traumatized patient, particularly in the management of a potentially difficult airway or concomitant C-spine injuries. We therefore undertook a systematic review of intraoperative positioning among patients with femoral shaft fractures following PRISMA guidelines. Title and abstract screening, full text screening, and data abstraction were all completed in duplicate. Methodological Index for Nonrandomized Studies (MINORS) scores were used to evaluate methodological quality. Results: 3018 studies were included in initial screening, with three studies ultimately meeting all inclusion criteria. A total of 1,949 patients were analyzed, with 684 patients treated in lateral positioning and 1,215 patients in supine positioning. Level of agreement was strong across title ($\kappa = 0.872$; 95% CI 0.794 to 0.951), abstract ($\kappa = 0.801$; 95% CI 0.585 to 1.000), and full-text screening ($\kappa = 1.000$). The consensus mean MINORS score of included studies was 17.67 ± 0.58, indicating good to high quality of evidence. Neither patient positioning offered obvious benefits such as fewer complications or shorter operative time. Furthermore, length of admission, days in ICU or on ventilator, and overall morbidity were not found to be significantly different between positions. Lateral positioning for intramedullary nailing of mid-shaft femur fractures appears to be a safe alternative to the standard supine positioning. There is a lack of both prospective and retrospective comparative studies investigating functional clinical outcomes in the literature.

Keywords: trauma, long bone fracture, femur fracture

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Introduction

Femoral shaft fractures are devastating injuries that can result from high-energy mechanisms in victims of poly-trauma. Identifying these injuries is a critical part of a primary trauma survey (1); they demand urgent management to control morbidity secondary to blood loss, inflammation, and pain (2,3). Less commonly, femoral shaft fractures can result from fracture through an area of bone weakened by metastatic disease, so called 'pathologic fracture'. Reamed intramedullary nailing (IMN) is the definitive treatment modality for femoral shaft fractures of any etiology (2–5). There are variations in surgical technique, including antegrade vs. retrograde nailing, variations in optimal entry point, and variations in patient positioning. The predominant positioning for IMN is supine, with the lateral position being infrequently used as it was considered to be unsafe, particularly in patients with blunt chest trauma and concomitant pulmonary injury (6). Instead, the supine position is often favoured as the optimal positioning for anesthetic care, particularly in the case of a C-spine injury or an otherwise compromised airway (7,8).

A fracture or traction table is often used with the supine position for reduction of a femoral shaft fracture. Traction tables are generally only available in the supine position, so in the absence of a traction table, lateral positioning with manual traction is used. In either case, traction is critical to maintain length and reduction of the fracture.

The main advantage of fracture table positioning includes the ability to hold and maintain the reduction for the duration of the procedure without use of an assistant. However, there have been studies that have questioning the superiority of a traction table compared to manual traction. Improved reduction quality has actually been demonstrated with manual traction in supine position compared to fracture table (9,10), likely due to improved ease of manipulation of the fracture fragments. Additionally, some literature suggests that manual traction has a shorter operative time compared to the use of a fracture table, though this has not been definitively shown in direct comparative studies (11,12). Operative time is critical as it may be part of the surgical burden that can provoke the development of systemic complications such as ARDS (Acute Respiratory Distress Syndrome) or SIRS (Systemic Inflammatory Response Syndrome), which are potentially devastating consequences of femoral fractures (2,13). Surgery can be considered an exacerbating 'second hit' of pathophysiologic inflammatory response following the initial traumatic injury (2). Manual traction could mitigate the risk of these complications if it did indeed produce shorter operative times for fixation of femoral fractures.

Some proposed advantages of manual traction in the lateral positioning for IMN of femoral fractures include obviating the need for a fracture/traction table, which is costly, not universally available, and may cause soft tissue complications (14), easier access to entry point, particularly with obese patients (15), and optimal positioning for lateral radiographs with good visualization of the femoral head and proximal femur (16).

