ORIGINAL ARTICLE

doi: 10.5455/medarh.2014.68.173-177

Med Arh. 2014 Jun; 68(3): 173-177
Received: February 28th 2014 | Accepted: May 05th 2014

Proximal Femoral Nail Antirotation in Treatment of Fractures of Proximal Femur

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ABSTRACT

Introduction: Fractures of the proximal femur and hip are relatively common injuries in adults and common source of morbidity and mortality among the elderly. Many methods have been recommended for the treatment of intertrochanteric fractures. **Material and methods:** We retrospective analyzed all the patients with fractures of the hip treated with proximal femoral nail antirotation (PFNA) at the Clinic of Orthopedic and Traumatology, University Clinical Centre Tuzla from the first of January 2012 to 31 December 2012 years. The study included 63 patients averaged 73.6±11.9 years (range, 29 to 88 years). Fracture type was classified as intertrochanteric (Arbeitsgemeinschaft für Osteosynthesefragen classification 31.A.1, A.2 and A.3) and subtrochanteric fractures (Seinsheimer classification). **Results and discussion:** The ratio between the genders female-male was 1.6:1. There was statistically significant difference prevalence of female compared to male patients (p=0.012). There were 31 left and 32 right hip fractured. Low energy trauma was the cause of fractures in 57(90.5%) patients. Averaged waiting time for hospitalization was 3.2±7.5 days (range, 0 to 32 days). 44 patients were admitted the same day upon injuring. The average waiting time for the treatment was 3.6±5.7 days. The ratio between with or without co-existent disease was 4.7:1. During the three months postoperatively with ASA score 3 and 4 six patients died. There were no significant differences in deaths from ASA score 1 and 2 (p=0.52). Reoperation for the treatment of implant or fracture-related complications was required in three (4.7%) patients (infection, reimplantation and extraction). Three patient developed deep vein thrombosis. Statistically significant difference was found in the deaths in the first three months compared to the next three months (p=0.02). We found statistically significant difference between pre-injury and postoperative mobility score (p=0.0001). **Conclusion:** PFNA is an excellent device for osteosynthesis as it can be easily inserted. Moreover, it provides stable fixation, which allows early full weightbearing mobilization of the patient.

Key words: fracture, femoris, PFNA, mobility.

1. INTRODUCTION

Fractures of the proximal femur and hip are relatively common injuries in adults and common source of morbidity and mortality among the elderly. Incidence of fractures is increasing, which is not unexpected because the general life expectancy of the population has increased significantly during the past few decades. Nearly nine of 10 hip fractures occur in patients older than 65 years old. Fractures of the upper part of the thigh bone (femur) are termed hip or proximal femoral fractures. Roughly half of all hip fractures are 'extracapsular' in that they lie outside the hip joint capsule. Extracapsular hip fractures are defined as those fractures that occur within the area of bone bounded by the attachment of the hip joint capsule and extending down to a level which is five centimeters below the distal (lower) border of the lesser trochanter (1).

Many of the patients have significant comorbidities, which lead to delays in surgery and functional recovery. These patients should be mobilized as soon as possible to prevent complications associated with immobilization. Therefore, a surgical technique allowing anatomic alignment and a stable fixation with early mobilization is accepted as the standard approach for intertrochanteric fractures. Surgeon can control of fracture reduction, implant selection and implant placement, all of which must be optimized to ensure the success of the surgical intervention. Operative treatment of hip fractures was introduced in the 1950s. Many methods have been recommended for the treatment of intertrochanteric fractures. Implants may be either extramedullary or intramedullary in nature. The most commonly used extramedullary implant is the sliding hip screw. A number of different designs have been developed and marketed by different manufacturers. Examples include the Gamma nail (Stryker-Howmedica), the intramedullary hip screw (Smith and Nephew Richards), the proximal femoral nail (Synthes) and the ACE trochanteric nail (DePuy Orthopaedics). PFNA, designed by AO in 2004, is an intramedullary device with a helical blade rather than a screw for better purchase in the femoral head (2, 3).

