The bridging nail in periprosthetic fractures of the hip. Incidence, biomechanics, histology and clinical outcomes
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CHAPTER 8

A less invasive salvage procedure for fractures below intramedullary nails of the proximal femur.

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Submitted
Abstract

Fractures around the intramedullary component of a trochanteric nail are rare complications but a large threat to the geriatric patient. Standard therapy consists of removal and re-insertion of a longer nail or the use of extramedullar implants. A less invasive method is the use of a retrograde nail which clamps the distal intramedullary nail. This eliminates the removal of the lag screw and exposure of the trochanteric region. Four patients (mean age 86.8 years), all female, were treated with the Bridging nail. The mean operative time was 75 minutes. At follow-up (mean 23.5 months) all patients regained preoperative functional level. The fractures showed consolidation in all cases. In conclusion, in geriatric patients, the retrograde bridging nail is a therapeutic option in treatment of fractures around an intramedullary nail in the proximal femur.
A less invasive salvage procedure for fractures below intramedullary nails

Introduction

Subtrochanteric fractures of the femur, caused by low-energy trauma, are less common than other proximal femoral fractures, however they occur in a similar population of elderly individuals. For the surgical fixation of extracapsular hip fractures two types of implants are mainly used; intramedullary nails and Sliding hip screws (SHS). Operative stabilisation of these fractures in the elderly is often technically difficult because of fracture comminution and osteoporosis. The optimal treatment of extracapsular hip fractures is still under debate, particularly for unstable multifragmented fractures. Of the intramedullary nails, the Gamma nail(r) is the most frequently used device, other intramedullary implants are the intramedullary hip screw (IMHS), the proximal femoral nail (PFN) and the Küntscher-Y nail.

The primary reason that the SHS is favoured in the meta-analysis by Parker is the occurrence of late fractures below the nail. This complication, although rare, is devastating for the patient requiring either major revision surgery or a prolonged period of traction and bed rest. This complication occurred in 2.7% of Gamma nailing and only in 0.16% of the cases of SHS fixation. Pooled results show that using these nails results in one extra later femur fracture in every 50 trial participants (95% CI; 1 in 33 to 1 in 100) and one extra re-operation in every 50 trial participants (95% CI; 1 in 33 to 1 in 100).

Treatment options for these fractures are: Removal of the nail and insertion of a long gamma-nail, a long DCS, LISS(R)-plating, cerclages (e.g. Partridge) with or without cortical allograft struts® and various systems of cable-plate fixation.

Closed retrograde nailing is a common solution for distal femoral fractures below an intramedullary nail and attractive for its minimal invasive aspects. However, retrograde nailing below an intramedullary leaves a possible stress-rising zone between the ends of the implants. Creating a rigid fixation between the intramedullary implant and the stem would solve this problem.

Good salvage experiences in treating periprosthetic fractures with retrograde femoral nails, that were guided over the tip of hip prostheses through a retrograde approach, initiated the use of the nail in fractures below the Gamma-nail(R). The first four patients treated with this Bridging nail are presented.

Materials & Methods

An adapted retrograde femoral nail is used to perform the osteosynthesis. The length is measured using an image intensifier and a sterile measuring staff during operation. The diameter of the tip of the gamma nail is 11 millimetre. A 13 millimetre diameter retrograde nail is used to perform the osteosynthesis. The patient is positioned supine on a radiolucent table with a bolster to flex the knee 60° and align the fracture. In the first phase a universal antegrade femoral nail was shortened with a sterilised industrial handsaw and polished with a file under aseptic conditions. In a later phase a complete set of nail sizes became available.
Through a short medial parapatellar incision the medullary canal of the distal femur is opened percutaneously under radiographic control. Limited reaming of the isthmus is usually necessary. Alignment of gamma-nail and bridging nail is more difficult in patients with contractures (Parkinson’s disease) and proximal long spiral fractures. A small direct lateral vastus splitting approach at the tip of the stem is needed to remove the locking bolt. Furthermore the nail can be guided at the tip of the implant through this incision in these cases.

When a rigid fixation is achieved by hammering the nail over the tip of the intramedullary nail, the nail is locked in the distal femur. For fractures reaching the supracondylar area, locking around the knee is best performed with thick bolts. For this purpose the Bridging nail has two holes, with a six millimetre diameter. At least three centimetres overlap of stem and nail was pursued. We found stability of the junction by mechanical testing done with an overlap of three centimetres average.

**Results**

Between 2000 and 2006, 4 patients, (all female) were treated with retrograde nailing of the intramedullary nail. Mean age at operation was 86.8 years (range 82-94). Patient characteristics are summarised in Table 1. Mean operation time was 75 minutes (range 60-120). In patient number 3 two cerclages wires were needed to reduce the osteoporotic fracture fragments around the lengthened implant which showed a stable connection. No adverse effects of the technique were seen during and after surgery concerning the hip screw or femoral head. All patients were instructed as good as possible to early mobilization and partial weight bearing. Patient 2 died after 23 months of cardiorespiratory failure. She lived in a nursing home and was able to mobilise with aid. Consolidation of the fracture was seen in all patients. The functional level was adequate considered the age group. Femoral shortening of 2 cm was noted in one patient, treated with a shoe raise. Pre and postoperative X-rays of patient number 3 are depicted in figure 1.

