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Original Article

Is distal locking of long nails for intertrochanteric fractures necessary? A clinical study

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ABSTRACT

Background: Few clinical studies have examined the utility of distal interlocking nails when fixing intertrochanteric fractures with intramedullary devices. In this study we performed a retrospective analysis comparing fixation method of intertrochanteric fractures with either a long unlocked cephalomedullary nail versus a long locked cephalomedullary nail. Our hypothesis was there would be no difference in device related failures or complications in stable intertrochanteric fractures treated with long locked or long unlocked cephalomedullary nails.

Methods: A retrospective chart review was performed of all stable intertrochanteric fractures treated with a long cephalomedullary nail between 2006 and 2012 at our institution. Clinical history as well as perioperative radiography was carefully reviewed for all subjects. AO classification, the use of locked or unlocked technique, and failure status was recorded.

Results: Overall, a device related failure rate of 1.8% (2/107) was observed for stable intertrochanteric fractures treated with long cephalomedullary nails. No statistical difference in failure rate was found between locked and unlocked nails within our studied population (0% long locked (0/56) versus 3.9% long unlocked (2/51), $p = 0.224$).

Conclusion: This clinical study supports our hypothesis that long cephalomedullary nails do not need to be locked for stable intertrochanteric fractures. We found no difference in failure rates between the two approaches across 107 patients.

1. Introduction

It is estimated that the number of hip fractures worldwide will increase from 1.26 million in 1990 to 2.6 million in 2025 and 4.5 million in 2050.[1–3] Intertrochanteric hip fractures account for approximately one half of all hip fractures.[4] For stable intertrochanteric hip fractures (AO classification A1.1, A1.2, A1.3) a fixed angle device in combination with a dynamic sliding lag screw is the favored treatment.[5] The sliding lag screw can be

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used in combination with an intramedullary nail i.e "cephalomedullary nail" or an extramedullary side plate i.e. "dynamic hip screw".[6]

Antegrade intramedullary nailing of intertrochanteric fractures incorporating a short nail with a large screw inserted into the femoral neck and head for interlocking was introduced by Halder in the 1980s in the form of the cephalomedullary nail.[7] Early reports suggested some substantial advantages in association with this type of fixation, including a minimally invasive surgical technique, shortened operating times, decreased blood loss, improved biomechanics, greater stability of fixation, earlier patient mobilization, and shorter lengths of stay.[8,9] The device was redesigned in 1997 with a smaller lateral bend, a shorter overall length, and only one distal interlocking screw. A longer, full-length version of the nail was also developed. Several companies have established versions of this device.[10]

Sliding compression hip screws have been directly compared with intramedullary fixation in many studies. The usage rate of intramedullary nail fixation for intertrochanteric fractures increased from 3% in 1999 to 67% in 2006 despite a lack of evidence in the literature supporting the change.[10] Presently, both short and long intramedullary nails are accepted treatment options for various intertrochanteric fractures. In comparing the two forms, some studies suggest that fractures fixed with long nails may be less prone to subsequent "periprosthetic" fracture.[11] At our institution we primarily use long cephalomedullary nails for the treatment of intertrochanteric fractures.

Few studies have looked at the utility of distal interlocking nails when fixing intertrochanteric fractures with intramedullary devices. In theory, cortical contact across the fracture site is achieved postoperatively as most of the compressive loads are borne by the bony cortex.[12] In stable intertrochanteric fractures, where by definition of the fracture pattern there is cortical apposition by definition of the fracture pattern, sufficient stability is likely present without the aid of a distal locking screw. The combination of this theoretical overdesign, along with our recent biomechanical studies (Kane et al.), has prompted the use of unlocked long cephalomedullary nails for stable intertrochanteric fractures at our institution.[13] In this study we performed a retrospective analysis comparing fixation method of intertrochanteric fractures with a long unlocked cephalomedullary nail versus a long locked cephalomedullary nail. Our hypothesis was there would be no difference in device related failures (DRF) or complications in stable intertrochanteric fractures treated with long locked or long unlocked cephalomedullary nails.

2. Methods

2.1. *Data collection*

Our Institutions IRB committee approved this study. Each patient's consent for the print and electronic publication of their case description was obtained. A retrospective chart review was performed of all stable intertrochanteric fractures treated with a cephalomedullary nail between 2006 and 2012. CPT code 820.21 was employed to perform an initial query. Subsequently, patients with fractures of types A1.1, A1.2, A.3 were identified and considered for further assessment only if sustained as an isolated injury on the extremity. Similarly, all patients fixed with a short nail ($n = 36$) were removed from the query.