In this study, we aimed to assess the results of osteosynthesis using the PFNA system, (Synthes, Switzerland),

in the treatment fractures of the proximal femur included operative and postoperative complications, general complications and final outcome measurements.

2. STATISTICAL ANALYSIS

Data were analyzed using: Chi-Square, proportions and Wilcoxon test. For all tests, p values <0.05 were considered to be significant. Statistical analysis was performed using the SPSS statistical package, version 15.0 for Windows.

3. PATIENTS AND METHODS

After approval by the ethics committee of the hospital we retrospective analyzed all the patients with fractures of the hip treated with PFNA at the Clinic of Orthopedic and Traumatology, University Clinical Centre Tuzla from the first of January 2012 to 31 December 2012 years. The study included 63 patients. The supine position were used in all of the patients. All surgical operations except one were carried out under general anesthesia. All operations were performed using the traction table and fluoroscopy. After achievement of closed reduction the implant was inserted using minimally invasive technique. The desired position of the implant was a central position in the femoral neck on both AP and lateral views, and the tip within 5–10 mm from the subchondral bone. All nails were statically locked. The nail was inserted proximally to the tip of the greater trochanter without canal reaming except from proximal 17 mm reaming. The blade was inserted with drilling. Closed nails were placed in all of the patients with the exception of two patients. Bone grafting was not used in any of the 63 cases. Radiographs were examined to assess the fracture type, post-reduction deformity and union. Fracture type was classified as intertrochanteric (31.A.1, A.2 and A.3; Arbeitsgemeinschaft für Osteosynthesefragen classification) and subtrochanteric fractures (Seinsheimer classification) (4, 5).

Control radiography were performed in the period 6-8 weeks. Nonunion was defined by routine clinical and radiological criteria, and the need for a further surgical procedure. The absence of the radiologic features of fracture healing after four months represents delayed union. Quality of fracture reduction was assessed on postoperative radiographs. For the reduction to be considered unsatisfactory there was misalignment on the antero-posterior radiograph of more than 10 mm of any fragment, angulation of 10 degrees and more in any plane, and shortening of the leg bigger than 1 cm.

Duration of operation was measured as the interval between the start of the act reposition to the surgical wound closure. Duration of the fluoroscopy was determined as the number of issues exposure, read on the fluoroscopy device at the end of the operation. The blood transfusions performed during or after the operation were recorded in terms of units. Traffic accident and fall from height as fracture cause was defined as high-energy trauma. In three cases the PFNA was used in reosteosynthesis: one angular plate broken, one Targon PF (Aesculap) broken and one condylar plate cut out. Three patients were admitted from the intensive care unit.

In the present study, all patients received prophylactic antibiotic therapy as follows: 2grams of cefazolin or ceftriaxon were given before and 72h after treatments. Also low-molecular-weight heparin was administered once everyday for six weeks. After treatment, the muscles active contraction exercises were carried out, such as ankle active dorsiflexion and plantar flexion and isometric contraction activity of quadriceps. One day after, joint of lower extremity passive activities were carried out by the assistance of rehabilitation therapists. After 2-3 days, the initiative straight leg and raising, and joint of lower extremity activity were carried out. After 4-6 days, (depending on the general condition) these patients were allowed to out-of-bed activity. All cases were mobilized using a walker if the walking was possible. On admission the medical condition was assessed and classified according to the American Society of Anaesthesiologists (ASA) grade (6). Health status was classified as poor (ASA 3–4) or good (ASA 1–2) (7). Prefracture and postoperativ functional level evaluated by the New Mobility Score (NMS) with a scale of 0 (immobile) to 9 (independently mobile) (8). During the work on the study, we contacted 56 patients (excluding two died in the hospital and no contact with five) or their family members by phone, which gave us information about the functional level evaluated by the NMS. The mean length of follow up was 22 months (range 14 to 25).

