

# Nailing or plating for subtrochanteric femoral fractures: a non-randomized comparative study

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## Abstract

**Background** The aim of the present study was to compare the outcomes of reverse less invasive stabilization system for distal femur (LISS-DF) plates and proximal femoral nail antirotation (PFNA) in the treatment of patients with subtrochanteric fracture.

**Methods** Thirty-one patients with 32 fractures were included in this study. The PFNA group consisted of 16 patients, and the reverse LISS-DF plate group consisted of 15 patients. Intraoperative data such as surgical time (min), amount of blood transfusion (units and erythrocyte suspensions) and radiation time (seconds) were noted. Time elapsed until fracture consolidation (weeks), time until full

weight bearing (weeks), mean Harris hip score and length of stay (LOS) at hospital (days) were recorded postoperatively.

**Results** The reverse LISS-DF group had a significantly longer elapsed time until fracture consolidation ( $p < 0.05$ ). The mean radiation time was significantly longer ( $p < 0.05$ ), and the Harris hip scores at last control were significantly higher ( $p < 0.05$ ) compared with the PFNA group. No significant differences were determined in terms of complications and re-operation rates.

**Conclusion** This study demonstrated that in the reverse LISS-DF-treated group, the mean time for bone union was longer and weight bearing was delayed. Considering the surgical technique, minimal surgical approach, reduced amount of blood transfusion and superior functional results following surgery, we concluded that the PFNA system offers advantages over reverse LISS-DF plating in the treatment of subtrochanteric femur fractures.

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## Introduction

Subtrochanteric fractures of the proximal femur have been defined as fractures involving the area between the femoral isthmus and the lesser trochanter [1, 2]. Various implants have been designed to allow early ambulation, facilitate fracture fixation and reduce the risk of complications. These implants fall into two categories: intramedullary (IM) and extramedullary. The device selected for the fixation of subtrochanteric fractures should provide resistance to medialization of the shaft, angular malalignment (varus deformity) and rotational force [3].

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Intramedullary nailing is the preferred method for the fixation of subtrochanteric fractures due to its biological and biomechanical advantages [4]. In 2004, the AO/ASIF group developed a proximal femoral nail antirotation (PFNA) system to ensure angular and rotational stability using a single device [5].

The PFNA system, which uses an IM device inserted through a limited incision, both enhances bone purchase in the femoral head and allows early weight bearing [6]. A reverse less invasive stabilization system for distal femur (LISS-DF) plate, acting such as an internal splint, has different biomechanics than conventional plating. LISS plating has been widely used to treat distal femoral fractures due to its satisfactory outcomes [7, 8]. Sidhom et al. successfully used LISS plates upside down on the left lateral side to treat proximal fractures of the right femur. Reverse LISS-DF plates are used upside down in the fixation of proximal femur fractures [9, 10].

The aim of the present study was to compare the functional outcomes and complications of traditional extramedullary reverse LISS-DF plating versus PFNA in patients with subtrochanteric femoral fractures.

## Patients and methods

In this retrospective study, 31 patients ( $n = 32$  fractures) who underwent surgical intervention for subtrochanteric fractures between January 2008 and October 2010 were reviewed. The treated patients from two different centers were assigned into two groups. Group A ( $n = 16$ ) contained all patients admitted to Izmir Tepecik Education and Research Hospital—a referral trauma center—who underwent internal fixation with PFNA (Synthes<sup>®</sup>, Oberdorf, Switzerland) by an experienced trauma specialist. Group B ( $n = 15$ ) contained all patients admitted to Dokuz Eylul University Faculty of Medicine who underwent fixation with reverse LISS-DF plating (Synthes<sup>®</sup>, Oberdorf, Switzerland) by another experienced trauma surgeon. Both surgeons have been practicing trauma surgery more than 15 years.

The inclusion criteria were as follows: displaced closed subtrochanteric fracture, mental competence (a standardized mini-mental state examination score of '30–20'), signed informed consent. Patients with pathologic fracture, any patients with active malignancy, organ transplantation or infection and immobile, and dependent patients (preoperatively or postoperatively) were excluded.

