



## Comparison of locking plate and cephalomedullary nailing in unstable proximal femur fractures

### İnstabil proksimal femur kırıklarında kilitli plak - sefalomeduller çivi karşılaştırılması

Unstable proximal femur fractures

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#### Öz

**Amaç:** Bu çalışmanın amacı, cefalomeduller nail (CMN) ya da proximal femur locking plates (PFLP) ile tedavi edilen, instabil pertrokanterik femur kırıklarının (AO/OTA 31A3) tedavi sonuçlarının karşılaştırılmasıdır. **Gereç ve Yöntem:** 2012-2016 yılları arasında hastanemizde tedavi edilen, ortalama yaş  $60.1 \pm 19.9$  (18-90 arası) olan, 25 erkek (69%) ve 11 kadın (31%), toplam 36 hasta retrospektif olarak incelendi. Hastalar iki gruba ayrıldı. İlk grupta, CMN uygulanan 12 hasta, ikinci grupta, PFLP uygulanan 24 hasta mevcuttu. **Bulgular:** CMN grubunda 1 hastada proksimal lateral korteks kırığı gelişti, 11 hastada (91%) kaynama sağlandı. PFLP grubunda 1 hastada mekanik başarısızlık, 1 hastada pseudoartroz gelişti, 22 hastada kaynama sağlandı (91,6%). CMN grubunda hiçbir hastada enfeksiyon görülmedi. PFLP grubunda ise 2 hastada derin, 1 hastada yüzeysel toplam 3 hastada (12,5%) enfeksiyon görüldü. CMN grubunda 2 (16,6%) hastada, PFLP grubunda 1(4,1%) hastada DVT gelişti. **Tartışma:** İnstabil femur pertrokanterik kırıklı hastalarda CMN ve PFLP sonuçlarının her ikisi de tatmin edici olup; cerrahi süreleri, peroperatif kan transfüzyon ihtiyaçları, postoperatif hastanede kalış süreleri, mekanik başarısızlık ve reoperasyon oranları benzerdir.

#### Anahtar Kelimeler

Kalça Kırığı; İntertrokanterik Femur Kırığı; Kilitli Plak; İntrameduller Çivileme; Internal Fiksasyon

#### Abstract

**Aim:** The aim of this study is to compare the treatment results of unstable pertrochanteric femur fractures with proximal femur locking plates (PFLP) and cephalomedullary nailing (CMN). **Material and Method:** Between 2012 – 2016, 36 patients (with mean age  $60.1 \pm 19.9$  std) (between 18-90) of which 25 were male (69%) and 11 were female (31%) were retrospectively analyzed. Patients were divided into two groups. There were 12 patients in the first group who undergone CMN, and there were 24 patients in the second group who undergone PFLP. **Results:** The proximal lateral cortex fracture occurred in one patient of CMN group, fusion was achieved in 11 patients (91%). In PFLP group, mechanic failure occurred in one patient, pseudoarthrosis occurred in one patient, and fusion was achieved in 22 patients (91,6%). There was no infection in CMN group, and in PFLP group infection was seen in 3 patients (12,5%) of which 2 were deep and 1 was a superficial infection. DVT occurred in 2 patient in CMN (16,6%) and 1 patient in PFLP group (4,1%). **Discussion:** CMN and PFLP treatment results in patients with unstable femur pertrochanteric fractures were both satisfactory; surgery time, peroperative blood transfusion need, postoperative hospitalization time, mechanical failure and reoperation rates were similar.

#### Keywords

Hip Fracture; Intertrochanteric Femur Fracture; Locked Plating; Intramedullary Nailing; Internal Fixation

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## Introduction

Unstable proximal femur fractures are problematic fractures in surgical treatment, and they are difficult to reduce and sustain the fixation [1]. Even if it is seen in all age groups, it is mostly seen in elderly patients (low energy trauma like falling) and young people (high energy trauma like falling from a high level and traffic accident) [2]. Recently, CMN has been the standard treatment due to fewer complication rates than hip nails in unstable proximal femur fractures [3]. However, in fractures in which the fracture line is extending through trochanter major, there are some difficulties in reduction and nail placement. Moreover, there may be secondary trochanteric or femoral shaft fracture, peroneal nerve injury, malrotation, instability, varus deformity, malunion or nonunion [4].

Recently, to minimize the possible complications, PFLP's which possess high pullout strength and stable strength with constant angle [4]. The advantage of locking plates is that it allows achieving stable fixation at various angles and leads to less footprint compared to large proximal lag screws [5]. However, high level of failure rates even with experienced surgeons and hands has risen doubts about PFLP [3]. PFLP, just like CMN fixation, in the proximal femur fractures have been used for years. The aim of this study is to compare CMN and PFLP treatments in unstable intertrochanteric/subtrochanteric femur fractures regarding surgery duration, blood transfusion need, complications, and frequency of reoperation retrospectively.