4. RESULTS

The study included 39 female patients and 24 male, averaged 73.6±11.9 years (range, 29 to 88 years). The ratio between the genders female-male was 1.6:1. There was statistically significant difference prevalence of female compared to male patients (p=0.012). There were 31 left and 32 right hip fractured. Low energy trauma was the cause of fractures in 57(90.5%) patients, fall from height three, traffic accidents two and one suicide attempt. All fractures were closed. Isolated fracture of the hip was in 57(90.5%) patients. Averaged waiting time for hospitalization was 3.2± 7.5 days (range, 0 to 32 days). 44 patients received the same day by injuring. The average waiting time for treatment was 3.6±5.7 days. Eight patients were treated on the same day after suffering the injury. The average length of hospital stay was 12.9±6.2 days. In 26(41.2%) patients the length of hospital stay was ≥10 days. The longest hospitalization was 43 days (patients with deep infection and subsequent nonunion) and another 41 days (with refixation, deep infection with Escherichia coli and Acinetobacter species and lethal outcome).

One patient was admitted to the hospital the same day after the injury. Because of urinary infection, suffered ICV a month ago, heart disease, and hypertension he did not receive consent for the operation. He was discharged to outpatient treatment and admitted to hospital again 25 days after injury. Seven days upon the second hospitalization he was operated. One 81-years-old female patient with a fracture was admitted 29 days after injury. Suspecting the hypostatic pneumonia she was treated with antibiotics (Ciprofloxacine eight days). As the CT of the lungs did not verify the pneumonia the patient got approval for surgery. In the postoperative course the patient got enterocolitis and died four days later. It was the longest waiting time for surgery (37 days).

0	1		2-3		≥3	
N %	N	%	N	%	N	%
11 18%	13	22%	29	48%	7	12%

Table 1. Number of co-existent disease

The ratio between with or without co-existent disease was 4.7:1 (Table 1). It was a significant difference between patients with two or more comorbidities compared to one or no comorbidity (p = 0.048). Of the 14 deaths two patients had no comorbidities. 28 (44.4%) patients had previous surgery (p=0.0001). Eight patients had eye surgery, two other hip fracture, and one knee prosthesis.

Good health status	1	8	13%
	2	28	44%
Poor health status	3	25	40%
	4	2	3%

Table 2. ASA score health status

There were no statistically significant differences between the patients of good and poor health status (p=0.164) (Table 2). During the three months postoperatively with ASA score 3 and 4 six patients died. There were no significant differences in deaths compared to ASA score of 1 and 2 (p=0.52). Fracture type was classified as: 48 intertrochanteric and 15 subtrochanteric. There were a statistically significant difference between intertrochanteric and subtrochanteric fractures (p=0.0001). 19 were classified as 31-A1; 13 as 31-A2; and 16 as 31-A3. Subtrochanteric type was classified as: 2 as II A; 2 as IIB; 1 as IIC; 3 as IIIA; 1 as IIIB; 1 as IV; 5 as V. There were no statistically significant differences between types A1, A2, A3 fractures (p=0.56). There were no statistically significant difference between stable and unstable fractures (p = 0.06).

18 (38.6%) patients did not receive blood. On average, each patient received 543.8±624 ml of blood or blood products. Most blood, 3300 ml, received a patient with attempted suicide (fracture of the pelvis), and patients with infection, revision surgery and nonunion 2530 ml. It was found significantly more patients who received blood or blood products (p=0.0001). The number of intraoperative radiation exposure was 65 (range, 13 to 148 exposures). The average duration of surgery was 73.1±38 min (range, 30 to 210 min).

Deeply placed nail		Long or short blade		Longer locked screw		Nail prominence	
N %		N	%	N	%	N	%
2 3.1		6	9.3	1	1.58	2	3.1

Table 3. Technical errors

In 13(20.6%) patients were not strictly followed the technical steps (p=0.009) (Table 3). Of the two poor positioning the blade in one we performed reoperation 12 days after the first surgery (infection and died). Another poor positioned blade is brought to cut out, nonunion and removal of the same (Table 4).

