



## Effect of End Cap Type on Outcomes in Elderly Intertrochanteric Fractures Treated With PFNA

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**Purpose:** Intertrochanteric hip fractures in the elderly are most commonly managed using a proximal femoral nail anti-rotation (PFNA) system, which employs a helical blade secured by either a locked or non-locked end cap. While locked end caps prevent blade migration, they may concentrate stress and increase cut-out risk; non-locked end caps allow controlled dynamization but can permit lateral sliding. This study evaluated the influence of end cap choice on radiographic union and mechanical complications in elderly patients.

**Methods:** We performed a retrospective cohort analysis of 107 patients aged  $\geq 60$  years with low-energy intertrochanteric fractures treated with PFNA at Sansai Hospital between January and December 2024. Surgeons selected locked ( $n = 54$ ) or non-locked ( $n = 53$ ) end caps based on fracture stability and bone quality. The primary outcome was radiographic union at final follow-up (mean  $267.5 \pm 50.0$  days). Secondary outcomes included screw cut-out, screw cut-through, and lateral blade migration. Fisher's exact test was used, with  $p < 0.05$  considered significant.

**Results:** Overall union was achieved in 95.3% of patients, with no significant difference between groups (92.6% vs. 98.1%,  $p = 0.363$ ). In the locked group, three patients (5.6%) had screw cut-out requiring arthroplasty. In the non-locked group, two patients (3.8%) developed lateral migration requiring implant removal. No central cut-through occurred.

**Conclusions:** Both end caps types yielded high union rates. Locked end caps carry a higher risk of screw cut-out, whereas non-locked end caps are associated with lateral blade migration. Locked end caps may have more catastrophic failure requiring major revision.

**Keywords:** intertrochanteric fracture, PFNA, end cap, elderly, fixation, complications

Thailand is transitioning toward an aging society; in 2024, nearly 20% of its population (over 14 million people) were aged 60 or above <sup>(1)</sup>. These demographic factors are associated with an elevat-

ed risk of osteoporosis and hip fractures. In Chiang Mai Province alone, more than 690 hip fractures occur annually <sup>(2)</sup>. Intertrochanteric fractures constitute the majority of these injuries and are most commonly treated with the proximal femoral nail anti-rotation (PFNA) system <sup>(3-5)</sup>, introduced by the AO Foundation in 1997.

Successful treatment depends on several factors. Many studies have identified several influencing factors, including time of surgery, bone quality of patients, male gender <sup>(6-11)</sup>, fracture morphology, reduction and fixation quality, implant

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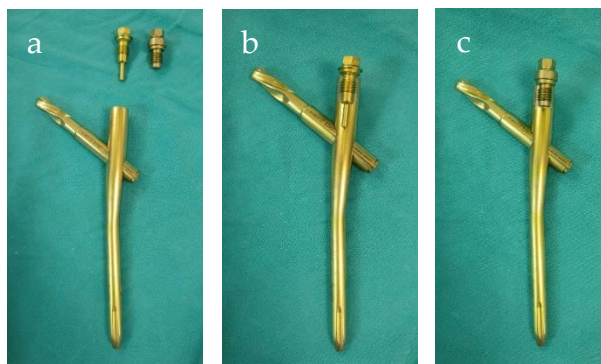
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selection, and postoperative care <sup>(12-14)</sup>. Surgical delays beyond 48 hours have been linked to increased mortality, longer hospital stays, and poorer functional recovery <sup>(6-10)</sup>.

This procedure may result in various complications, including helical blade migration (medial migration, screw cut-through, and lateral migration), varus collapse, screw cut-out, peri-implant fracture, nonunion, delayed union, shortening and infection.

The PFNA system achieves fixation through a helical blade that compacts the cancellous bone in the femoral head, enhancing rotational stability and resistance to cut-out. An end cap is recommended if bony ingrowth into the proximal end of the nail is a concern <sup>(15)</sup>. Two end cap designs are available to secure the blade within the intramedullary canal (Figure 1).

- The locked end cap incorporates an extended rod that rigidly connects the blade to the nail, preventing dynamization and medial and lateral migration, potentially increasing screw cut-out risk, and is not recommended for osteoporotic bone <sup>(16,17)</sup>.
- The non-locked end cap lacks the rod, permits controlled blade sliding, provides dynamization, reduces cut-out, and possibly allows lateral migration <sup>(18)</sup>.



