**Araştırma Makalesi** *Research Article*

Pamukkale Tıp Dergisi
*Pamukkale Medical Journal*

*doi:10.31362/patd.451668*

# Comparison of dynamic hip screw and proximal femoral nail in intertrochanteric femur fractures and cost analysis

## *İntertrokanterik femur kırıklarında dinamik kalça çivisi ile proksimal femoral çivisi karşılaştırılması ve maliyet analizi*

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Gönderilme tarihi: 18.12.2017 Kabul tarihi: 26.03.2018

**Abstract**

**Purpose:** The study was planned to compare the results of dynamic hip screw (DHS) and proximal femoral nail antirotation (PFNA) applications to femur intertrochanteric fractures and to implement a cost analysis.

**Materials and methods:** A retrospective evaluaton was made of 75 patients who were treated for intertrochanteric femur fracture between May 2009 and December 2012. Evaluation was made of differences between the groups in reduction quality, mean duration of hospitalization, complication rates, functional outcomes and treatment costs.

**Results:** Thirty patients were treated with DHS and forty five patients with PFNA. The average follow-up period was 21.5 (12-49) months. Functional outcomes were similar, with no significant difference between the groups. Length of hospital stay was shorter in the PFNA group, the treatment and care costs were lower compared to the DHS group.

**Conclusion:** Although PFNA is a much more expensive implant than DHS, there is no significant difference between total hospital costs. Nevertheless, as DHS has similar functional results, it is still a preferrable treatment method for intertrochanteric femur fractures.

**Key words:** Intertrochanteric, dynamic hip screw, proximal femoral nail

Başkan MV, Yörükoğlu AÇ, Aydemir AN, Buker N, Ök N, Demirkan AF. Comparison of dynamic hip screw and proximal femoral nail in intertrochanteric femur fractures and cost analysis. *Pam Med J* 2018;11(3):287-292.

**Özet**

**Amaç:** Çalışmamız femur intertrokanterik kırıklarında dinamik kalça vidası (DHS) – proksimal femoral çivi antirotasyon (PFNA) uygulamalarının sonuçlarının karşılaştırılması ve bu konuda maliyet analizinin yapılması için planlanmıştır.

**Gereç ve yöntem:** Mayıs-2009 Aralık-2012 tarihleri arasında intertrokanterik femur kırığı nedeniyle ameliyat olmuş 75 hasta retrospektif olarak değerlendirildi. Gruplar arasında redüksiyon kalitesi, ortalama yatış süresi, komplikasyon oranları, fonksiyonel sonuçlar ve tedavi masrafları açısından fark olup olmadığı değerlendirildi.

**Bulgular:** Otuz hastaya DHS, Kırk beş hastaya PFNA uygulandı. Çalışmamızda takip süresi ortalama 21.55 (6-49) aydır. Fonksiyonel sonuçlar gruplar arasında anlamlı fark olmayacak şekilde birbirine yakındı. PFNA uygulanan hastaların DHS uygulanan hastalara göre hastanede yatış sürelerinin kısa; tedavi ve bakım masraflarının daha düşük olduğu görülmektedir.

**Sonuç:**PFNA; DHS'ye oranla pahalı bir implant olsa da hastane toplam maliyeti değerlendirildiğinde aralarında anlamlı bir farklılık görülmemektedir. Bunun yanında benzer fonksiyonel sonuçları ile DHS intertrokanterik femur kırıklarında tercih edilebilir bir tedavi yöntemidir.

**Anahtar sözcükler:**İntertrokanterik, dinamik kalça vidası, proksimal femoral çivi

Başkan MV, Yörükoğlu AÇ, Aydemir AN, Buker N, Ök N, Demirkan AF. İntertrokanterik femur kırıklarında dinamik kalça çivisi ile proksimal femoral çivisi karşılaştırılması ve maliyet analizi. *Pam Tıp Derg* 2018;11(3):287-292.

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## Introduction

Intertrochanteric hip fractures generally occur as a result of low-energy trauma in elderly osteoporotic patients. The incidence of intertrochanteric fractures has been increasing progressively due to the increased incidence of osteoporosis and rate of the geriatric population [1]. Mortality and morbidity rates are comparatively high as these fractures are often observed at an advanced age. Therefore, the aim of the treatment is to achieve sufficient reduction and rigid fixation to provide early recovery and mobility.