## Material and Method

Patients who have unstable femur pertrochanteric fractures (AO/OTA 31A3) treated surgically between 2012-2016 were included. Exclusion criteria were pathologic fractures, age less than 18 and follow-up period less than 6 months. All the subjects gave their informed consent before their inclusion in the study. The principles outlined in the Declaration of Helsinki were followed.

The clinical and radiologic data of the patients at the first application, peroperative and the last control examination were retrospectively evaluated. The reviewed demographic data were the time elapsed from injury to surgery, surgical procedure type (osteosynthesis with a proximal femoral nail (Smith and Nephew; Texas, USA) or proximal femoral locking plate fixation [4.5 mm locking compression plate (LCP) Proximal Femur Plate, Smith and Nephew; Texas, USA]) and complications.

The clinical and radiologic data follow up data were evaluated postoperative 3rd and 6th weeks and 45 days later than the last one. All surgical procedures were in supine position. Traction table was not used in any of the patients.

All the patients in both groups were mobilized in the 1st postoperative day. In CMN group, the patients were mobilized by applying the recommendation of the surgeon without laying on the healing extremity in the first 6 weeks or just partially laying on. All the patients were mobilized as much as they can tolerate from the 6th postoperative week. In PFLP group, patients were mobilized without laying on the healing extremity in the first 6 weeks and laying on as much as they can tolerate in the following 3 months.

The patient characteristics were gender, age, diabetes mellitus, smoking history, comorbidities, and the time elapsed until surgery.

Mechanical failure was described as 10-degree alignment loss or 2 cm shortness. Nonunion was described as no union in the postop 6th month or no progressive fusion in the control examinations. Superficial wound infection is defined as an infection of the wound, in which there is no evidence that the infection extends to the site of the implant, deep wound infection, defined as infection around the implant.

36 patients all with unstable femur fracture (OTA 31A3) were included in the study. In the first group CMN was applied to 12 patients (11 subtrochanteric, 1 intertrochanteric fracture) with a mean age of  $56.2 \pm 21.3$  (range 18-86) and in the second group, PFLP was applied to 24 patients with a mean age  $62.1 \pm 19$  (range 32-90).

All the operations were carried out by the same team of experienced surgeons. In all cases, antibiotic prophylaxis and low molecular weight heparin prophylaxis were provided. The radiographs of the cases were obtained via taking anteroposterior and lateral graphies 24-72 hours after the operations, and these graphies were analyzed regarding reduction and implant position.

Complications were counted as varus collapse, implant related problems, secondary fractures, deep or superficial infection, cardiac ischemia, pneumonia and urinary tract infection.

All patients were followed for at least 6 months. Mean follow up period for all patients was 17.1 months (6-41), it was 15.2 (6-24) in CMN group and 18.1 months (6-41) in PFLP group.

The variables between CMN and PFLP groups were compared via univariate analysis. A p value of 0,05 was considered significant. Confidence interval (CI) was chosen as 95% in the study. All statistical analyses were performed using SPSS 22.0 statistical software (SPSS, Chicago, IL, USA).

## Results

There was no difference between two groups regarding age, gender, time elapsed until surgery, diabetes mellitus and comorbidities. Patients in CMN group were 4 years older than those of PFLP group (58.2vs. 62.1) (Table 1).

Mean time elapsed till the surgery after the injury was 1.7 days in PFLP group (0-5 days) and 1.5 days (0-3 days) in CMN group. Mean surgery time in CMN group was 101 minutes (70-145 minutes) and 103 minutes (80-180 minutes) in PFLP groups. Intraoperative blood transfusion need in CMN group was 0,2 unit and 0,4 unit (0-1) in PFLP groups. Hospital staying time after surgery in PFLP group was 5,3 days (2-9 days) and 4,2 days (2-8 days) in CMN group (table 1).

The intraoperative and postoperative blood transfusion need were 0,2 unit (0-1 unit) and 0,9 unit (0-2 unit) and 0,4 unit (0-1 unit) and 1 unit (0-3 unit) in CMN and PFLP groups relatively.

While in 11 patients (91% of CMN group) fusion was achieved, in one patient proximal lateral cortical femur fracture occurred and conservatively followed because patient relatives did not accept an operation and the patient died 6th month postoperatively. In 1 patient in PFLP group mechanic failure (varus collapse) and pseudoarthrosis in another patient occurred. Hemiarthroplasty and pseudoarthrosis surgery + iliac autogenous grafting + fixation revision were applied relatively. Fusion was achieved in 22 patients (91,6%) (Table 1) (figure 1 and 2).