Group A consisted of 11 male and five female patients. The mean age was  $43.25 \pm 23.39$ . Group B consisted of eight male and seven female patients. The mean age was  $48.20 \pm 21.67$ . Demographic data and the mean follow-up period are listed for each group individually in Table 1.

All fractures were listed according to the AO/OTA classification (Table 1). Short nails (240 mm) were applied to six patients who had a distance longer than 5 cm (determined both preoperatively and perioperatively) between the most distal end of the fracture line and the distal locking screw. A long PFNA was used in 11 patients (300, 340 and 380 mm). These devices were used to manage fractures in those patients who had a distance shorter than 5 cm between the most distal end of fracture line and the distal locking screw.

Eight patients had concurrent fractures (three patients with radius distal fractures and one patient each with a lumbar vertebrae fracture, cervical vertebrae fracture, tuberculum majus fracture, olecranon fracture and clavicle fracture). One patient had a diaphragmatic rupture. None of the patients had major neurovascular pathology or open fractures. One patient with a subtrochanteric femoral fracture also had osteopetrosis; osteosynthesis was performed on this patient with standard PFNA.

All patients were administered prophylactic antibiotics (2 g/day cefuroxime IV) and low molecular weight heparin (enoxaparin sodium 40 mg/0.4 mL/day). Patients in both groups underwent either spinal or general anesthesia. The patients in Group A were operated on in the lateral decubitus position under C-armed fluoroscopy. A fracture table was not used. Initially, an attempt was made to perform a closed reduction of the fractures. A limited open surgical approach was used in complex and comminuted fractures. The patients in Group B were operated on in the lateral decubitus position under C-armed fluoroscopy. Open reduction was performed in group B. Antibiotics were continued in prophylactic doses for 3 days postsurgery.

Physical therapy, consisting of isometric and passive range of motion (ROM) exercises of the knees and hips, was begun on the second postoperative day and was assisted by a physiotherapist to the extremes of motion that the patients were able to tolerate. All the patients in both groups were allowed to bear partial weight as tolerated. Thereafter full weight bearing is allowed after confirmation with clinical and radiological evaluation. All patients were seen back for routine evaluation at 6 weeks, 6 months, 12 months and a final control appointment after surgery.

Intraoperative data such as surgical time elapsed (min), amount of blood transfusion (units) and radiation time were recorded for each group.

Postoperative data such as time to ambulation with full weight bearing, time elapsed until fracture consolidation, length of stay at the hospital and Harris hip score for each patient were noted at last control after surgery [11].

**Table 1** Comparison of the main characteristics of the patients included in the study and the outcomes obtained using the PFNA and the reverse LISS-DF devices

	PFNA (Group A; <i>n</i> = 16)	Reverse LISS-DF (Group B; <i>n</i> = 15)	<i>p</i> value
Gender			
Male	11	8	0.379
Female	5	7	
Age (year): averages (ranges)	43.25 (19–81)	48.20 (21–86)	0.547
Seinsheimer AO/OTA classification			0.537
Type A	6	7	
Type B	6	6	
Type C	5	2	
Surgical time (min)	78.44 (45–140)	69 (55–100)	0.194
Mean follow-up period (months)	22.18 (11–40)	20.05 (12–36)	0.499
Open reduction or cerclage or Dall-Miles cable	11	15	<0.05
Blood transfused (units) (erythrocyte suspensions)	8	15	<0.05
Average hospital stay (days)	15.75 (9–47)	18.40 (12–35)	0.377
Full weight bearing (weeks)	7.50 (1–15)	15.87 (9–29)	<0.05
Consolidation time (weeks)	18.50 (10–28)	25.20 (15–34)	<0.05
Nonunion	–	–	
Infection	Superficial 1	Deep 1	
Varus malalignment	2	2	>0.05
Mortality at 1-year follow-up	–	–	
Harris hip score (range)	78.06 (55–95)	68.20 (50–86)	<0.05
Scopy time (seconds)	248.75 (120–550)	115 (75–160)	<0.05