Clinical history as well as perioperative radiography was carefully reviewed for all subjects. AO classification, the use of locked or unlocked technique, and failure status was recorded. A DRF was defined as requiring a return to the operating room for modification of the cephalomedullary nail or substitution to another fixation modality secondary to hardware failure. Cases that returned to the operating room resulting from patient-centric complaints (pain, loss of motion) were also recorded, however, such cases were considered complications as opposed to DRF.

2.2. *Surgical management*

All operations were performed at the same institution under the orthopedic trauma service. A Gamma 3 nail (Stryker, Mahwah NJ) was universally employed for repair of stable intertrochanteric fractures. Post-operatively, all patients were weight-bearing as tolerated and evaluated by physical therapy post-operative day one or when medically stable.

2.3. *Statistical analysis*

Fisher's exact test was used to evaluate outcome differences between the long locked and long unlocked cohorts (STATA, College Station, TX). In all cases, statistical significance was set to $p < 0.05$ *a priori*.

3. Results

In total, 107 subjects were identified that met inclusion criteria after undergoing long cephalomedullary nail fixation for a stable intertrochanteric fracture. A nearly equal number of locked (56) versus unlocked (51) nails were placed (Table 1) across all stable AO classifications. A1.2 was the most common type of intertrochanteric fracture observed amongst the studied patient population.

Overall, a DRF rate of 1.8% (2/107) was observed for stable intertrochanteric fractures fixed with long cephalomedullary

Table 1 – This table demonstrates the classification distribution of intertrochanteric fractures in our study.

AO classification	Number
1.1 ($n = 25$)	
Locked	10
Unlocked	15
1.2 ($n = 61$)	
Locked	33
Unlocked	28
1.3 ($n = 21$)	
Locked	13
Unlocked	8
Total	107

nails at a minimum of 1 year follow-up. No difference in failure rate was found between locked and unlocked nails within our studied population (0% long locked (0/56) versus 3.9% long unlocked (2/51), $p = 0.224$) (Table 2).

Of the total cases requiring secondary intervention ($n = 4$), an equal number was observed between DRF secondary to hardware and patient related complications (Table 3). Again, no difference was identified in complication rates between the two constructs (1.8% long locked (1/56) versus 2.0% long unlocked (1/51), $p = 0.224$) (Table 2). The cases requiring secondary operations are described below:

3.1. *Case 1*

94 year old male sustained an intertrochanteric hip fracture secondary to a fall down a set of stairs. A long unlocked gamma nail was placed with a 110 mm lag screw. The fracture site was compressed. Two and a half years after the initial surgery, the patient continued to have lateral hip pain over the Iliotibal band. Patient underwent bursectomy and revision to a 95 mm lag screw.

3.2. *Case 2*

80 year old female sustained a left intertrochanteric hip fracture secondary to fall. Underwent gamma nail fixation with a long unlocked construct. Tip-apex distance was 46.7, as demonstrated in Fig. 1. Fracture fixation failed secondary to cutout of the lag screw 4 months after initial fixation. Revision to calcar replacing hemiarthroplasty was required.

3.3. *Case 3*

82 year old female who sustained a left intertrochanteric hip fracture secondary to a fall. Underwent fixation with a long unlocked gamma nail and 100 mm lag screw. Five months after initial surgery, patient underwent exchange of the lag screw to a shorter 85 mm screw due to trochanteric bursitis. Patient developed avascular necrosis (Fig. 2) of the femoral head and was revised to a total hip arthroplasty after healing of her original fracture.

3.4. *Case 4*

83 year old female who sustained a left intertrochanteric hip fracture secondary to a fall. Underwent fixation with a long locked gamma nail and a 90 mm lag screw. Three months after initial surgery, the lag screw was revised to a 75 mm screw due to trochanteric bursitis.

Table 2 – This table demonstrates the distribution of cases requiring secondary operations due to a hardware failure or a patient-related complication.

Type	Percent (number)
DRF	
Locked	0% (0/56)
Unlocked	3.9% (2/51)
Complication	
Locked	1.8% (1/56)
Unlocked	2.0% (1/51)
Total	3.7% (4/107)

4. Discussion

In this study we looked at 107 stable intertrochanteric fractures fixed with a cephalomedullary nail. A near equal number of stable fractures were fixed with a long locked cephalomedullary ($n = 56$) nail versus a long unlocked cephomedullary nail ($n = 51$). Our hypothesis was that there would not be a difference in DRF or complications in stable intertrochanteric fractures treated with locked or unlocked cephalomedullary nails.