To date, the authors are not aware of a review of lateral versus supine positioning for reamed intramedullary fixation of femoral shaft fractures. Hence, the aim of this review was to examine clinical outcomes of intraoperative supine and lateral positioning for intramedullary fixation of femoral shaft fractures in papers directly comparing both groups. The primary hypothesis was that clinically important outcomes are comparable in both positions. The secondary hypothesis was that fewer intraoperative complications and shorter operative times are reported with lateral positioning.

Methods

Search strategy

Two independent reviewers searched EMBASE, MEDLINE (including Epub Ahead of Print), CINAHL, and Web of Science for titles comparing lateral to supine positioning for intramedullary fixation of mid-shaft femur fractures from data inception to May 25, 2018. The purpose, research question, and eligibility criteria for the search were determined *a priori*. Study eligibility criteria are presented in Table 1.

Table 1. Eligibility Criteria

Inclusion Criteria
1. Comparative studies with supine positioning as control 2. Mid-shaft femur fractures 3. Clinical outcomes reported 4. Human studies 5. English language papers
Exclusion Criteria
1. Inverse of inclusion criteria 2. Pediatric or skeletally immature population 3. Results that are not stratified for comparison with supine position outcomes 4. Non-clinical outcomes reported 5. Review, technical, or otherwise non-prognostic articles

The protocol of this systematic review was prospectively registered via the PROSPERO database (ID: CRD42018099373).

Key articles were identified by a senior author prior to the search, all of which were screened for relevant keywords, subject headings, and relevant references. The primary author met with a senior librarian in order to verify that the search strategy was neither too broad nor too narrow, and to verify correct database syntax (Appendix Figure 1; Search Terms). The grey literature was reviewed through keyword searches of conference abstracts from the Orthopedic

Trauma Association (OTA) and the American Association of Orthopedic Surgeons (AAOS) between 2015 and May 2018. Registered clinical trials were screened by duplicate keyword searches of the clinicaltrials.gov website and the online International Standard Registered Clinical/soCial sTudy Number (ISRCTN) database.

Study screening

A systematic screening approach was undertaken in accordance with R-AMSTAR and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) (17) criteria from title to full text screening. Screening was performed by two independent reviewers (M.S. and S.Z) in duplicate. In the case of screening disagreement at the title and abstract stage, titles were automatically included in the next stage. At the full text stage, discrepancies were resolved by consensus decision with input from an independent senior reviewer (H.J).

Quality assessment

Quality and reporting assessment of included non-randomized papers were performed in duplicate using the Methodological Index for Non-Randomized Studies (MINORS) (18), a validated appraisal tool based on study design features such as inclusion of consecutive patients and prospective collection of data. 12 items on the MINORS checklist are each scored 0-2, with maximum scores of 16 for non-comparative studies and 24 for comparative studies. Scoring for MINORS was done via consensus decision.

Data abstraction & statistical analysis

Data abstraction was performed independently in duplicate (M.S and S.Z.) for all included studies and recorded in separate Google Docs spreadsheets. The spreadsheets were combined, and discrepancies were resolved by consensus decision. Inter-reviewer agreement was calculated for each stage, including MINORS, with a Kappa (κ) statistic. Agreement was categorized *a priori* as follows; 0.20 or less; poor, 0.21 to 0.40; fair, 0.41 to 0.60; moderate, 0.61 to 0.80; substantial, and 0.81 to 0.99; excellent. Study data were presented descriptively with means, proportions, and measures of variance when provided in the original source papers.

Results

Study Quality

There was substantial agreement amongst reviewers at each screening stage; title ($\kappa = 0.872$; 95% CI 0.794 to 0.951), abstract ($\kappa = 0.801$; 95% CI 0.585 to 1.000) and full-text ($\kappa = 1.000$).

Scoring of MINORS criteria demonstrated moderate agreement (κ = 0.663; 95% CI 0.433 to 0.893). Following discussion, the consensus mean MINORS score of included studies was 17.67 ± 0.58.