A value of  $p < 0.05$  was considered statistically significant

## Statistical methods

Two tests were used for statistical analyses. Mean age, operation time, duration of follow-up, length of hospital stay, number of blood units transfused, time till full weight bearing was allowed, Harris functional hip score, radiation time, mean follow-up period and time elapsed for fracture consolidation were compared between the groups using Student's *t* test. Gender, concomitant problems, AO/OTA classification of fractures and mortality rate at the 1-year follow-up were evaluated using the Chi-squared test. A value of  $p < 0.05$  was considered statistically significant.

## Results

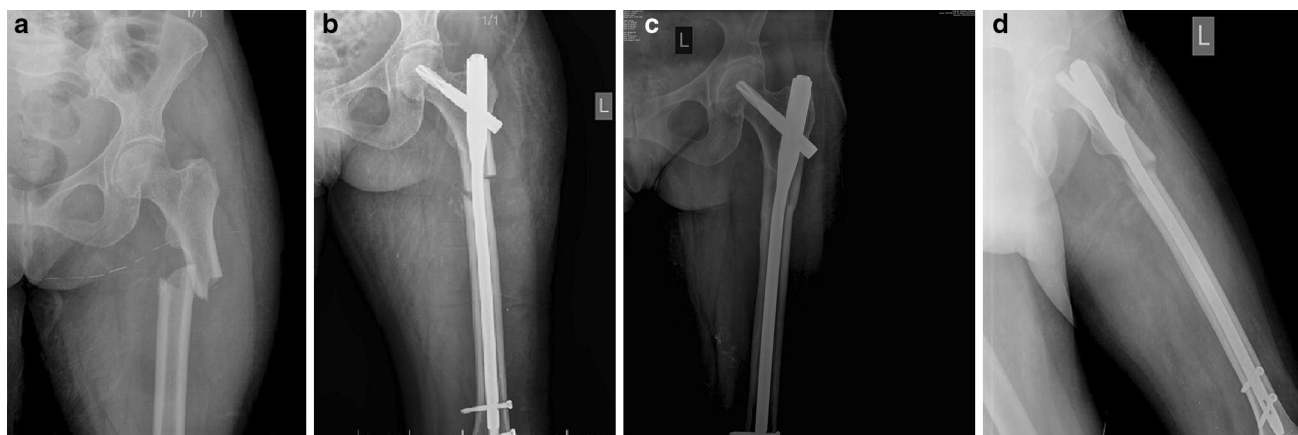
The patients in Group A did not show any implant failure, femoral head penetration, coxa vara, collapse or cutout (Fig. 1a–c). Only one patient developed a superficial wound infection. This wound did not require surgical intervention and fully recovered following the administration of IV antibiotherapy (during 10 days, 2 g/day cefuroxime IV and 400 mg/day ciprofloxacin IV). One patient developed malrotation. Separation of the lateral femoral cortex occurred in one patient during surgery, and

the fragment was fixed using cerclage wiring in the same session. At day 2 postoperation, one patient who was treated with short PFNA developed a fracture extending to the distal locking, and a revision was performed using long PFNA. According to the Harris functional hip score, the outcomes were determined as excellent in six patients, very good in seven patients, good in two patients and moderate in one patient.

None of the patients in Group B exhibited mechanical failure (Fig. 2a–c). In one patient, the original plan was to perform PFNA. However, this patient underwent osteosynthesis with reverse LISS-DF because the nail could not be extended distally during the operation due to extensive bowing of the femoral diaphysis. One patient developed a deep wound infection, which was treated by performing surgical debridement twice. Complete resolution was achieved by antibiotherapy.