Table 1. The abstract of patient and surgical results

	PFLP (n=24 patients) n(%) mean(±SD) range	CMN (n:12 patients) n(%) mean(±SD) range	p value
Age (years)	62.1±19.4std (32-90)	56.2±21.3std (18-86)	0.993
Gender			0.104
Female	18(75)	7(58)	
Male	6(25)	5(42)	
Mechanism of injury			0.666
High energy	9(38)	5(42)	
Low energy	15(62)	7(58)	
BMI(kg/m <sup>2</sup> )	24,5	22,7	0.493
Diabetes mellitus	5	2	0.556
Smoker	9	3	0.115
Time from trauma to surgery (days)	1,7	1,5	0.055
Mean surgery time (minutes)	103	101	
Intraoperative blood transfusion (units)	0,2	0,4	
Postoperative blood transfusion (units)	0,9	1,0	
Postop. Hospitalization	4,2	5,3	
Mortality (1 year)	1	1	0.324
Mechanical failure	1	0	
Prox. Femoral fracture	0	1	
Infection			
Superficial	1	0	
Deep	2	0	
Nonunion	1	1	
Malunion	0	0	
Reoperation need	5	1	
Follow-up (months)	18,1	15,2	

major complications. There was no statistically significant difference in mortality in the first year ( $P > 0.05$ ). All the patients except for a deceased patient, are under our follow up in all groups.

**Discussion**

Unstable proximal femur fractures are difficult entities even for experienced surgeons [2]. To achieve a successful treatment, the clinical, anatomical and biomechanical characteristics of the region must be well known [3, 6].

Although these fractures are seen in all age groups, they are mostly seen in elders with low energy injuries (falling) and in young people with high energy injuries (traffic accident or falling from a high level) [2]. In our study, the number of high energy trauma was 14, and low energy trauma was 22. The mean age was 60, but the age interval was 19-90.

In the surgical method of implant selection in unstable proximal femur fractures, many treatment methods were suggested in the past, and there were still discussions about that [2-4, 7-10]. In one of them that is 95 degree wedged condylar plates,



Figure 1. Subtrochanteric fracture of right femur, preoperative and anteroposterior radiographs (a), anteroposterior radiograph in the 4th month postoperatively after internal fixation with cephalomedullary nails (b).

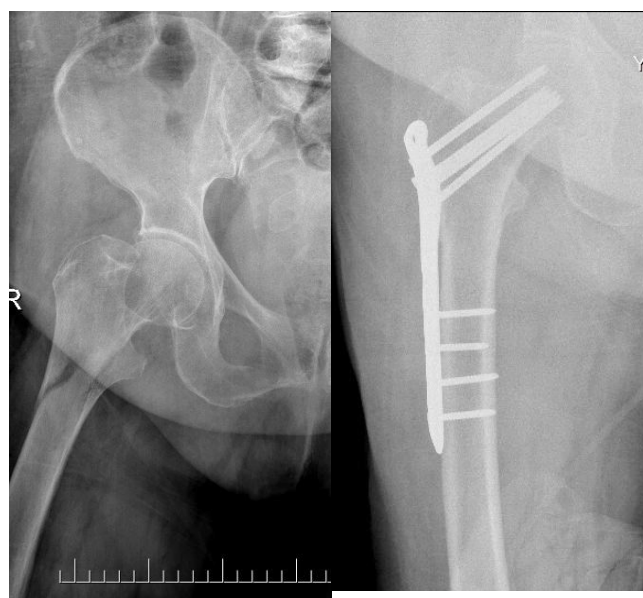


Figure 2. Preoperative x ray of the intertrochanteric fracture of the right femur (a), anteroposterior radiograph in the 3rd month postoperatively after internal fixation with proximal femoral locking plates (b).

There was no infection in any of the patients in CMN group. On the other hand, in PFLP group infection was seen in 3 patients (12,4%) (2 with deep and 1 with superficial infection). Superficial infection was treated using irrigation + debridement, and deep infection was treated by irrigation + debridement + implant removal. The patient treated with implant removal healed with a 1 cm shortness. DVT occurred in 2 patients (16,6%) of CMN group and 1 patient (4,1%) of PFLP group. Malunion was not seen in any patient of any group. As a result, 3 cases (25%) of CMN group and 6 cases (25%) of PFLP group developed

fusion rate had been found 92-100 %, malunion was 13-24%, the late union was 6-19%, nonunion was 3-12%, and implant failure was 6-24% [9].

The intertrochanteric femur fractures in which the fracture lines reach the lateral femoral cortex beyond the vastus ridge of trochanter major, show some unique mechanical and anatomic features that have been found to cause insufficient results when sliding hip screws were used. For these type of fractures, the standard method of treatment has become cephalomedullary nails [6, 10].