Study and Patient Characteristics

Based on the search strategy, 3,085 papers were identified. Three full texts met inclusion criteria (Table 1). Manual, grey literature, and registered trial searching did not yield any additional papers. All included studies were level III evidence in the form of retrospective cohort studies. One study was conducted in Canada (19), one in Turkey (20), and one in the USA (21). All included studies were published within the last decade, between 2009 and 2018.

This review analyzed a total of 1,949 patients, with 684 patients in the study sample (lateral positioning) and 1,215 patients in the control sample (supine positioning). Patient characteristics are presented in Table 2. In the lateral position, 74.4% were male, while in the supine position, 67.4% of the patients were male. The weighted mean age of the two groups were comparable at 36.7 ± 19.4 (n = 684) for lateral positioning, and 39.5 ± 20.6 (n = 1215) for the supine sample.

All included studies reported data on patient demographics. There were no significant differences in the mean age or gender of included patients, save for one study where the lateral group had a younger mean age (35.8 vs. 40.1), which was “not deemed to be clinically significant” (19). Two studies (19,21) reported injury severity score (ISS) and abbreviated injury score (AIS) scores. The only significant difference found in these scores was a higher mean AIS chest score in the lateral (2.2 +/- 1.7) compared to the supine group (1.5 +/- 1.9) (P=0.01).

Table 2. Overview of selected studies

Author	**Published**	**Study design**	**Total Sample Size (patients)**	**Number of males (%)**	**Mean age (years)**	**Follow up**	**Mean MINORS score**
Apostle et al.	2009	Retrospective Cohort Study	988	(Lateral) 65.4 (Control) 65.8	(Lateral) 35.8 (Control) 40.1	NR	18
Firat et al.	2012	Retrospective Cohort Study	63	(Lateral) 63.7 (Control) 70	(Lateral) 37.3 (Control) 38.1	46 months	17
Reahl et al.	2018	Retrospective Cohort Study	848	(Lateral) 65.3 (Control) 70.5	(Lateral) 37.1 (Control) 38.4	NR	18

NR = Not reported

Surgical technique

Operative technique was reported to varying degrees of specificity (Table 3). All included studies reported the same surgical technique was used for both lateral and supine groups; and used reamed statically locked intramedullary nailing for both groups. In terms of approach, two studies utilized antegrade nailing (19,20) while Reahl et al. used a combination of both antegrade and retrograde nail placement depending on surgeon preference (Table 3) (21).

Lateral positioning involves specific positioning details, such as placing the patient on a radiolucent table with a bean bag, fracture side up. C-arm positioning for a true lateral is obtained by adjusting 10-20 degrees beyond perpendicular to match the anteversion of the femoral neck. After dissecting tissue to the entry point of the nail, the appropriate reduction technique depends on the nature of the fracture. A detailed exploration of surgical technique is beyond the scope of this article and other papers have been published detailing unique technical aspects of the lateral approach to various femoral fractures (6,16).

Supine and lateral positions across all studies were stated to be standard, with the exception of the study by Firat et al. (20). In their supine position, the uninjured leg was raised in a semilithotomy position with the knee at 45-90 degrees flexion, and the hip at 45-90 degrees flexion and 30-45 degrees abduction.

Table 3. Overview of operative information

Author	Surgical Approach	Reaming and Locking	Site of entry	Positioning (study; control)
Apostle et al.	Antegrade	Reamed and statically locked	NR	Lateral standard; Supine standard
Firat et al.	Antegrade	Reamed and statically locked	Piriform	Lateral standard; Supine contralateral leg elevated (SCLE)*
Reahl et al.	Antegrade and Retrograde	Reamed and statically locked	NR	Lateral standard; Supine standard

NR = Not reported
*SCLE positioning has uninjured leg elevated in semilithotomy position with knee at 45-90 degrees flexion and hip at 45-90 degrees flexion and 30-45 degrees abduction. It also uses manual traction on the affected limb (20).