Fracture of greater trochanter		Poor reduction		Limb shortening		Poor position blade	
N %		N	%	N	%	N	%
1 1.58		5	7.93	3	4.76	2	3.1

Table 4. Intraoperative complications

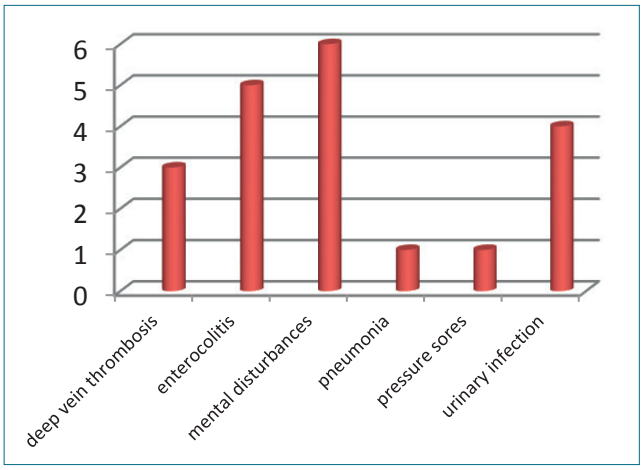

Figure 1. Post-operative complications and hospital stay

The most common postoperative complication in the treatment was mental disturbances (p=0.017). Five out of six subjects, the ASA was 3 and 4 but there was no statistical significance (p=0.09). Two patient developed deep vein thrombosis and was diagnosed by phlebography. One patient developed deep vein thrombosis and was diagnosed by color Doppler sonography after a week postoperatively and treated by the high dose of low-molecular-weight heparin (Figure 1).

Reoperation for the treatment of implant or fracture-related complications was required in three patients (infection, reimplantation and extraction). There were three nonunion: one is infected nonunion (Staphylococcus aureus), one after the cut outs (the blade was poor

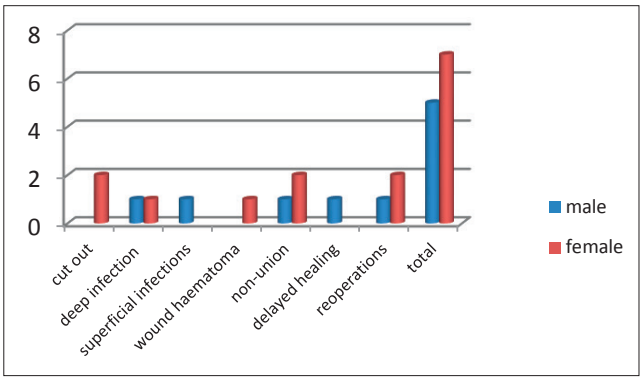

Figure 2. Fracture-related postoperative complications and gender of the patient

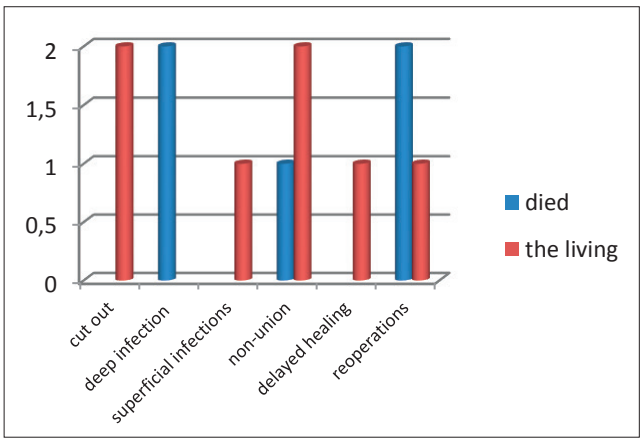

Figure 3. Fracture-related postoperative complications and outcome

placed). The three patients underwent reoperation: after the broken Targon PF, occurred cut out blade (nonunion, dropped from the new operative treatment, patient alive, walk with a walker indoors), and when we removed the broken angular plates of 130°, there was a healing and a full functional recovery (NMS=9), after removal of the condylar blade plate and complications with urinary infection, the patient did not walk and died the eighty-eighth postoperative day. Delayed healing was patient with poor reduction (Figure 2, 3).

There was no mechanical failure of the implants despite the early patient mobilization.