Fusion rate was 87-100 %, the nonunion rate was 3-13%, malunion rate was 3-6%, and implant failure rate was 0-4% in the first and second generation CMNs [9, 11].

The disadvantages of IMNs were the high frequency of need for intraoperative fluoroscopic imaging, difficulties in techniques in implementation, the need for experienced surgeons, the difficulty in implant removal in need, and implantation difficulty especially in fractures extending trochanter major and fossa piriformis [7, 9, 10, 12].

High level of complication rates after surgical fixation in unstable proximal femur fracture in elder patients brought up primary hip prosthesis implementation [8,9]. However, due to luxation risk, high level of mortality, complication risks in case of revision, internal fixation was suggested for young and active elder people [8, 9, 13].

In last ten years, locking plates have been in use for proximal femur fracture treatments [3, 10]. Locking plates have some advantages such as letting multiple angularly stable fixation points in the proximal femur while leaving a smaller footprint by keeping more bone reserve after implantation in comparison with the large proximal leg screws. Biochemical studies have implied that stronger and more stable fixation was achieved with locking plates in comparison with other angularly stable implants [5].

There are very few studies in the literature comparing CMN and PFLP. In these studies, high level of failure rates of locking plates more than expected had risen worries.

In recent times, in a study that Collinge et al. had done, all the 111 proximal femur fractures were treated with proximal femur anatomic plates, and 41,4% treatment failure was found. Which were fixation loss, malunion, nonunion, surgical malalignment and deep infection or the combination of these [1].

In another study that includes 114 patients, Mirbolook et al. compared PFLP and CMN. Infection in 27% of all patients, side device failure in 12%, malunion in 11% and nonunion in 8% and combinations of these in various rates were seen. Mirbolook et al. have suggested in this study that plate or IMN selection may not be a factor for the complications developed [2].

Kanthimathi et al. have suggested that the talent of the surgeon and the selection of right technique may decrease the complications [14].

In this study, we compared CMN and PFLP treatments in unstable intertrochanteric/

subtrochanteric femur fractures retrospectively regarding surgery time, blood transfusion need, surgery results, complications and reoperation frequency.

In our study, there are similar union rates as 91% in CMN group and 91,6% in PFLP group. In the face of literature, PFLP just like CMN may be evaluated as having satisfactory union rates. Similarly, Streubel et al. reported 33% cumulative failure in 12 months in patients with 31A3 intertrochanteric fracture. The high rate of failure in this study can be attributed to the use of two or three screws for fixation of the proximal part [3]. The better results with PFLP in our study were thought to be due to the usage of at least 4 screws of which at least 3 of them with 6,5 mm size were implanted into proximal.

In general, as we evaluate treatment complications of subtrochanteric femur fractures, high rate of nonunion (3-12%), malunion (13-24%), implant failure (6-24%) and infection (8-20%)

may be counted. Moreover, mostly in elder people, there are complications as dvt, pneumonia, UTI, pressure ulcers, feeding insufficiency [9]. In our study in PFLP group, pseudoarthrosis in one patient and varus collapse in another patient occurred. In CMN group, lateral femoral cortex fracture occurred in one patient. Besides that, one patient in each group developed DVT. Even if there was no infection mentioned in the condylar screw and IMN fixation, 8-20% infection was reported in cases of the 95-degree condylar plate [9]. In our study, likewise literature, while no infection was seen in IMN group, 3 cases were seen in PFLP group as 2 of them with deep and 1 of them with superficial infection.

In PFLP group, for 5 patients totally (2 deep infections, 1 superficial infection, 1 pseudoarthrosis, 1 varus collapse) and in CMN group for 1 patient reoperation was planned.

In one patient only, proximal lateral cortical femur fracture occurred and conservatively followed because patient relatives did not accept an operation and the patient died at the 6th postoperative month. Totally 2 patients, one in CMN and one in PFLP groups each, died in the first year of follow ups.

There were some limitations of this study. The sample size was small, and it led to low comparison power in comparing group characteristics. There was no significant difference found between two groups regarding age, smoking, injury mechanism and diabetes mellitus. However, there may be a significant difference with a larger sample size.

### Conclusion

Both the results of CMN and PFLP in patients with unstable proximal femur fractures are satisfactory; surgery time, peroperative transfusion need, postoperative hospital staying time, mechanical failure and reoperation rates are similar. Infection rates and reoperation need were higher in PFLP group than that in CMN group. PFLP group was a good alternative for CMN in proximal femur fractures.

### Scientific Responsibility Statement

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

### Animal and human rights statement

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

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### Conflict of interest

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