Operative time

The study by Firat at el. reported a significantly shorter operating room time in SCLE position in comparison to the lateral position at 98.4 minutes and 108.2 minutes, respectively (20). No other studies reported operative time.

Indications

Indications for supine or lateral positioning were not specified across the included studies. Reahl et al. did not specify reasons for positioning (21), Apostle et al. reported different positioning was due to surgeon preference (19), and Firat et al. reported positioning was due to integration of a newly acquired skill of performing femoral nailing in the SCLE position (20).

Patient Morbidity

Results for different measures of morbidity were reported heterogeneously across all included studies. However, the studies by Apostle et al. and Reahl et al. reported similar outcomes (19,21). Apostle et al. measured patient morbidity with admission into intensive care unit (ICU) and length of stay (LOS) in the ICU (19) while Reahl et al. collected information regarding patient's the length of stay in the ICU and days of ventilator use as an indirect indicator of pulmonary complications (21).

With regards to patient ICU admission, Apostle et al. reported lower admission in the supine position at 11.9% of patients in comparison to 12.8% of the laterally positioned patients (Table 4) (19). This difference was not found to be statistically significant in the study, however a subgroup analysis of patients with AIS≥3 found that lateral positioning was protective against ICU admission ($P=0.044$). Apostle et al. reported no statistically significant difference in mean LOS when comparing supine and lateral positioning (19).

Reahl et al. reported a significantly decreased length of ICU LOS in the lateral position in comparison to supine control (Table 4) (21). They also found a mean 1.29 days shorter postoperative time on a ventilator in the lateral group, though this was not statistically significant.

Patient Mortality

Patient mortality was only reported by Apostle et al., monitored at up to 115 days post-operatively (19). There was a higher rate of patient mortality in the supine positioning, however this was not significant and had an odds ratio near 1 (Table 4).
The most common cause of death was progression of metastatic disease, followed by head injury and sepsis leading to multiorgan failure. Two deaths were attributed to fat embolism syndrome (FES), both of which were in the supine sample.

Complications

Post-operative complications, specifically leg length discrepancy, malalignment, and malrotation were reported in one study by Firat et al. (20). They found no difference in coronal-sagittal malalignment between the lateral and supine groups. Mean difference in limb length was +0.4mm (range -14 to +17mm) in the SCLE group and -1.6mm (range -12 to +14mm) in the lateral group, with no statistically significant difference found in subgroups. Of patients who experienced leg length discrepancy, a significantly higher number of patients had leg shortening of less than 10mm in the lateral group compared to the SCLE group (10% SCLE group vs. 30% lateral group, $p<0.001$). However, the percentage of patients with malrotation was higher in the laterally positioned group, with the mean rotation difference in the lateral group being internal while the SCLE group had an external mean rotational difference (mean +1.2 degrees in SCLE group vs. mean -2.6 degrees in lateral group). This difference has an unknown statistical significance, although there was a significantly higher number of patients with >15^{o} of internal malrotation in the lateral group in comparison to the SCLE group ($p<0.001$).

Table 4. Overview of patient outcomes

Author	Lateral Position Sample	Supine Position Sample	ICU admission (%)	ICU LOS (days)	Ventilator (days)	Mortality (%)	Leg length discrepancy (%)	Malrotation (%)
Apostle et al.	227	761	(Lateral) 12.8 (Control) 11.9	(Lateral) 1.7 (Control) 1.1	NR	(Lateral) 1.8 (Control) 3.0	NR	NR
Firat et al.	33	30	NR	NR	NR	NR	(Lateral) 36.7 (Control) 45.5	(Lateral) 57.6 (Control) 50.0
Reahl et al.	424	424	NR	(Lateral) 1.64 (Control) 3.63	(Lateral) 2.89 (Control) 4.18	NR	NR	NR

NR = Not Reported

Discussion

Findings

Findings of this review suggest that lateral positioning is a safe alternative to the standard supine approach. One article (19) found that lateral positioning was not associated with an increased risk of mortality or ICU LOS, and may actually be protective against ICU admission in patients with AIS greater than 3. Another large retrospective cohort in this review (21) found that lateral positioning yielded a mean 1.88 days shorter ICU stay, with a mean 1.29 fewer days with ventilator support.