When comparing locked and unlocked techniques (0% long locked (0/56) versus 3.9% long unlocked (2/51), $p = 0.224$), we found no observable difference. This overall failure rate obtained at our institution is consistent with previously published data for cephalomedullary nailing independent of locking technique.[3,14,15]

We consider our findings valuable in unveiling an approach to fixing stable intertrochanteric fractures, especially in light of supporting results within previous literature. Our previous biomechanical study (Kane et al.) looked at torsional stability in stable intertrochanteric fractures fixed with locked and unlocked cephalomedullary nails in both initial fractures and in a healed fracture model.[13] The initial fractures treated with unlocked long cephalomedullary nails had a higher yield load than the locked nails. In the healed model there was no difference in the stiffness between the locked and unlocked nails. The similar outcome observed in our clinical study provides increasing support for using unlocked cephomedullary nails for stable intertrochanteric fractures without increasing the rate of DRF.

There are several advantages to not locking a nail when utilizing a long cephalomedullary construct. Difficulty in locating the distal locking screws has prompted conventional technique to include fluoroscopy.[16] Unfortunately, the increased radiation exposure, despite meeting government regulations, comes at a health cost to the operative team and surgeons.[17–20] In a search of the literature, radiation exposure for freehand locking, the method performed at our institution, differs depending on the experience of the surgeon and the staff. Gugala et al. reported a fluoroscopy time of 36 s for placement of two screws in the tibia,[21] whereas Suhm et al. stated intense use of fluoroscopy during freehand locking of 108 s per screw.[22] Additional radiation exposure is not to be taken lightly and is a growing problem among orthopedic surgeons. One study estimates a relative risk for cancer of 5.37 with respect to the general population.[23] Without the need to lock long cephalomedullary nails, extra radiation would be avoided.

Another drawback to locking screws is the introduction of a large defect into the cortex during initial penetration by the trocar, or drill, when accurate positioning is not achieved.[24] The placement of two holes in close proximity produces an area of stress concentration and repeated drilling may lead to screw loosening. The creation of a large defect may also weaken the bone.[25] Our observation has been that if a fracture

Table 3 – This table summarizes the reasons for secondary operations due to either hardware failure or patient-related complications.

Failure type	Reason	Second procedure	Technique	Lag screw placement	TAD
Patient	Pain	Placement of shorter lag screw	Unlocked	Center-low	22.4
Hardware	Cutout	Total hip arthroplasty	Unlocked	Center-high	23.58
Hardware	AVN	Total hip arthroplasty	Unlocked	Center-low	36.7
Patient	Pain	Exchange of lag screw	Locked	High-center	13.94

AVN – Acute Avascular Necrosis.
TAD – Tip-Apex Distance.

occurs in conjunction with a locked cephomedullary nail it usually occurs at the tip of the nail and requires some type of internal fixation. However, with an unlocked nail we have observed that the fracture occurs in the mid-shaft and can be treated with reduction with locking screws in order to fix the fracture (unpublished data).

The extra operative time needed to place the distal interlocks is also an important consideration. Proximal femoral fractures (intertrochanteric and femoral neck) are the most common reason for admission to an acute orthopedic ward.[4] A 2005 study of U.S. hospitals found that operating room charges averaged $62 per min (range $22 to $133/min). These figures are actually higher when extra resources are considered including those specific to the procedure and surgeon as well as anesthesia provider fees. According to the literature, interlocking may add 12 min to a procedure[26] when using the