**Table 1. Patient characteristics.**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Comorbidity</th>
<th>Time to fracture</th>
<th>Operation time</th>
<th>Blood loss (ml)</th>
<th>Follow up</th>
<th>Consolidation outcome</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87</td>
<td>IDDM, breast ca.</td>
<td>2 weeks</td>
<td>60</td>
<td>500</td>
<td>60m</td>
<td>+</td>
<td>Bed-chair</td>
</tr>
<tr>
<td>2</td>
<td>94</td>
<td>Dementia</td>
<td>19 m</td>
<td>60</td>
<td>300</td>
<td>23m</td>
<td>+</td>
<td>FWB with aid</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td></td>
<td>21 m</td>
<td>120</td>
<td>100</td>
<td>3m Callus formation</td>
<td>FWB with aid</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>84</td>
<td>IDDM COPD</td>
<td>20 m</td>
<td>60</td>
<td>200</td>
<td>8m</td>
<td>+</td>
<td>FWB</td>
</tr>
</tbody>
</table>

m= months, FWB=full weight bearing, IDDM= Insulin dependent Diabetes Mellitus, ca.=Carcinoma, COPD= chronic obstructive pulmonary disease.
Discussion

The compromised geriatric patient has often a poor physical condition not suitable for extensive surgery. We presented four compromised patients with fracture below a gamma nail treated with a retrograde Bridging nail. Satisfactory functional results were achieved and slow but reliable union of all femoral fractures has been observed with the intramedullary nail in situ.

Nowadays retrograde nailing is common practice in the treatment of femoral fractures and multiple studies demonstrate its safety. Positive experiences with periprosthetic fractures initiated the use of the retrograde bridging nail in frail patients with a fracture below an intramedullary implant. The compromised group benefits from reduced duration of surgery with minimal dissection that enables early postoperative mobilisation. The exposure of the trochanteric region with removal of the nail increases the intensity of the operative hazard. Complications associated with nail removal are weakening of the collum femoris, fracture of the proximal femur, infection and wound complications. The tip of the lag screw is self tapping with a tapered neck. Modern designs exclude a tapered contour. Counterwise rotation for extraction of the hip screw could create additional damage to the bony screw hole hereby weakening the collum femoris. In case of revision to long gamma nail, less grip of the new lag screw during reinsertion is expected. This can lead to inadequate implant fixation.

The necessity for removal of the intramedullary implant is eliminated by the Bridging nail, hereby avoiding the possible problems described above. Dissection of the trochanteric region is prevented and the medullary cavity is only distally opened which reduces postoperative bleeding and less surgical trauma.

The phenomenon of femoral widening of the diaphysis is seen in osteoporosis and geriatric patients. As a result the diameter of the medullary cavity is usually large enough for the nail to be inserted with only minimal reaming. Besides the minimal invasive aspects, elimination of a stress rising zone initiated the development of the Bridging nail. In the treatment of fractures near intramedullary implants elimination of stress risers, contributing to re-fracturing, is desirable. Overlapping implants tolerate the highest loads. When it is impossible to achieve overlapping a minimum distance between implants of twice the diameter of the shaft is advised in literature based on biomechanical testing.\(^7,8\)

The gamma nail is slightly tapered and a rigid fixation is achieved after 3 centimetre bridging. When the retrograde nail engages the tip of the gamma nail, additional a minimum of 2 centimetres is necessary for adequate stability. Mechanical evaluation of the junction of the nail with hip stems shows adequate stability with 2.0 cm pure contact overlapping. This is described in chapter 6 of this thesis. In plate-osteosynthesis overlapping is not always possible. The idea of LISS plating for fracture treatment is combining the principles of rigid fixation with minimal invasive surgery. Furthermore, arthrotomy of the knee is avoided. However, callus formation is
commonly slow and complete bridging of the fracture usually takes several months. Moreover, weight bearing after LISS plating is delayed to avoid plate breakage while early loading is possible after intramedullary nailing.\textsuperscript{9,10} In our series early weight bearing was not encouraged but permitted in this age group. No adverse effects were seen of this policy. In geriatric patients this early load bearing makes rapid ambulation possible which is desirable to prevent complications due to inactivity. Especially in patients with poor compliance after surgery this might be an important reason the treat with the Bridging nail.

In conclusion, retrograde nailing seems a less invasive salvage procedure for the old compromised patient eliminating the necessity for removal of the hip screw. Weight bearing is possible shortly after the operation, creating favorable nursing conditions.

\textbf{Figure 1.} Patient 3, pre- and postoperative X-rays.
A less invasive salvage procedure for fractures below intramedullary nails

Reference list