Intertrochanteric fractures are fractures that occur between the trochanter minor and major and can extend to the subtrochanteric region. For patients with adequate bone quality, osteosynthesis is the preferred method of treatment. The objective of the treatment is to preserve the bone structure of the patient and ensure a rapid return to daily social life [2]. Historically, dynamic hip screw has been used as the gold standard in the treatment of intertrochanteric fractures. Since the first use of proximal femoral nail in the early 1990s, with the advances in implant technology, the use of proximal femoral nail (PFN) is becoming more widespread. Although there are publications in the literature that compare the results of PFN and DHS [3], we have not found a study of cost analysis.

The aim of this study was to compare the radiological and functional outcomes of patients treated with PFNA and DHS and to evaluate cost analysis.

## Patients and methods

A retrospective evaluation was made of a total of 75 patients who were surgically treated for an intertrochanteric femoral fracture between May 2009 and December 2012. The fractures were classified according to the AO-ASIF classification. DHS (Hipokrat Inc., Izmir, Turkey) was applied to 30 of 75 patients (40%) and PFNA (Synthes, Hertfordshire, UK) was applied to 45 (60%) patients. The patients comprised 39 (52%) females and 36 (48%) males with an average age of 72.85 years (range, 21-94 years). Postoperatively, the patients were followed-up for 12-49 months.

Surgery was performed in the supine position on a traction table. The mean time from trauma to surgery was 2.8 days (range, 1-7 days). Postoperative evaluation was made of fracture displacement (mm), position of reduction, ideal implant position, (anterior-posterior-lateral radiography), and tip apex distance (anterior-posterior-lateral radiography). Displacement of ≤2mm on post-operative radiographs was considered good, and >2 mm displacement was considered unfavorable. If the implant position is in the centre of the femoral head or in the inferior position on anterior-posterior radiographs and in a central position on lateral radiographs were evaluated as ideal [4]. Tip-apex distances were evaluated on anterior-posterior-lateral radiographs as described by Baumgartner et al. [5] The radiological bone healing period and mobilization period of the patients were also evaluated in respect of complications, revision and mortality.

For pain evaluation, a Visual Analogue Scale (VAS) was used. Functional assessment was made using the clinically modified Harris Hip Scale (HHS) and Jergesen Functional Scale (JFS).

Statistical analyses of categorical data were made using the Chi-Square test and Fisher's Exact Test, and for measured values, the Kruskal Wallis test and the Mann Whitney U-test. When the Kruskal Wallis test result was significant, multiple comparison tests were applied to determine which groups were different from each other. Categorical data were stated as frequency and percentage, data acquired via measurements as median (min.-max.) values.

## Results

When the patients were evaluated in terms of age distribution, the patients operated on with PFNA were in a more advanced age group than the DHS group ($p$=0.003) (Table 1). The average age was 66.2±17.3 years in the DHS group and 77.2±12.8 years in the PFNA group. The fracture was the result of low-energy trauma in 62 patients and of high-energy trauma in 13 patients. Multiple fractures were determined in six (8%) patients, isolated fractures in 69 (92%), pathological fractures in two (2.7%) and chronic diseases in 62 (82.7%) patients.

**Table 1.** Descriptive information of the pathology

| Variables | DHS (n=30 ) | | PFNA (n=45 ) | | |
|---|---|---|---|---|---|
| | n | % | n | % | p |
| **Trauma** | | | | | |
| **High Energy** | 8 | 26.7 | 5 | 11.1 | |
| **Low Energy** | 22 | 73.3 | 40 | 88.9 | 0.077 |
| **Fracture** | | | | | |
| **Multiple** | 4 | 13.3 | 3 | 6.7 | |
| **Isolated** | 26 | 86.7 | 42 | 93.3 | |
| **Pathological** | 0 | 0 | 2 | 4.4 | 0.357 |
| **Chronic Diseases** | | | | | |
| **Present** | 24 | 80 | 38 | 84.4 | |
| **N/A** | 6 | 20 | 7 | 15.6 | |
| **AO Classification** | | | | | |
| **A1** | 12 | 40 | 8 | 17.7 | |
| **A2** | 13 | 43.3 | 35 | 77.7 | |
| **A3** | 5 | 16.7 | 2 | 4.4 | |
| **Full Mobilization** | 3-9 | 5.0±3.35 | 2-8 | 3.9±2.18 | 0.166 |
| **Duration (Months)** | | | | | |
| **Hospitalization (days)** | 5-58 | 15.30±12.2 | 4-23 | 8.93±4.47 | **0.005** |

Mortality during the follow-up period was observed in 11 of 30 patients (36.7%) treated with DHS and in 14 of 45 patients (31.1%) treated with PFNA. A statistically significant effect on mortality was determined of advanced age and postoperative follow-up in intensive care unit ($p$=0.001, $p$=0.019, respectively).

