ABSTRACT

Aim: To analyse the early complications following the use of PFN in subtrochanteric fractures. Background: Osteosynthesis with PFN in subtrochanteric fracture features the advantages of high rotational stability of the head–neck fragment, an unreamed implantation technique and the possibility of static or dynamic distal locking. However, the use of the nail requires technical expertise and is accompanied by some risks of error which can lead to osteosynthesis failure. Methods: Between May 2009 and May 2011, 50 consecutive patients with PFN fixations for subtrochanteric fractures were observed for intraoperative and postoperative complications. Results: We identified intraoperative technical difficulties in four patients and six patients showed postoperative complications. Conclusion: When subtrochanteric fractures are to be stabilised with a PFN, the precise and expert technical performance of implantation is the basic surgical requirement. Good reduction with minimal dissection and the use of an appropriate implant is necessary to avoid treatment failure.

Key Words: Subtrochanteric fractures, trochanteric fractures, proximal femoral nail, PFN.

INTRODUCTION

Subtrochanteric fractures account for 7 to 44% of all proximal femoral fractures1,3. The inherent instability of the fracture and the enormous muscle forces acting across the fracture fragments render treatment options difficult5. Often, these fractures are comminuted. A medial buttress is important to minimise implant stress and fatigue failure5,17, but when comminution is severe, this cannot be achieved. Options for surgical stabilization of subtrochanteric fractures include dynamic hip screw, gamma nail, proximal femoral nail (PFN) and proximal femoral plates. Intramedullary devices such as PFNs are biomechanically stronger and more rigid compared to extramedullary devices such as dynamic hip screws6. Fixation with PFN using Association for Osteosynthesis/Association for Study of Internal Fixation (AO/ASIF) techniques has been reported to produce superior results compared to other fixation devices5. Osteosynthesis with the PFN offers the advantages of high rotational stability of the head–neck fragment, an unreamed implantation technique and the possibility of static or dynamic distal locking10.

The operative technique of proximal femoral nailing for subtrochanteric fractures has a steep learning curve11,12. Precise fracture reduction and adherence to the principles of PFN are crucial in the management of subtrochanteric fractures. We report our early experience with PFN in the management of subtrochanteric fractures and the accompanying complications.

MATERIALS AND METHODS

Fifty consecutive patients with subtrochanteric fractures who underwent intramedullary fixation with PFN, all performed by a single surgeon in our hospital during two-year period from May 2009 to May 2011 were included in this study. The Seinsheimer classification1 classification system was used to classify the fractures (Table I). All patients underwent femoral nailing.

All closed subtrochanteric fractures in adults treated with short PFNs with a minimum follow up period of one year were included in this study. Those with open subtrochanteric fractures and those treated with long PFNs were not included in this study. Postoperative rehabilitation protocol included: Day 0, static quadriceps exercises and ankle pump; Day 1, in bed, knee mobilisation exercises; Day 2, if fracture construct and fixation stable, partial weight bearing started as tolerated; if fracture construct and fixation unstable, weight bearing started after 6 weeks.

All patients who underwent surgery with short PFNs were placed in supine position on the fracture table. The limb was kept in traction and adducted. Entry point was visualised under C-arm guidance and a guide wire passed across the fracture site. Under C-arm guidance, a short PFN with proximal and distal locking was inserted to fix the fracture.

RESULTS AND DISCUSSION

In the present study, fifty patients were treated with PFN, of which ten encountered complications and treatment failure.

Corresponding Author: Narayanan VL, Sakthi Medicare Center, 112, Bazaar Street, Chidambaram, Tamil Nadu, India, Pin - 608002
Email: vlnars@gmail.com, raghukanthi@sify.com
Loss of reduction, inadequate fixation, a need to change implant and breakage of nails were considered as implant failure. The age distribution was from 24- to 60-years-old with an average age of 46-years-old. Thirty-two were males and eighteen were females. The right side was involved in thirty patients and the left side was involved in twenty patients. The mean follow up was twelve months (Table II).

Thirty-eight patients underwent closed reduction whereas twelve patients required open reduction. Ten out of fifty patients encountered complications. All were early complications and causes for failure were analysed. Complications include broken nail at the distal locking screw level(4%), screw back out(2%), perioperative proximal femur fracture(2%), inadequate fracture reduction(2%), varus deformity(2%), improper positioning of distal locking screw(2%), placement of single screw in the neck(2%), abductor lurch(2%) and superficial infection (2%) (Table III).

Subtrochanteric fractures are generally associated with slightly higher failure rates compared to other fractures\textsuperscript{13}. In a multicentre study, the failure rate of PFN secondary to poor reduction, malrotation or wrong choice of screw was reported to be 5%, whereas the screw cut out rate was reported to be 0.6%. The reasons for failure include the higher intrinsic instability of the subtrochanteric fracture, poor control of fracture fragments\textsuperscript{13} and the difficulty in achieving the medial buttress due to comminution.

Intramedullary nails with an entry point in the piriformis fossa have a tendency to displace the proximal fragment into varus or may even explode the proximal femur during insertion\textsuperscript{14}. The nail insertion point for the PFN should be at or slightly lateral to the tip of the greater trochanter\textsuperscript{14}.