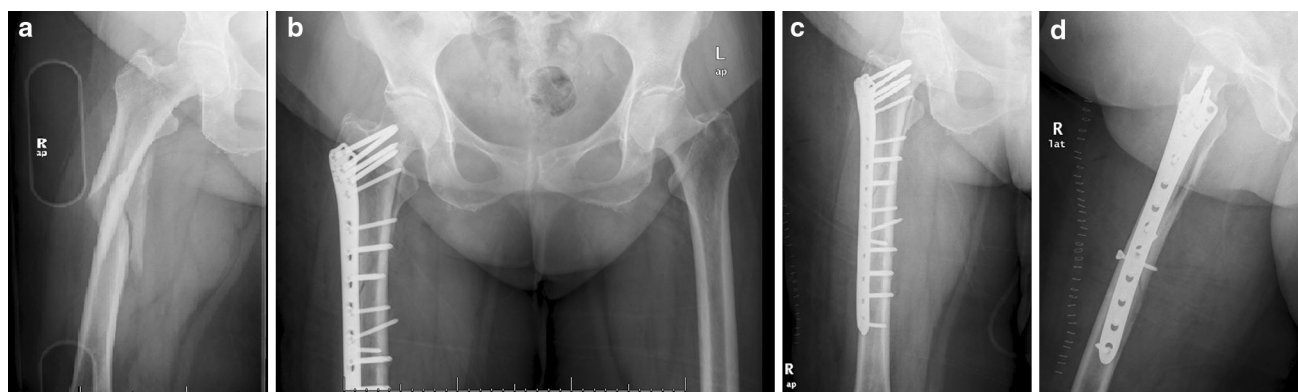
According to the Harris functional hip score, the outcomes of the patients in Group B were excellent in three patients, very good in four patients, good in seven patients and moderate in one patient.

Group B had a significantly increased number of blood units (15 units) transfused ( $p < 0.05$ ). Eight patients (50 %) in the PFNA group and 14 patients (93.3 %) in the reverse LISS-DF group required blood transfusions in the



**Fig. 1** **a** Left hip AP radiography from a 60-year-old female patient shows a subtrochanteric type II fracture of the left femur after a simple fall. **b** AP radiographic appearance after closed reduction and

internal fixation with long PFNA after 12 months of follow-up. **c** AP and **d** lateral radiographs



**Fig. 2** Subtrochanteric type III fracture of the right femur in a 72-year-old female patient. **a** AP radiograph of the right hip sustained after a pedestrian motor vehicle crash. **b** Pelvic AP radiography after

open reduction and extramedullary fixation by reverse LISS-DF plating after 12 months of follow-up. **c** AP and **d** lateral radiographs

postoperative period ( $p < 0.05$ ). Group B also had significant delay in fracture consolidation ( $p < 0.05$ ).

In Group A, performing the closed surgical technique, the verification of the position of the helical blade on the femoral head and the use of fluoroscopy due to the use of the freehand technique in the distal locking of the long nailing contributed to significantly longer radiation time ( $p < 0.05$ ). It was noted that the patients in Group B (reverse LISS-DF) experienced difficulties in mobilization due to extensive surgical dissection. The mean Harris hip score at the final control appointment was significantly lower in Group B compared with Group A ( $p < 0.05$ ).

No significant differences were observed between the two groups in terms of complications and additional interventions ( $p > 0.05$ ). There was no significant difference in terms of the type of fracture between the two groups ( $p = 0.537$ ).

Fracture consolidation was achieved in all patients without further problems, and no mortalities were noted in our study.

## Discussion

Various implants have been designed to treat subtrochanteric fractures of the femur. Among the extramedullary fixation methods, sliding hip screw fixation, dynamic condylar screw fixation and angular blade plate have found a wide area of utilization in the treatment of proximal femoral fractures [3, 12, 13]. The potential disadvantages of extramedullary devices include the necessity for extensive surgical exposure, extensive soft tissue damage and blood loss, and, thus, delayed union or nonunion and high risk of implant failure. Furthermore, eccentric plates are mechanically prone to cause fatigue fractures upon weight bearing, and the use of these plates to treat fractures with a tendency to nonunion would result in mechanical failure [6, 12, 14]. None of the patients in the current study experienced mechanical failure, and this was attributed to avoiding early weight bearing and providing good posteromedial support in fixation.