Intraoperative advantages, including ease of access to entry point and optimal imaging, were not directly assessed in the included papers. Though shorter operative time may be a proxy for these measures, this was only reported in Firat et al. (n=63) and was indeed shorter in the lateral group (20). Additionally, although anesthesia-related complications have been raised as a concern for lateral positioning, no such direct complications were reported in the included papers. Thus, the aforementioned mortality outcomes do demonstrate the overall safety of this positioning for mid-shaft femur fractures.

No papers included reported functional outcomes or long-term measures such as union rate, re-operation, or pain. Complications of lateral positioning were poorly defined by the included studies. Only one paper (20) reported malrotation and limb length discrepancy, demonstrating decreased limb length discrepancy, yet increased malrotation, in the lateral position. Angular malalignment was found to be similar in both groups. However, this article had a small study sample (n=33) and was comparing lateral positioning to a novel technique (SCLE). No other intraoperative complications were reported. No conclusions could be made about operating time as the measure was only reported in one paper (n=33) which compared lateral positioning to a novel modified (SCLE) supine approach (20). Literature on supine positioning suggests that manual traction reduces operating time compared to the use of a fracture table (11,12), however, there is no definitive literature regarding operative time required for lateral positioning.

Apostle et al. was the only paper including pathologic femur fractures in their analysis (19). They found no association between mortality in this population and surgical positioning, finding mortality to be the result of progression of already existing metastatic disease.

Strengths and limitations

This review only included papers that directly compared lateral positioning to the standard supine position. Hence the comparisons yielded in this review are standardized by time, institution, and methods, thereby minimizing variability. Though few papers are included in this review, there is a large total sample size with robust methodology for included papers, as evidenced by the high mean MINORS score.

The high heterogeneity in outcome measures among studies precluded a meta-analysis or data pooling of any kind. All included studies were retrospective and thus treatment allocation was not randomized, which introduces a source of bias. Despite large samples, the main outcomes addressed by these papers, such as ICU admission and mortality, have a low incidence, making it difficult to draw statistically significant conclusions from the results. This is compounded by the fact that these outcomes are multifactorial and that all studies included poly-traumatized patients who may have had severe concomitant injuries.

Lateral positioning appears to be a valuable tool in the surgeon’s armamentarium, with reported advantages including circumferential access to the affected limb, ease of conversion to an extensile approach if needed, and increased access to the piriformis fossa (6,16,19). The advantage of easier access to an entry point is particularly relevant in the context of the increasing global prevalence of obesity (6,22–24). Challenges associated with this technique include difficulty accessing distal third femoral fractures and decreased access for anesthesia. Some contraindications for lateral positioning are unstable spinal injuries and pulmonary pathology (6).

The principal findings of this paper are not related to functional outcomes, but rather to safety. This paper confirms that, particularly in resource-scarce settings where access to an expensive traction table may not be available, cost is not traded for mortality with lateral positioning.

Further comparative research evaluating functional outcomes, especially with subgroup analyses of obese patients and other groups, would be valuable in further elucidating the role for this positioning in treating femoral fractures. Such studies may also clarify whether the proposed intraoperative advantages of lateral positioning with manual traction, for instance decreased operative time, are materially significant.

Conclusion

Lateral positioning for intramedullary nailing of mid-shaft femur fractures appears to be a safe alternative to the standard supine positioning. There is a lack of both prospective and retrospective comparative studies investigating functional clinical outcomes in the literature.