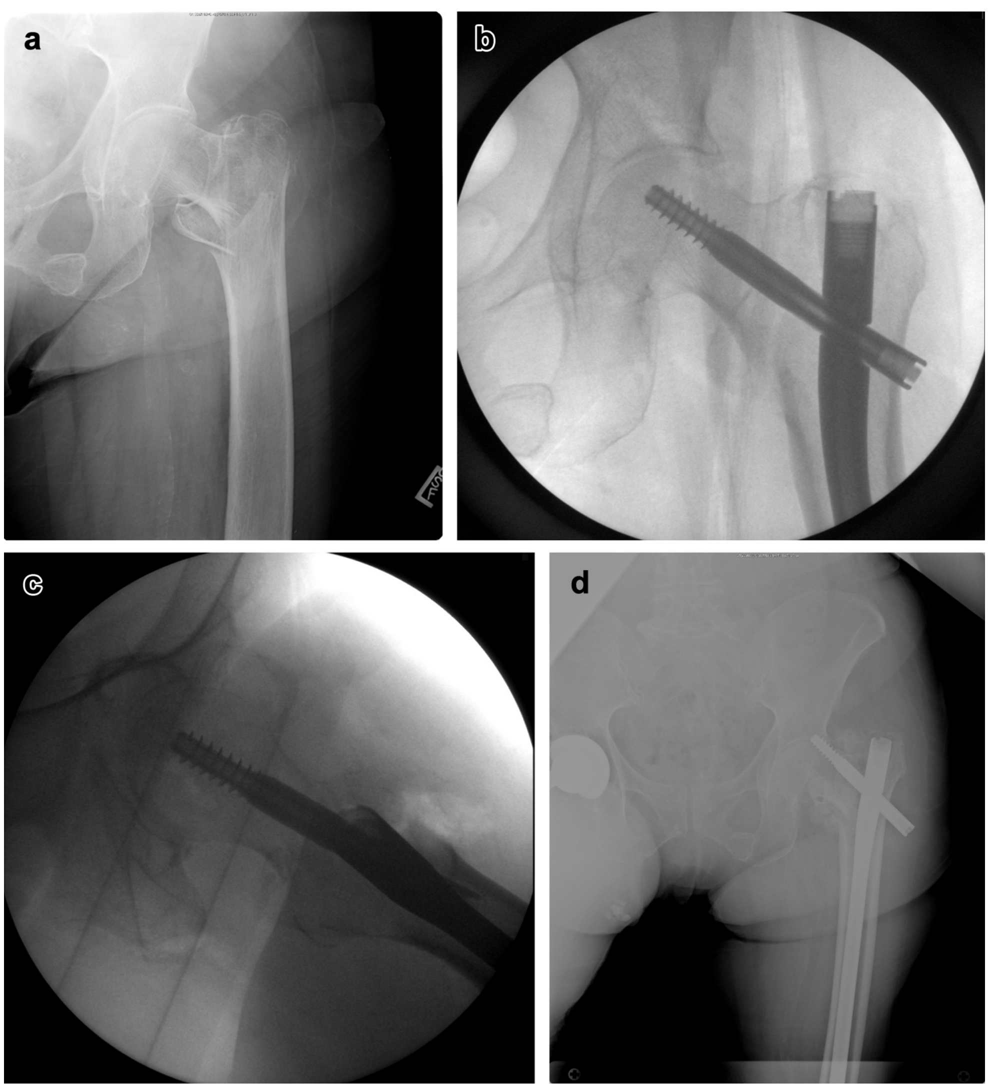

Fig. 1 – a–d: This demonstrates a stable intertrochanteric fracture (a) that was treated with a long unlocked cephomedullary nail that was placed center-high in the femoral head (b, c). The patient went on to cutout, which is seen in (d).