**Fig. 1** a) PFNA and two types of end cap; comparison of the two end cap designs, PFNA nail and helical blade. b) locked end cap that prevents dynamization, medial and lateral migration of helical blade. c) non-locked end cap that permitting controlled blade sliding provide dynamization.

Although both designs are widely used, few clinical studies have directly compared their

outcomes in elderly patients. This retrospective analysis of 107 patients aged 60 years and older treated at Sansai Hospital evaluates whether end cap choice influences fracture union rates and the profile of mechanical complications. The selection of end caps at Sansai Hospital was based on individual surgeon preference; three surgeons utilized locked end caps for all patients, whereas two surgeons preferred non-locked end caps.

The study hypothesis proposes that the end cap design influences the occurrence of specific mechanical complications, without affecting the overall rate of fracture union.

## MATERIALS AND METHODS

We conducted a retrospective cohort study of consecutive patients aged  $\geq 60$  years with intertrochanteric femoral fractures caused by simple fall or low energy trauma, treated with PFNA at Sansai Hospital between January and December 2024. All procedures followed standard PFNA protocols. The surgeons selected end cap type (locked vs. non-locked) based on the intraoperative judgment of fracture stability and bone quality.

The exclusion criteria were fractures from high-energy trauma, pathological or old fractures and follow-up less than six months. The Ethics Committee waived the requirement for informed consent.

The diagnosis of nonunion for hip fractures was determined by the Radiographic Union Score for the Hip (RUSH) at the 6 – 12 months follow-up. A RUSH score below 18 indicates nonunion of the fracture, while a score of 18 or above indicates union <sup>(19, 20)</sup>.

Patient files were reviewed and the following data were extracted: age, sex, AO/OTA fracture classification, time interval between surgery and the 12-month follow-up visit or last visit, type of end cap used, status of fracture union (RUSH score), occurrence of postoperative complications, and the need for revision.

All patients followed a similar post operative care protocol, aiming for ambulatory progress based on their individual tolerance levels and using wheelchairs for long distance transfers. At the first month follow-up, patients underwent

bone mineral density (BMD) measurement and received oral bisphosphonate if their T-score was less than or equal to 2.5.

### Outcomes and Definitions

- Primary outcome: radiographic union by final follow-up<sup>(21)</sup>.
- Complications:
  - Screw cut-out—cranial blade penetration of the femoral head
  - Screw cut-through—central blade entry into the joint
  - lateral blade migration causing soft-tissue irritation<sup>(22, 23)</sup>

### Statistical Analysis

Continuous variables are presented as mean  $\pm$  SD. Categorical comparisons were performed using Fisher's exact test, with  $p < 0.05$  considered significant. Analyses were performed using Stata/MP v17.0.

## RESULTS

Within the observation period, 107 patients (mean age  $76.3 \pm 8.1$  years; range 61-90) met inclusion criteria. The cohort demonstrated the typical demographic profile of intertrochanteric fractures: nearly three-quarters were female (80/107, 74.8%), and left-sided injuries slightly

outnumbered right (59 vs. 48). The fractures were classified using the corresponding AO classification, with the pertrochanteric, two-part (31A1.2) occurring most frequently ( $n = 30$ , 28%), followed by 31A2.1 (multifragmentary pertrochanteric fractures) ( $n = 22$ , 20.6%), reflecting a mix of stable and unstable (Table 1)<sup>(24)</sup>. Left-sided fractures were slightly more common (55.1 %) than right (44.9 %). Among the 107 patients, 54 (50.5%) received a locked end cap and 53 (49.5%) received a non-locked end cap. The mean follow up duration was  $244.8 \pm 45.0$  days; range 182-356 days. Average follow-up was  $250.9 \pm 45.5$  days in the locked group and  $238.6 \pm 44.0$  days in non-locked group, which was sufficient to capture early mechanical failures and union status ( $p = 0.160$ ). Fracture union was achieved in 50 patients (92.6%) in the locked group and 52 patients (98.1%) in the non-locked group ( $p = 0.363$ ), indicating no statistically significant difference in union rates between the two cohorts. In the locked end cap group, three patients experienced screw cut-out, each requiring a second operation for implant removal and hip arthroplasty (Figure 2)<sup>(25)</sup>. In the non-locked end cap group, two patients developed lateral blade migration, necessitating implant removal (Figure 3) (Table 2).