Of the 16 deaths, eight were females. The incidence of deaths in the first three months was more frequent (10/16) of which seven women (p=0.20). Two patients died in the early postoperative period in the hospital and one for complications nine months after surgery (Figure 4).

Two patients have been moved to the physiotherapy and the others were discharged home, regardless of

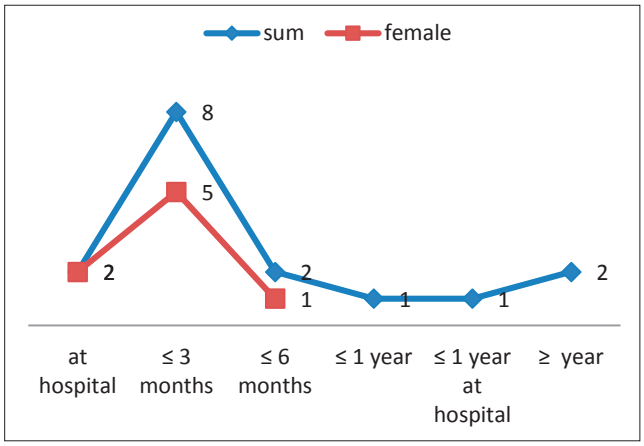

Figure 4. Died postoperatively.

functional recovery. 20(34.4%) of the patients regained the pre-trauma mobility. One patient who returned to pre-fracture mobility status died after 15 and the other after 19 months. 38 patients had not returned to pre-fracture mobility status. Wilcoxon test was used to establish whether differences of parameters measuring preinjury and postoperative mobility score. We found statistically significant difference (p=0.0001) in preinjury and postoperative mobility score.

5. DISCUSSION

The incidence of hip fractures has been growing as a result of longer life expectancy owing to better quality of life but also better health care. These patients usually have additional systemic diseases and require prolonged hospital stay after fracture occurrence, making them susceptible to many complications that adversely affect prognosis and increase mortality, such as deep vein thrombosis, pulmonary embolism, pneumonia, urinary tract infections, and pressure ulcers. For this reason, there is general consensus in the literature that the primary goal of treatment should be to obtain a stable fixation of the fracture that will allow early mobilization (1).

Siegmeth at al. study on 3628 patients shows a significant increase in length of stay that was found in patients operated on after 48 hours when compared with those in the earlier group (21.6 vs 32.5 days). Their study did not find any difference in mortality rates for patients who underwent surgery within 48 hours of admission. The mortality rate for those undergoing surgery after this increased from 7% to 15.8%. Any delay of more than 48 hours, other than to improve an acute and treatable condition, must be avoided (2). In our study there were 33(52.3%) patients operated on within 72 h of their injury, the average length of hospital stay was 12.9±6.2 days. In 26(41.2%) patients the length of hospital stay was ≥10 days. Complications following hip fracture surgery shows a significant increase in length of hospital stay.

Comorbidities before and complications following hip fracture surgery can impact the return of function. The ASA class is strongly associated with medical problems in the perioperative period following hip fracture surgery in the elderly. Patients in ASA class 3 had a 3.78 times greater chance of having a medical complication than did those in class 2 ($p < 0.001$). Patients in ASA class 4 had a 7.39 times greater chance of having medical complications than did those in class 2 ($p = 0.001$). No significant relationship was identified between the ASA class and surgical complications (9). In our study there were no statistically significant differences in the patients of good and poor health status (p=0.164). During the three months postoperatively with ASA score 3 and 4 six patients died. There were no significant differences in deaths compared to ASA score of 1 and 2 (p=0.52). The most common postoperative complication in the treatment was mental disturbances (p=0.017). Five out of six subjects, the ASA was 3 and 4 but there was no statistical significance (p=0.09).