References

1. Trunkey D. Initial Treatment of Patients with Extensive Trauma. *N Engl J Med*. 1991;324(18):1259-1263. doi:10.1056/NEJM199105023241806

2. Gänsslen A, Gösling T, Hildebrand F, Pape HC, Oestern HJ. Femoral shaft fractures in adults: treatment options and controversies. *Acta Chir Orthop Traumatol Cech*. 2014;81(2):108-117.

3. Bone LB, Johnson KD, Weigelt J, Scheinberg R. Early versus delayed stabilization of femoral fractures. A prospective randomized study. *J Bone Joint Surg Am*. 1989;71(3):336-340.

4. *The Science and Practice of Intramedullary Nailing*. 2nd ed. Baltimore: Williams & Wilkins; 1996.

5. O'Brien PJ, Meek RN, Powell JN, Blachut PA. Primary intramedullary nailing of open femoral shaft fractures. *J Trauma*. 1991;31(1):113-116.

6. Bishop JA, Rodriguez EK. Closed intramedullary nailing of the femur in the lateral decubitus position. *J Trauma*. 2010;68(1):231-235. doi:10.1097/TA.0b013e3181c488d8

7. Johnson KD, Greenberg M. Comminuted femoral shaft fractures. *Orthop Clin North Am*. 1987;18(1):133-147.

8. Aiyer S, Jagiasi J, Argekar H, Sharan S, Dasgupta B. Closed antegrade interlocked nailing of femoral shaft fractures operated up to 2 weeks postinjury in the absence of a fracture table or C-arm. *J Trauma*. 2006;61(2):457-460. doi:10.1097/01.ta.0000210269.05305.75

9. Stephen DJG, Kreder HJ, Schemitsch EH, Conlan LB, Wild L, McKee MD. Femoral intramedullary nailing: comparison of fracture-table and manual traction. a prospective, randomized study. *J Bone Joint Surg Am*. 2002;84-A(9):1514-1521.

10. Jaarsma RL, Pakvis DFM, Verdonschot N, Biert J, van Kampen A. Rotational malalignment after intramedullary nailing of femoral fractures. *J Orthop Trauma*. 2004;18(7):403-409.

11. Rohilla R, Singh R, Rohilla S, Magu NK, Devgan A, Siwach R. Locked intramedullary femoral nailing without fracture table or image intensifier. *Strateg Trauma Limb Reconstr*. 2011;6(3):127-135. doi:10.1007/s11751-011-0122-3

12. Karpos PA, McFerran MA, Johnson KD. Intramedullary nailing of acute femoral shaft fractures using manual traction without a fracture table. *J Orthop Trauma*. 1995;9(1):57-62.

13. Pape H-C, Hildebrand F, Pertschy S, et al. Changes in the Management of Femoral Shaft Fractures in Polytrauma Patients: From Early Total Care to Damage Control Orthopedic Surgery. *J Trauma Acute Care Surg*. 2002;53(3):452.

14. A Flierl M, Stahel P, Hak D, J Morgan S, Smith W. *Traction Table-Related Complications in Orthopaedic Surgery*. Vol 18.; 2010. doi:10.5435/00124635-201011000-00004

15. Winquist RA, Hansen ST. Comminuted fractures of the femoral shaft treated by intramedullary nailing. *Orthop Clin North Am*. 1980;11(3):633-648.

16. Carr JB, Williams D, Richards M. Lateral Decubitus Positioning for Intramedullary Nailing of the Femur Without the Use of a Fracture Table. *Orthopedics*. 2009;32(10). doi:10.3928/01477447-20090818-05

17. Kung J, Chiappelli F, Cajulis OO, et al. From Systematic Reviews to Clinical Recommendations for Evidence-Based Health Care: Validation of Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) for Grading of Clinical Relevance. *Open Dent J*. 2010;4:84-91. doi:10.2174/1874210601004020084

18. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. *ANZ J Surg*. 2003;73(9):712-716.