The utilization of LISS plates developed by the AO group in the treatment of distal femur and proximal tibia fractures has yielded successful results. Biological fixation with locking plates has been utilized in the treatment of proximal femur fractures in the literature in biologically closed fracture fixation methods [6–8, 15, 16]. In reverse LISS plating, the system can be used as a splint by locking the screws to the plate, thereby preventing the screws from loosening [15, 17]. It has been suggested that this method is not superior to IM nailing apart from the lack of drilling, and it may offer an alternative to IM implants due to the high union rates and low rate of complications [4]. IM locked nailing has always been valued above extramedullary lateral plating [18]. Although Han et al. [7] used biological fixation principles in the treatment of such fractures in their study, no significant difference was observed between the groups in terms of re-operation frequency. We consider that the price of the better outcomes in the PFNA group is paid by longer surgical times and longer exposure to radiation by operating room personnel.

The method that offers the least damage to soft tissues and bone fragments should be preferred to attain faster recovery of the fracture after internal fixation [19]. From the biomechanics perspective, the structure resulting from the method used should withstand stress to the subtrochanteric area, which is accomplished by maintaining the continuity of the posteromedial cortex [13]. However, complying with the rules of biological fixation would not suffice to accelerate the healing process of these fractures [7]. In the current study, although sufficient posteromedial support was ensured for patients treated with reverse LISS plates, the time at which weight bearing was permitted to the patients postoperatively was postponed to protect the fixation. The time to weight bearing and duration of fracture healing was longer in the plating group than in the PFNA group ( $p < 0.05$ ). Time to union was postponed as time to weight bearing was delayed, and the functional status at the end of 1 year was worse than that in the PFNA group ( $<0.05$ ). Furthermore, insufficient restoration of the femur head-shaft angle has been shown to be associated with failure of the internal fixation [20]. Varus malalignment is one of the consequences of failed fixation [19].

The most common reason for failure with IM devices is the cutout of the femur head by the screws [5, 20]. No such complications were observed in the current study. Numerous studies have shown that early mobilization after surgery resulted in reduced complications, such as thromboembolic events and infections of the respiratory system and urinary tract [20–22]. Other advantages of IM devices include avoiding implant failure, nonunion and reduced blood loss and surgical time [3, 23, 24]. In our study, patients in Group B had a significantly increased number of blood transfusions ( $p < 0.05$ ). This was attributed to the use of the open

surgical technique. Some patients in Group A underwent closed surgery, and others underwent limited open surgery. No significant difference was found between the groups in terms of overall and orthopedic complications.

Studies using reverse LISS-DF plating and PFNA in subtrochanteric fractures are scarce [7, 8, 10, 15]. The current study is limited by having a retrospectively controlled design and including a small sample size.

Although we have small data about these two techniques used for proximal femoral fractures, we think the main advantages of LISS-DF plating include the achievement of anatomic improvement, shorter exposure of the surgical team to radiation and improved medial support.

We experienced some difficulties as need of extensive dissection, increased amount of blood loss and delayed fracture consolidation leading to delayed weight bearing with LISS-DF plating. We did not restrict weight bearing in the PFNA group as it was believed that the proximal screw contributed to stabilization of the fracture because it was strong enough to withstand stresses to the subtrochanteric region.

For clarity, it is impossible to infer that the reverse LISS plate technique is superior or at least equal to the PFNA technique in the treatment of subtrochanteric fractures. However, because one of the main goals in treating a fracture is to achieve fracture consolidation, we found the reverse LISS plate technique to be as successful as PFNA in our study. We think that LISS plate technique can be an alternative technique in the treatment of subtrochanteric fractures when intramedullar fixation is not suitable due to extensive bowing of the femoral diaphysis and fracture configuration such as the violence of the entry points. Future prospective and controlled larger are warranted to compare the advantages and disadvantages of these two different techniques.

**Conflict of interest** None.

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