Kenzora et al. concluded that a delay of more than 24 hours resulted in a mortality rate of 34% vs 11% for patients treated between the second and fifth day. They included patients with serious medical comorbidities in their study, and recommended a delay of 24 hours to treat and improve acute medical conditions (10). Efstathopoulos at al. believe that early operation was crucial for the good functional outcome and for the absence of serious postoperative complications. All 112 patients were operated on within 36 h of their injury, and 59% of the patients were operated on within the first 6 h. At the latest follow-up, 65% of the patients of the Gamma nail group and 63% of the patients of the ACE TN group had reached the preoperative mobility status. Additionally, there was no significant difference between the two groups as far as the final mobility scores were concerned. Of the patients five were lost to follow-up and 19 died within the study period (3).

Considering the injuries, the length of hospitalization and surgeries in our study, we expected to have poorer results. Of the patients 16 died within the study period. The mortality rate was 24.1% during the period up to one year. Statistically significant difference was found in the deaths in the first three months compared to the next three months (p=0.02). Postoperatively, five patients were not available to follow up. Of the patients, 20(34.4%) regained the pre-trauma mobility. 38 patients had not returned to pre-fracture mobility status. We found statistically significant difference (p=0.0001) in preinjury and postoperative mobility score.

Theoretically and experimentally due to de-central implant positioning the load torque can outrun resistance of the cancellous bone around the implant in normal daily activities. The rotation of the head might lead to a cutting out. The center-center position in the head of femur of any kind of lag screw or blade is to be achieved to minimize rotation of the femoral head and to prevent further mechanical complications (11). In our study there were the two poor positioning the blade. In one, 12 days after the first surgery was performed reoperation (infection and died). Another poor positioned blade is brought to cut out, nonunion and removal of the same.

Gardenbroek at al. study shows that osteosynthesis with the PFNA does not improve the position of the implant in the femoral head compared with the PFN. However, the risk of a secondary complication and the necessity of a late reoperation are significantly higher in patients treated with a PFN compared with patients treated with a PFNA Because of implant-related complications, three patients in the PFN group and four patients in the PFNA group needed an early reoperation (p=0.136) (12). In our study, long or short blade was no indication of a new surgical treatment. After the broken Targon PF, occurred cut out blade (nonunion, dropped from the new operative treatment, patient alive, walk with a walker indoors). Reoperation for the treatment of implant or fracture-related complications was required in three (4.7%) patients (infection, reimplantation and extraction).

The analysis PFNA and PFNAII Macheras at al. emphasizes that regardless of the implant choice and its specific technical characteristics, in the end, it is the technique of inserting it properly that is the key to succeed with stable fixation and prevent major complications (13). In our study there were 13(20.6%) patients where not strictly followed the technical steps with one cut out (p = 0.009). There were two deep and one superficial infection (4.8%). In a large study from Strasbourg in 3066 patients was 1.5% infection and 1.85% cut out (14).

The American College of Surgeons National Surgical Quality Improvement Program database was used to identify 4331 patients undergoing surgery for hip fracture. Thirty-day mortality was 5.9%. Patient age, especially age greater than 80 years and male gender were associated with both increased mortality and morbidity. Additionally, complete functional dependence, active malignancy, patient race, cardiopulmonary disease, laboratory derangements, prolonged operating time, and open versus percutaneous surgery independently influenced outcomes (15). In our study of the 16 deaths, eight were females. The incidence of deaths in the first three months was more frequent (10/16) of which seven women (p = 0.20). Two patients died in the early postoperative period in the hospital and one for complications nine months after surgery. Of the 14 deaths two patients had no comorbidities.

Surgical technique is an important factor in the outcome of treatment for intertrochanteric hip fracture, and that it can be influenced by education and improved methods of assessment (16). PFNA has shared an excellent implant for a wide variety of indications. However, adequate knowledge and experience of operative technique is imperative (17).

CONFLICT OF INTEREST: NONE DECLARED

6. CONCLUSION

Despite the poor results in the treatment of intertrochanteric fractures in comparison with other studies which occur as a result: a longer time the past from injury to admission, time from admission to surgery, comorbidity, lack of proper implants and deviations from strict surgical techniques, we have concluded that PFNA is an excellent device for osteosynthesis as it can be easily inserted and provides stable fixation, which allows early full weight bearing mobilization of the patient. Technical steps must be strictly followed.

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