19. Apostle KL, Lefaivre KA, Guy P, et al. The Effects of Intraoperative Positioning on Patients Undergoing Early Definitive Care for Femoral Shaft Fractures. *J Orthop Trauma*. 2009;23(9):615. doi:10.1097/BOT.0b013e3181a6a941

20. Firat A, Tecimel O, Deveci A, Ocguder A, Bozkurt M. Surgical Technique: Supine Patient Position With the Contralateral Leg Elevated for Femoral Intramedullary Nailing. *Clin Orthop*. 2013;471(2):640-648. doi:10.1007/s11999-012-2722-8

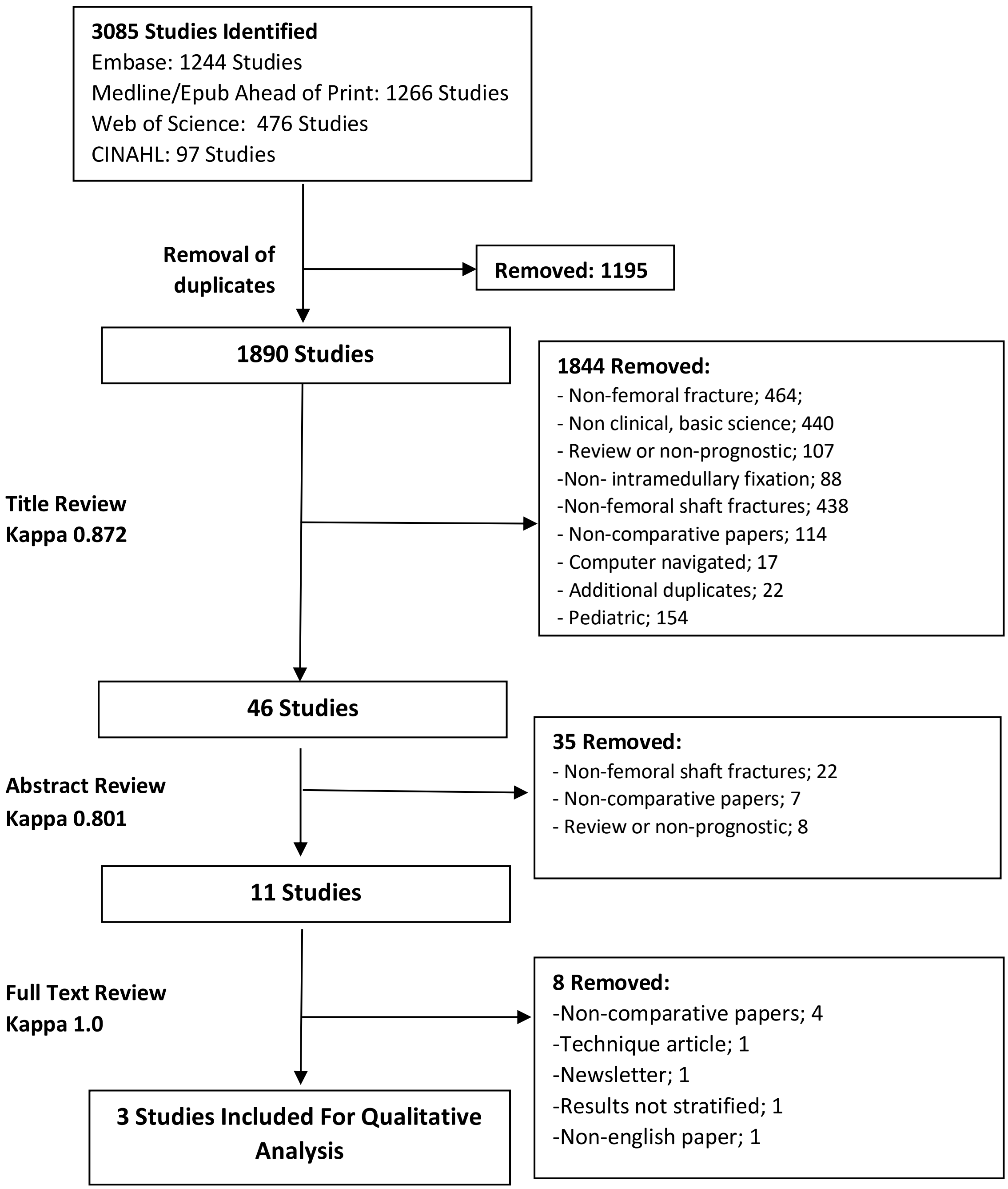
21. Reahl GB, O’Hara NN, Coale M, et al. Is Lateral Femoral Nailing Associated With Increased Intensive Care Unit Days? A Propensity-Matched Analysis of 848 Cases. *J Orthop Trauma*. 2018;32(1):39-42. doi:10.1097/BOT.0000000000000999