The proximal component of the PFN construct consists of two screws- the larger (lag) screw is designed to take the load, and the smaller screw (hip pin) provides rotational

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<tr>
<th>Table I: SEINSHEIMER Classification</th>
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<th>Table II: Patient demographics and outcome</th>
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<tbody>
<tr>
<td><strong>Parameters</strong></td>
</tr>
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<td>Mean age (years)</td>
</tr>
<tr>
<td>Gender</td>
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<td>Mean time for fracture union (weeks)</td>
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<td>Complication (%)</td>
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<th>Table III: Complications of treatment</th>
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<td><strong>Complications</strong></td>
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<td>Implant broken</td>
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<td>Proximal femur fracture</td>
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<td>Screw cutout</td>
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<td>Varus deformity</td>
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<td>Inadequate fracture reduction</td>
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<td>Improper positioning of distal locking screw</td>
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<td>Abductor lurch</td>
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<td>Superficial infection</td>
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<td>Single neck screw</td>
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Complications in Proximal Femoral Nail

The lag screw is longer than the hip pin, because if the hip pin was longer than the lag screw, vertical forces would increase on the hip pin thereby inducing cut out, a knife effect or Z-effect. This might force the hip pin to migrate into the joint and the lag screw to slide laterally.\(^{15,16}\)

The cut out rate with use of PFNs is reported to be 0.6% to 8%\(^{17}\). Overall, ten patients (20%) encountered complication. All complications were either perioperative, immediate postoperative or within three months of the index procedure.

In one patient, the hip pin slide laterally at the sixth postoperative week. This was due to incorrect choice of length for the lag screw and hip pin (the hip pin was longer than the lag screw, Figure 1).

Two complications consisted of implant failure at the distal locking screw hole with breakage of nail. One patient had breakage ten weeks postoperatively and the other at fourteen

Fig. 1: Hip pin longer than lag screw.

Fig. 2: Nail breakage at the distal interlocking level.

Fig. 3: Intraoperative femoral shaft fracture.

Fig. 4: Screw cut-out (hip pin backing out).

Fig. 5: Ten degree varus deformity of the femur.
weeks (Figure 2). In both the patients, a short PFN was used.
The distal tip of the nail was close to the fracture site (3cm
and 4cm), an appropriate distance as cited in a previous
publication\textsuperscript{11}. We found no other clarification of the
minimum effective distance between the distal locking screw
and the fracture site. Ideally, the distal tip of the nail and the
distal locking screw hole of the implant should be at a
distance distal to the fracture that will provide sufficient
mechanical stability but exert minimal internal mechanical
stress on the implant. In subsequent cases, we used long
PFN for all comminuted fractures as they are inherently
unstable even after fixation.

One patient suffered an intraoperative fracture of the
proximal femur fragment. This complication was due to use
of an incorrect entry point. For regular intramedullary
nailing, the preferred entry point is at the piriformis fossa.
but for PFNs it is at or slightly lateral to the tip of the greater
trochanter\textsuperscript{14}. If the PFN is passed at the piriformis fossa, the
proximal fragment tends to displace into varus and may even
explode the greater trochanter during nail insertion\textsuperscript{14}. This is
what happened with our patient (Figure 3). The nail was then
exchanged and proximal femoral plating with bone grafting
was performed. This patient had a delay in fracture healing
(radiological union was not present until 20 weeks after
surgery).

The hip pin should preferably be 10 mm shorter than the lag
screw to reduce the load carried by the hip pin. One of our
patients, who had a screw backing out (Figure 4), underwent
a revision surgery and subsequently the fracture healed. In
one patient, placement of both the lag screw and the hip pin
in the neck was not possible. It was due to a very small
femoral neck which could not accommodate both screws.
Despite attempting to vary the position of the nail, both the
screws could not be placed. It was decided to leave the
patient with just the lag screw. This patient went on to union
in the usual time frame. One patient had varus deformity due
to failure of reduction at the fracture site (Figure 5). The
varus was less than ten degrees and no attempt was made to
revisit. Fracture union was uneventful. One patient had
wrong placement of distal locking screw. In this case short
PFN was used. As the radiological union was evident at first
review in six weeks no intervention was done. However the
postoperative rehabilitation was not aggressive. The other
two complications were superficial wound infection and
abductor lurch when the patient started walking. The
infection was treated with wound wash and specific
antibiotics. The other patient with abductor lurch improved
with progression of time.

In PFN fixations, proper alignment between the two main
fragments and proper placement of the lag screws in the
femoral head should be ensured\textsuperscript{18}. It is imperative to reduce
fractures with minimal dissection to achieve a stable
fixation, with an emphasis on good closed reduction.
Restoration of the axis and rotation between the head-neck
fragment and the shaft is mandatory. A long nail is needed for
fractures that extend distally. Multiple factors have been
implicated as relevant to good outcomes; these include
implant design, fracture stability, operative technique,
surgeon skills and learning curve. Optimal reduction of the
fracture, conformation of reduction in both anteroposterior
and lateral views and accurate positioning of the nail and
screws remain of crucial importance and should be obtained
at all times to prevent the important complication of screw
cut-out. Reduction in distal nail diameter, pre-reaming of the
femoral canal one size bigger than the implant and
meticulous placement of the distal locking screws without
creating additional stress risers decreases the complication
rate of femoral shaft fractures. Intramedullary fixation with
PFN is contraindicated in patients with narrow femoral
canals and/or abnormal curvature of the proximal femur.

**CONCLUSION**

Though the Asian version of the PFN is designed with a
smaller diameter to accommodate for our population, it still
poses problems in fixation. A surgeon needs to adhere to
precise, meticulous and expert surgical technique.
Placement of proximal locking screws – the lag screw and
the hip pin are not possible in certain patients. Further
modifications of nail design may be required to suit the
Asian population.
REFERENCES