Reasons for mortality during the postoperative hospitalization period or after discharge were determined as pulmonary thromboembolism in 12 patients, heart failure in eight patients, chronic diseases in two, gastrointestinal system bleeding due to cirrhosis in one, gastric bleeding in one and malignancy in one patient.

The time to mortality of patients was grouped as during the first 12 months postoperatively and after 12 months. Of the 22 patients who died in the first 12 months, 14 were treated with PFNA and eight with DHS. The three patients who died after the first 12 months were treated with DHS.

Classification of the patients with intertrochanteric femoral fractures was made according to AO-ASIF classification. Fracture distribution of the 30 DHS patients were 12 (40%) AO Ttype A1, 13 (43.3%) AO Ttype A2, and 5 (16.7%) AO Ttype A3. Fracture distribution of the 45 PFNA patients were 8 (17.7%) AO Ttype A1, 35 (77.7%) AO Ttype A2, and 2 (4.4%) AO Ttype.

Of the 30 patients treated with DHS, reduction degree was evaluated as good in 23 (77%) and unacceptable in seven patients (23%). Of the 45 patients treated with PFNA, reduction degree was evaluated as good in 28 (62.2%) and unacceptable in 17 (37.8%). No statistically significant difference was determined between the two groups in terms of reduction degree. On anterior-posterior and lateral radiographs of the hip taken during postoperative or control examinations, the implant position was evaluated as acceptable or unacceptable. In the 30 DHS patients, implant position was evaluated as acceptable in 21 (70%) and unacceptable in 9 (30%). In the 45 PFNA patients, implant position was evaluated as good in 40 (88.9%) and unacceptable in five patients (11.1%). The difference between the groups was statistically significant ($p$=0.004).

The median tip-apex distance was 28 mm (10-54 mm) in patients treated with DHS and 17.4 mm (3-48 mm) in the PFNA group. No statistically significant difference was determined between the two groups ($p$<0. 001).

Revision surgery was applied to two of the 30 patients (6.7%) treated with DHS and two of the 45 patients (4.5%) treated with PFNA. No statistically significant difference was determined between the two groups.

The total average hospitalization period was 15.3 (5-58) days for patients treated with DHS and 8.9 (4-23) days for the patients treated with PFNA. The hospitalization period of PFNA patients was statistically significantly shorter than that of the DHS group ($p$=0.005).

Postoperative complications were observed in two (6.7%) patients treated with DHS; in one patient, non-union was revised with PFNA and in one, a periprosthetic fracture observed on postoperative day 20 was revised with a long DHS plate. Postoperative complications were observed in two (4.5%) patients treated with PFNA; both patients had periprosthetic fracture during follow-up and were revised with PFNA Long. No statistically significant differences were determined between the groups in terms of postoperative complications.

The results of the Harris Hip Score, Jergesen Functional Score and VAS scores were very approximate to each other-with no statistically significant differences, although the Harris Hip Scores and Jergesen Functional Scores of the PFNA patients were seen to be better. Functional status and pain scores are presented in Table 2.

The costs of the 75 patients who underwent surgery for an intertrochanteric femoral fracture are shown in Table 3. Although the average implant cost of the PFNA patients were 63.6% more than the average implant cost of DHS patients, the revision and treatment costs of DHS patients were 47.8% more than those of the PFNA patients, which resulted in a total cost difference of 4%.