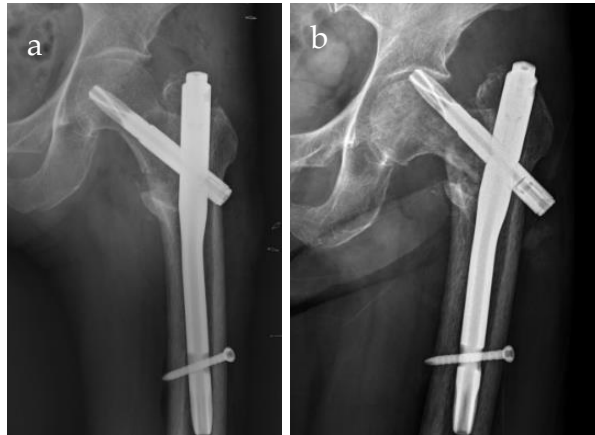
**Table 1** Demographic characteristic of patients.

Demographic characteristic of patients	Locked end cap	Non-locked end cap	Sum	p-value
Number of patients	54	53	107	
Age, mean (range) (years) (t-test)	$74.2 \pm 8.4$	$77.0 \pm 7.6$	$75.6 \pm 8.1$ (61-90)	0.079
Sex, n (%)				0.827
Female	41 (38.3)	39 (36.5)	80 (74.8)	
Male	13 (12.1)	14 (13.1)	27 (25.2)	
Side, n (%)				0.170
Right hip	18 (16.8)	25 (23.4)	43 (40.2)	
Left hip	36 (33.6)	28 (26.1)	64 (59.8)	
Types of fracture (AO/OTA), n (%)				0.627
31A1.1	10 (9.4)	7 (6.5)	17 (15.9)	
31A1.2	15 (14.0)	15 (14.0)	30 (28.0)	
31A2.1	9 (8.4)	13 (12.2)	22 (20.6)	
31A2.2	8 (7.5)	10 (9.3)	18 (16.8)	
31A2.3	3 (2.8)	4 (3.7)	7 (6.5)	
31A3.3	9 (8.4)	4 (3.7)	13 (12.2)	
Duration of follow up, mean (range) (days) (t-test)	$250.9 \pm 45.5$	$238.6 \pm 44.0$	$244.8 \pm 45.0$ (182-356)	0.160

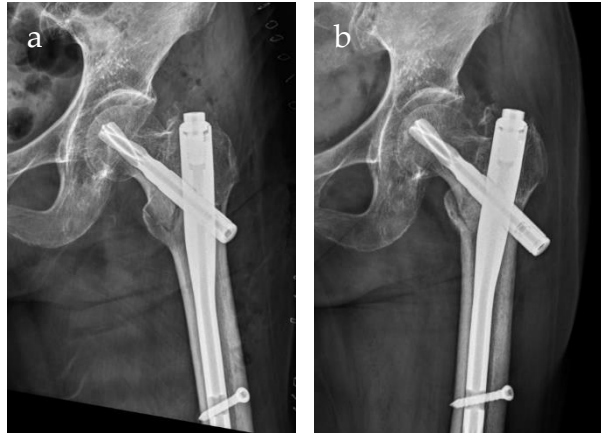
**Table 2** Union and Complication Rates.

End cap Type	Union Rate	Non union	Complications
Locked (n = 54)	92.6%	7.4%	3 screw cut-outs → hip arthroplasty
Non-Locked (n = 53)	98.1%	1.9%	2 lateral migrations → implant removal

No significant difference in union ( $p = 0.363$ ), No significant difference in complication ( $p = 1.000$ )



**Fig. 2** PFNA with locked end cap. **a.** Immediate post-operative radiograph **b.** One-month follow-up radiograph reveals cut-out of the helical blade from the femoral head.



**Fig. 3** PFNA with non-lock end cap. **a)** Immediate post-operative radiograph. **b)** Three-month follow-up radiograph reveals lateral migration of the helical blade, which eventually protruded through the skin and required helical blade removal.

