Abstract
Currently, intramedullary devices are widely used for the treatment of trochanteric femoral fractures. A new device designed by AO/ASIF, the PFNA (proximal femoral nail antirotation), represents a unique intramedullary nail system for improved management, particularly in the elderly. The aim of the present study was to analyze the results of treatment with PFNA in 50 patients with trochanteric fractures. The operating time, intraoperative blood loss, and intraoperative and postoperative complications were recorded. The length of the surgical procedure averaged 20.3 min, and intraoperative blood loss averaged 22.8 mL. Reoperation was necessary in two patients (4%). We conclude that the PFNA nail is as effective as other implants in the treatment of trochanteric fractures.

Trochanteric fractures represent a major health risk for elderly individuals. Although a large number of different implants are available for fixation, the ideal implant for treatment of peritrochanteric fractures is still a matter for discussion. The imperative goals of treatment are early mobilization by means of stable fixation using as minimally invasive a procedure as possible. Intramedullary devices appear to be most appropriate in view of their biomechanical properties. However, perioperative and postoperative technical complications are common in some cases, necessitating reoperation.1-3 The proximal femoral nail (PFN) was designed by AO/ASIF to solve the problems associated with the use of intramedullary fixation devices. Several studies have demonstrated a good outcome with few complications after treatment with the PFN.4-6

Recently, the AO/ASIF developed and introduced a new intramedullary nail system, the proximal femoral nail antirotation, which is generally referred to as the PFNA (Fig. 1). This new implant design was intended to improve the treatment of trochanteric fractures, especially in elderly patients. Short-term results of the PFNA relative to complications, outcome, and advantages and disadvantages are herein described.

Proximal Femoral Nail Antirotation
The PFNA system was developed by the AO/ASIF in 2004. The main design characteristic of the implant is the use of a single blade with a large surface area. Insertion of the blade compacts the cancellous bone. These characteristics provide optimal anchoring and stability when the implant is inserted into osteoporotic bone.

The PFNA XS (extra small) has been developed for Asian patients (Fig. 2). Since Asian patients have a narrower and shorter femur than Americans or Europeans, this nail was engineered, accordingly, with a narrower and shorter stem. The nail measures 170 mm. The distal part of the nail is available in diameters of 9, 10, 11, or 12 mm, and its proximal part is 16.5 mm in diameter. The angle of both distal and proximal parts is 6°. The tip of the nail is specially shaped to reduce stress concentration, as in the PFN.5,6 Distal locking can be static or dynamic.

Operative Technique
Surgery was carried out under spinal anaesthesia. A fracture table and image intensifier were used in all cases. The PFNA was inserted without reaming of the medullary canal. The
guide wire for the blade was introduced into the femoral neck in such a way that the blade would be placed into the lower half of the neck in the AP view and centrally in the lateral view through the aiming arm to decrease tip-apex distance. The blade, attached to a special inserter, was introduced over the guide wire with a hammer. Once the introduction was complete, the blade could be locked to prevent rotation. The PFNA can be distally locked either dynamically or statically.

Materials and Methods

A retrospective study was performed of 50 consecutive patients with trochanteric fractures, who were treated by osteosynthesis with the PFNA XS between 2003 and 2005. Clinical and radiographic controls were performed on admission to the hospital and at 1 and 3 months and, thereafter, at 3-month intervals in the outpatient clinic. A minimum follow-up of 4 months was required. The average follow-up period was 6.5 months (range, 4 to 21 months). Fractures were classified according to AO classification.

Operating time and operative blood loss were recorded, together with early and late intraoperative and postoperative complications.

Results

The age, sex, and type of fracture for each patient are shown in Table 1. The average age at the time of injury was 84 years (range, 63 to 94). This group included five male and 45 female patients. Type A1 fractures were the most common in the study and were seen in 25 patients (50%). Type A2 fractures were found in 20 patients (40%) and type A3 in 5 (5%). All fractures had resulted from a low-energy injury, most often a fall. The length of the surgical procedure averaged 20.3 minutes (range, 9 to 83 minutes). Intraoperative blood loss averaged 22.8 mL (range, 5 to 100 mL). Closed reduction of the fracture was successful in all patients. Intraoperative and postoperative complications are listed in Table 2. There were no cases of deep infection and no failures or breakages due to implant fatigue. Fracture of the greater trochanter during insertion of the nail was seen in one patient, and treated conservatively. Lateral sliding of the blade (> 10 mm) due to impaction of the fracture was seen in four patients but did not necessitate reoperation, because