**Table 2.** Comparison of functional status and pain scores of the patients

| Variables | DHS (n=30 ) | | PFNA (n=45 ) | | p |
|---|---|---|---|---|---|
| | Min-Max | x̄±Ss | Min-Max | x̄±Ss | |
| **HHS** | 30-96 | 60.25±30.66 | 20-100 | 66.20±25.95 | 0.950 |
| **JFS** | 0-84 | 35.50±38.37 | 0-100 | 52.27±33.35 | 0.670 |
| **VAS** | | | | | |
| **Activity** | 0-7 | 3.00±2.94 | 0-7 | 2.72±2.19 | 0.973 |
| **Resting** | 0-5 | 1.50±2.38 | 0-5 | 2.08±1.90 | 0.555 |

**Table 3. Costs related to the implants**

| | Implant cost | Treatment cost | Total cost |
|---|---|---|---|
| **PFNA** | 3830 TL | 2594 TL | 6424 TL |
| **DHS** | 2340 TL | 3834 TL | 6174 TL |

## Discussion

Intertrochanteric hip fractures generally occur as a result of low-energy trauma in females aged>60 years [6-8]. The population aged over 65 years old was 323 million in 1990, and it is estimated that this will reach up to 1,5 billion by 2050. With extrapolation of this same ratio, it can be estimated that the 1.5 million hip fracture incidence will rise to 6.3 million [9]. The expected cost of hip fracture treatments in the USA, in 2040, is estimated to be 240 billion dollars and this leads to the necessity of developing cheaper implant materials and products [1].

Many implant models have been developed for the surgical treatment of intertrochanteric fractures. Although dynamic hip screws have maintained priority for stable hip fractures, there is controversy concerning the implants to be used on unstable fractures [8, 10]. Previous studies have shown that PFNA is a good choice for both stable and unstable fractures and PFNA is a simple operation with fewer postoperative complications and full postoperative mobilization of patients [11-13]. Meredy et al. [14] stated that the usage of PFNA is important especially on

unstable fractures and for osteoporotic patients, and the results are good.

Different outcomes are encountered in literature when the cut-out ratio and the difference in the tip-apex distance are considered [15, 16]. No cut-out was encountered in any of the current study patients, and the tip-apex distance was observed to be much shorter in the PFNA group than in the DHS group.

In a large patient series study by Radcliff et al, 1013 proximal femur nails and 1013 DHS were compared and no difference was determined in mortality rates between the two groups. [17], In the current study, no statistically significant difference was observed in terms of mortality between the DHS and PFNA groups.

The most important advantage of intramedullary nailing versus plating is early mobilization and rehabilitation. Mansukhani SA et al. [18], compared DHS and PFN in respect of functional status and no significant differences were determined at the end of the 12 months follow-up. In the current study, the two groups were evaluated according to the Harris Hip Score and the Jergesen Functional Score and no significant differences were observed.

Peri-implant femoral fracture is another complication encountered in intertrochanteric femur fracture treatment. Müller et al. [19] examined peri-implant femoral fractures in 705 cases of proximal femoral nail and 597 cases of dynamic hip screw and reported that the risk was more than three times higher with the use of PFN compared to DHS. In the current study, periprosthetic femur fracture was observed in 2 patients in the PFN group and in 1 patient in the DHS group. However, the patient series was not large enough to make any statistical evaluation in this respect.

Differences in mortality rates of PFN and DHS have been reported in literature. Guerra MT et al. [20] observed a higher mortality rate in the DHS group and Kumar R et al. [21] found similar mortality rates in their prospective study. In the current study the mortality rate in the PFN group was higher, but not statistically significant. This could be attributed to the factor of older average in the PFN group compared to the DHS group.

In a study by Jonnes C et al. [22] the average hospital stay was 12.4 days in the DHS group and 7.8 days in the PFN group ($p$=0.001). In the current study the duration of hospitalization of the patients treated with PFNA compared to patients treated with DHS was statistically significantly shorter ($p$=0.005). That may have been related to early mobilization and rehabilitation of the PFN group patients who required less intensive care and nursing services.

It's widely known that DHS is an older implant with lower application costs compared to PFNA. When a cost analysis was conducted in this study, it was observed that the difference between the hospital invoice costs of DHS patients and PFNA were close to each other. The reasons for the small difference between the costs were the shorter postoperative duration of hospitalisation, fewer hematological and biochemical tests at postoperative follow-up examinations, reduced treatment need in postoperative intensive care unit, and lower medical treatment costs. When both groups were compared in terms of non-union, revision surgery, complications and mortality, no statistically significant differences were observed.

When DHS is compared with PFNA in terms of functional results there is no significant difference. The costs of DHS were slightly lower and the complication, revision surgery and mortality rates of the two groups were identical. Therefore, DHS is still a preferable surgical method of treatment for intertrochanteric femur fractures.

**Disclosure of interest:** The authors declare that they have no competing interest.

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**Funding:** The authors received no financial support for the research and/or authorship of this article.