22. Wild S, Roglic G, Green A, Sicree R, King H. Global Prevalence of Diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27(5):1047-1053. doi:10.2337/diacare.27.5.1047

23. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of Obesity and Trends in the Distribution of Body Mass Index Among US Adults, 1999-2010. *JAMA*. 2012;307(5):491-497. doi:10.1001/jama.2012.39

24. Caballero B. The Global Epidemic of Obesity: An Overview. *Epidemiol Rev*. 2007;29(1):1-5. doi:10.1093/epirev/mxm012

APPENDIX



Appendix Figure 1. Systematic Search Flowchart

Appendix Table 1. Search Terms

Embase (1244 titles)	Medline[1] (1266 titles)
1. intramedullary nailing/ or ((intramed* or IM) adj4 fix*).ti,kw,ab. or ((intramed* or IM or inter* or Kuntscher or gamma) adj4 (nail* or rod)).ti,kw,ab. or bone nail/ 2. exp femur/ or (femur or femor* or leg).ti,kw,ab. or femur fracture/ 3. (lateral* or decub* or side or slopp* or (free* adj3 leg*)).ti,kw,ab. 4. 1 and 2 and 3 5. 4 not animals/ not (humans/ and animals/) 6. limit 5 to "review" 7. 5 not 6	1. Fracture Fixation, Intramedullary/ or ((intramed* or IM) adj4 fix*).ti,kf,ab. or ((intramed* or IM or inter* or Kuntscher or gamma) adj4 (nail* or rod)).ti,kf,ab. or Bone Nails/ 2. exp FEMUR/ or (femur or femor* or leg).ti,kf,ab. or Femoral Fractures/ 3. (SUPINE POSITION/ or flat.mp. or recumbent.mp. or supin*.mp. or reclin*.mp. or prostrat*.mp. or (fracture adj2 table).mp.) and (lateral* or decub* or side or slopp*).mp. 4. 1 and 2 and 3 5. 4 not animals/ not (humans/ and animals/) 6. limit 5 to "review articles" 7. 5 not 6
Web of Science (476 titles)	**CINAHL (97 titles)**
TOPIC ((intramed* OR IM OR inter OR Kuntscher OR gamma) NEAR/2 (fix* OR nail* OR rod*)) AND TOPIC: (femur* OR femor*) AND TOPIC: (lateral* OR decub* OR side OR slopp* OR (free* NEAR/2 leg*)) Refined by: DOCUMENT TYPES: (ARTICLE OR MEETING ABSTRACT)	((MH "Femur+") OR (MH "Femoral Fractures+") OR fem?r*) AND ((intramed* N3 (nail* OR rod*)) OR (im N3 (nail* OR rod*)) OR (gamma N3 nail* OR Kuntscher) OR (inter* N3 (nail* OR rod)) OR (intramed* N3 fix*)) AND ((MH "Lateral Position") OR lateral* OR decub* OR side OR slopp* OR (free* N3 leg*))

Ti, kw, ab = Term appears in title, keywords, or abstract
Mp = Term appears in title, abstract, subject heading, author keywords, or other category
[1]OVID Medline Epub ahead of print, in-process & other non-indexed citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present