## DISCUSSION

A locked end cap incorporates an extended rod that rigidly secures the helical blade to the nail, preventing dynamization and medial or lateral migration, although it may increase the risk of

screw cut-out<sup>(16, 17)</sup>. In contrast, a non-locked end cap lacks this rod, permitting controlled blade sliding that provides dynamization and may reduce the cut-out risk; however, it can allow lateral migration<sup>(18)</sup>.

Both end cap designs yielded high union rates (overall 95.3%): 92.6% in the locked group and 98.1% in the non-locked group ( $p = 0.363$ ). The absence of a statistically significant difference suggests that union is primarily driven by reduction quality and biological factors rather than by end cap mechanics alone<sup>(12-14)</sup>. However, distinct complications have been observed. Locked end caps were associated with three catastrophic screw cut-outs requiring conversion to hip arthroplasty. In contrast, non-locked end caps incurred two episodes of lateral blade migration and were managed with straightforward implant removal. The nature of these failures underscores a fundamental trade-off: rigid fixation can increase point loading in osteoporotic bone, potentially leading to screw cut-outs, whereas controlled dynamization mitigates the cut-out risk at the expense of potential lateral sliding<sup>(16, 17)</sup>.

Beyond bone quality, fracture morphology must inform end cap choice. Comminuted or reverse-oblique patterns (AO A2.2–A3.3,  $n = 38$ , 35.5%) benefited from supplemental stability. Locked end caps can prevent micromotion at the nail–blade junction in these unstable configurations, thereby reducing varus collapse. In our series, three of the nine patients with highly comminuted A3 fractures received locked end caps without mechanical failure, suggesting that locking remains valuable when bone quality is adequate. A decision algorithm combining fracture classification, reduction score, and DEXA results could optimize the outcomes, which warrants evaluation in future prospective trials.

Our analysis has limitations inherent to its retrospective, single-center design. Selection bias may arise from surgeon preference; more severe fractures may have been preferentially assigned to locked end caps, inflating the observed complication rates. We lacked standardized functional assessments (e.g., Harris Hip Score and timed up-and-go) and quality of life metrics, leaving the clinical relevance of minor mechanical events unquantified. Radiographic union does not capture patient-reported outcomes, pain levels, or gait disturbances. Finally, nine months of follow-up may have missed late-onset issues, such as implant fatigue or secondary nonunion.

Despite these limitations, our findings provide clear guidelines for future clinical practices. First, non-locked end caps should be strongly considered for elderly osteoporotic patients with simple fracture patterns to minimize the risk of screw cut-out, thereby objectively preventing serious complications that might necessitate complex revision surgery. The potential for lateral migration is reduced, facilitating implant removal. Second, locked end caps remain valuable for managing comminuted or reverse-oblique fractures with adequate bone stock to provide increased stability for optimal bone healing.

## CONCLUSIONS

Both locked and nonlocked end caps yield high union rates in elderly patients with intertrochanteric fractures. However, locked end caps carry a higher risk of screw cut-out, whereas non-locked end caps are associated with lateral blade migration. A locked end cap may experience a more catastrophic failure that requires major revision.

## REFERENCES

1. National Statistical Office, Thailand. Executive Summary: The 2024 Survey of The Older Persons in Thailand [Internet]. 2024. Available from: [https://www.nso.go.th/nsoweb/storage/survey\\_detail/2025/20241209145003\\_88327.pdf](https://www.nso.go.th/nsoweb/storage/survey_detail/2025/20241209145003_88327.pdf). Accessed Sep 14, 2025.
2. Wongtriratanachai P, Luevitoonvech S, Songpatanasilp T, et al. Increasing incidence of hip fracture in Chiang Mai, Thailand. *J Clin Densitom* 2013;16:347-52.
3. Feger J, Qureshi P, Er A. Proximal femoral nail fixation. *Radiopaedia*. Available from: <https://radiopaedia.org/articles/proximal-femoral-nail-fixation-1>. Accessed Sep 14, 2025.
4. Huang SG, Chen B, Zhang Y, et al. Comparison of the clinical effectiveness of PFNA, PFLCP, and DHS in treatment of unstable intertrochanteric femoral fracture. *Am J Ther* 2017;24:e659-66.
5. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary nails for hip fractures. *Cochrane Database Syst Rev* 2010;(11):CD000093.
6. Butler A, Condon F. The effect of time to surgery on functional ability at six weeks in a hip fracture population in Mid-West Ireland. *Int J Orthop Trauma Nurs* 2017;26:36-42.
7. Shiga T, Wajima Zi, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. *Can J Anaesth* 2008;55:146-54.
8. Simunovic N, Devereaux PJ, Sprague S, et al. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. *CMAJ* 2010;182:1609-16.
9. Al-Ani A, Samuelsson B, Tidermark J, et al. Early operation on patients with a hip fracture improved the ability to return to independent living. A prospective study of 850 patients. *J Bone Joint Surg Am* 2008;90:1436-42.
10. Klestil T, Roder C, Stotter C, et al. Impact of timing of surgery in elderly hip fracture patients: a systematic review and meta-analysis. *Sci Rep* 2018;8:13933.
11. Kinglam T, Wang CW, Kit MY. An analysis: Risk factors of cut-out following treatment of intertrochanteric hip fractures with proximal femur nail antirotation (PFNA) system. *J Orthop Trauma Rehabil*. Accessed June 4, 2025.