<table>
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<tr>
<th>Type of fracture</th>
<th>PFNA (N = 50)</th>
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<td>A1</td>
<td>25 (50%)</td>
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<tr>
<td>A2</td>
<td>20 (40%)</td>
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<td>A3</td>
<td>5 (5%)</td>
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<th>PFNA (N = 50)</th>
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<tr>
<td>Superficial infection</td>
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<td>Greater trochanter fracture</td>
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<td>Lateral sliding of the blade (&gt; 10 mm)</td>
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<td>Cut out</td>
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<td>Diaphyseal fracture</td>
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the patients were asymptomatic.

Reoperation was necessary in two patients (4%). One was a case of cut-out and was treated using a bipolar hip prosthesis. The other was a fracture of the femoral shaft below the tip of the implant and was due to new trauma. This case was treated using a PFNA long (340 mm) and healed uneventfully. Fracture union was achieved in all cases except the one case of cut-out.

Discussion

Trochanteric fractures occur mostly in elderly patients, and the outcome may be extremely poor if there is prolonged bedrest. Stable fixation that allows early mobilization is the treatment of choice. The best treatment for trochanteric fracture remains controversial. Intramedullary devices are currently used widely because of their mechanical and biological advantages. The objective of this study was to ascertain whether the PFNA is as effective as other intramedullary devices.

The PFNA was developed to obtain better fixation strength in the presence of osteoporotic bone, using a simpler technique in comparison with other implants. The inserted PFNA blade achieves an excellent fit through bone compaction and requires less bone removal compared to a screw. Biomechanical tests have demonstrated that the blade has a significantly higher cut-out resistance than commonly used screw systems. The PFNA blade may be a more suitable implant biomechanically for unstable trochanteric fractures and trochanteric fractures associated with osteoporotic bone. However, our study revealed that the PFNA blade cut-out can be due to inadequate insertion. A careful and adequate insertion of the blade or lag screw may be a more important consideration than the biomechanical stability.

In this study, operating time and operative blood loss seemed to be lower, compared with previous study of the PFN. Although more accurate analysis with a randomized clinical trial is necessary, we attributed this to the fact that the PFNA has a single blade, which may allow for a simpler operative procedure than that of the PFN. Thus, the PFNA, with a lower degree of invasiveness in terms of operative procedure, may be a better implant for trochanteric fractures, especially in elderly patients.

The PFN was developed to solve problems such as the perioperative and postoperative technical complications described in patients treated with the gamma nail. According to the literature, these complications, which necessitate reoperation, occur in 3% to 7% of cases. In this study, the reoperation rate (4%) was as low as that of the PFN. There were two cases of reoperation in our series. One was a diaphyseal fracture due to an accidental fall, and the other was a case of cut-out due to inadequate insertion of the blade. The latter case indicates that careful and adequate insertion of the blade or lag screw is one of the most important considerations for preventing complications, as described previously.

We identified the complication of concern, the lateral protrusion of sliding blades in four patients. Although local tenderness over the lateral aspect of the thigh has been described in the use of other intramedullary implants, fortunately our study did not identify these discomforts. The reason may be the tail of the PFNA blade, which is a processed rounded shape that could contribute to a reduction in stimulation of the skin and fascia. However, it is important to pay attention to the telescoping or local tenderness of the lateral thigh in further studies, because the PFNA blade must be impacted without reaming, and this may cause the marked degree of the telescoping.

Conclusions

We concluded that the newly developed PFNA is as effective as previously reported intramedullary devices. Even if the complication rates of the PFNA implant were lower than in most previous studies of the gamma nail, we must carefully chose the implants for treatment of trochanteric fracture based on individual patient assessment. Furthermore, there are several limitations to our study. Dual-energy X-ray absorptiometry (DEXA) measurements to quantify bone mineral density (BMD) were not performed. A randomized trial comparing the PFNA with other devices in elderly patients with osteoporotic bone, evaluated with a BMD study, will probably be required for definitive assessment. While there are numerous operative devices for treatment of trochanteric fractures, none of them are totally free of complications. Therefore, it goes without saying that optimal reduction and an appropriate choice of surgical procedure are most important.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

References

6. Al-yassari G, Langstaff RJ, Jones JW, Al Lami M. The AO/ASIF proximal femoral nail (PFN) for the treatment of un-