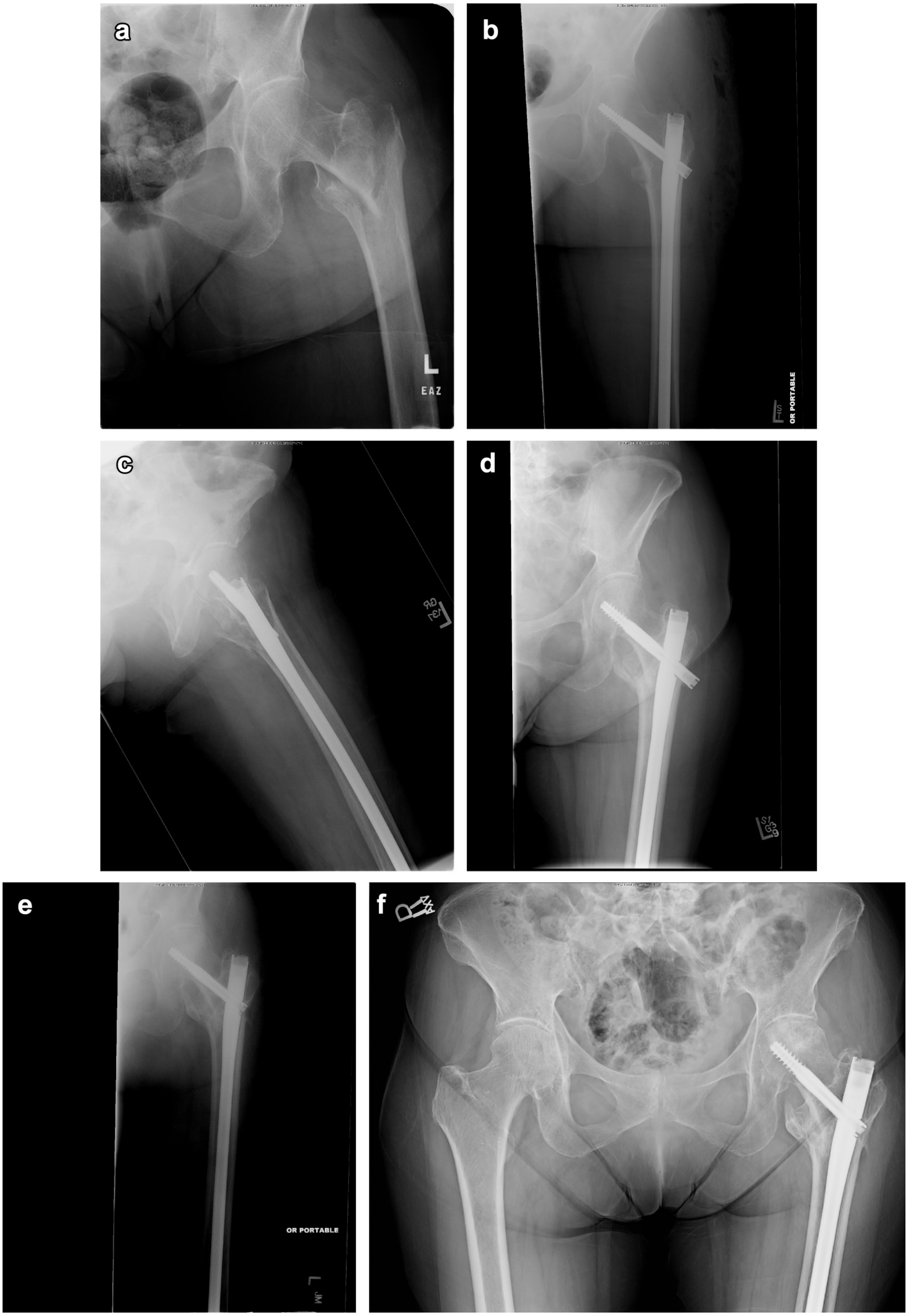

Fig. 2 – a–f: This figure demonstrates a stable intertrochanteric fracture (a) treated with a long unlocked cephomedullary nail (b, c), that caused trochanteric bursitis (d) and was revised to a shorter lag screw (e). The patient then went on to develop avascular necrosis of the hip (f) and was treated with a total hip arthroplasty.

free hand technique, increasing the cost of the operation by approximately $750 when using long nails.

5. Limitations

Our study does not come without limitations. First, this is a retrospective study and we are relying on the information recorded in the charts. To this extent, we acknowledge the variability inherent with a large trauma attending pool overseeing the study population between 2006 and 2012. For example, we were unable to control for patient selection in regards to locking or unlocking the distal part of the nail, as full discretion was with the surgeon. Fortunately, we do not believe this factor impacted our findings given the calculated failure rate is comparable to the literature. We feel this serves to validate the technical approach practiced at our institution across the general treatment team.

We also recognize that the short window (approximately 1 year) of follow-up for a portion of our patients increases the probability of missing failures occurring over a longer-time scale as well as patients who return to other institutions. In response, we again cite our biomechanical study (Kane et al.) that showed no difference between locked and unlocked stiffness in a healed fracture model.[13] Similarly, a meta-analysis found that mean time to secondary fracture following cephalomedullary nail fixation was 1.5 months, a minimum period of follow-up that was exceeded by all our patients.[11]

Lastly, cephalomedullary nailing of intertrochanteric fractures has historically produced low failure rates. Consequently, our study is underpowered to statistically conclude that no difference exists in failure rates between unlocked and locked techniques. Accepting a 5% difference between failure rates, a sample size of 616 is required to achieve adequate power ($\beta = 0.8$, $\alpha = 0.05$). The lack of statistical power, however, does not discredit our findings. First, this is currently the largest retrospective study looking at stable intertrochanteric fractures fixed with an unlocking technique. Second, the failure patterns (lag screw cut-out, avascular necrosis) observed in our unlocked cohort mirrors those frequently cited in the literature for locked techniques.[6] We believe the observations of this study suggest that locked and unlocked nails may be associated with similar rates of serious adverse device related failures and complications.

6. Conclusion

This clinical study supports our belief that long cephalomedullary nails do not need to be locked for stable intertrochanteric fractures. We found no observable difference in failure rates or complications between the two approaches across 107 patients. Our results are important because not locking the distal nail leads to decreased operative time, radiation, and costs. Future studies should be designed to help further characterize differences in failure rates on larger populations.

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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