12. Liu JJ, Shan LC, Deng BY, et al. Reason and treatment of failure of proximal femoral nail antirotation internal fixation for femoral intertrochanteric fractures of senile patients. *Genet Mol Res* 2014;13:5949-56.
13. Li Z, Gao J, Wu X, et al. Risk factors for implant failure of PFNA-II in the treatment of intertrochanteric fractures (AO/OTA 31 A1 and A2). *BMC Musculoskelet Disord* 2025;26:784;
14. Koyuncu Ş, Altay T, Kayalı C, et al. Mechanical failures after fixation with proximal femoral nail and risk factors. *Clin Interv Aging* 2015;10:1959-65.
15. Synthes. TFNAdvance proximal femoral nailing system, For intramedullary fixation of proximal femoral fractures, Surgical technique. 2021. Available from: <https://www.kalteq.com/wp-content/uploads/2024/07/TFN-ADVANCED™-Proximal-Femoral-Nailing-System.pdf>. Accessed Sep 17, 2025.
16. Davis TR, Sher JL, Horsman A, et al. Intertrochanteric femoral fractures. Mechanical failure after internal fixation. *J Bone Joint Surg Br* 1990;72:26-31.
17. Synthes. DHS/DCS System. Including LCP DHS and DHS Blade, Technique Guide. 2010. Available from: <https://pdf4pro.com/cdn/dhs-dcs-system-including-lcp-dhs-27aad7.pdf>. Accessed Sep 17, 2025.
18. Synthes. PFNA Leading the way to optimal stability, Surgical Technique. 2005. Available from: [https://www.rch.org.au/uploadedFiles/Main/Content/ortho/PFNA-Proximal\\_Femoral\\_Nailing-A\\_System.pdf](https://www.rch.org.au/uploadedFiles/Main/Content/ortho/PFNA-Proximal_Femoral_Nailing-A_System.pdf). Accessed Sep 17, 2025.
19. Bhandari M, Chiavaras MM, Parasu N, et al. Radiographic union score for hip substantially improves agreement between surgeons and radiologists. *BMC Musculoskelet Disord* 2013;14:70.
20. Frank T, Osterhoff G, Sprague S, et al. The radiographic union score for hip (RUSH) identifies radiographic nonunion of femoral neck fractures. *Clin Orthop Relat Res* 2016;474:1396-404.
21. Hoffmann MF, Khoriaty JD, Sietsema DL, et al. Outcome of intramedullary nailing treatment for intertrochanteric femoral fractures. *J Orthop Surg Res* 2019;14:360.
22. Siddiqui YS, Khan AQ, Asif N, et al. Modes of failure of proximal femoral nail (PFN) in unstable trochanteric fractures. *MOJ Orthop Rheumatol* 2019;11:7-16.
23. Yoon JY, Park S, Kim T, et al. Cut-out risk factor analysis after intramedullary nailing for the treatment of extracapsular fractures of the proximal femur: a retrospective study. *BMC Musculoskelet Disord* 2022;23:107.
24. Kellam JF, Meinberg EG. Fracture and dislocation classification compendium-2018. *J Orthop Trauma* 2018;32 Suppl 1:S1-S170.
25. Brunner A, Büttler M, Lehmann U, et al. What is the optimal salvage procedure for cut-out after surgical fixation of trochanteric fractures with the PFNA or TFN?: A multicentre study. *Injury* 2016;47:432-8.