"Push-past" Reaming as a Reduction Aid With Intramedullary Nailing of Metadiaphyseal and Diaphyseal Femoral Shaft Fractures

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Abstract: Eccentric reaming of cortical bone near a fracture site can introduce malalignment when an intramedullary nail is placed. The authors describe a technique of reaming meta-diaphyseal and diaphyseal femur fractures in which maintaining reduction at the fracture site is not necessary to obtain an excellent alignment of long bone fractures after intramedullary nailing. They have found that central reaming proximal and distal to, but not at, the fracture site allows for excellent reduction of long bone fractures when the intramedullary nail is passed. The reamer is stopped just before the fracture site and then “pushed” across the fracture prior to resumption of reaming. The authors present “push-past” reaming as a technical trick to facilitate reduction of femoral fractures treated with intramedullary nails and a consecutive series of 18 cases in which excellent postoperative alignment was achieved. [Orthopedics. 2014; 37(6):393-396.]

Femoral shaft fractures are frequently seen and treated by orthopedic surgeons. Statically locked intramedullary nailing is the gold standard for these injuries, leading to excellent rates of union and low rates of infection.1 Prospective, randomized series have shown equivalent results for antegrade and retrograde nailing.2,3 Randomized, prospective trials have also shown no difference in clinical results between piriformis and trochanteric entry site with antegrade nail placement.4-6 Often, the most difficult portion of the procedure is obtaining adequate fracture reduction for passage of the guidewire across the fracture and maintaining the reduction to avoid eccentric reaming of cortical bone. This can require additional surgical instrumentation, assistants, or open reduction if all other methods fail to maintain reduction while reamers are passed across the fracture site.

The authors present their technique and case series to demonstrate a method that reduces the need for perfect reduction during reaming and yet provides excellent postoperative alignment.

MATERIALS AND METHODS

Between August 2011 and February 2012, a single fellowship-trained orthopedic trauma surgeon (J.L.G.) treated 14 consecutive patients with 15 femoral shaft fractures (AO/OTA type 32). Institutional review board approval was obtained for the retrospective review. The patients’ average age was 35 years (range, 18-57 years), and 14 patients were male.

On the basis of fracture pattern, associated injuries, and body habitus, the attending surgeon chose nail entry site and use of blocking screws. The Table lists the fractures, their patterns, the AO/OTA and Winquist classifications, and the entry site for nailing. In general, a piriformis entry nail was chosen for fractures of the proximal one-third and a retrograde entry nail was chosen for fractures of the distal one-third. Fractures of the middle one-third were treated with both antegrade and retrograde starting points.

Surgical Technique

The patient is positioned according to the preference of the operating surgeon. The technique can be used with patients in either the supine or the lateral position on either a flat radiolucent table or...
The femoral canal is entered via a retrograde, piriformis, or trochanteric starting point in a standard fashion. For metadiaphyseal fractures, perfect positioning of the entry reamer or awl is essential from either a retrograde or an antegrade starting point, as previously described. Fluoroscopy is used to ensure a proper entry portal. A piriformis starting point is often chosen for proximal one-third fractures to help prevent varus malalignment, as previously described. If a trochanteric entry point is chosen for a proximal one-third fracture, preoperative templating with the contralateral intact femur may provide the optimal entry point for the nail.

The fracture is brought out to length and a ball-tipped guidewire is passed across the fracture site and impacted into metaphyseal bone opposite the entry portal. The authors typically start reaming with an

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**Table**

**Fracture Characteristics and Nail Entry Sites**

<table>
<thead>
<tr>
<th>Case</th>
<th>Location</th>
<th>AO/OTA Classification</th>
<th>Winquist Classification</th>
<th>Associated Injuries</th>
<th>Entry Site</th>
<th>Blocking Screws</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Middle one-third</td>
<td>A</td>
<td>I</td>
<td>Intertrochanteric femur fracture</td>
<td>Trochanteric</td>
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</tr>
<tr>
<td>2</td>
<td>Middle one-third</td>
<td>A</td>
<td>0</td>
<td>-</td>
<td>Piriformis</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Distal one-third</td>
<td>A</td>
<td>III</td>
<td>-</td>
<td>Retrograde</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Middle one-third</td>
<td>C</td>
<td>IV</td>
<td>Femoral neck fracture</td>
<td>Retrograde</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Proximal one-third</td>
<td>B</td>
<td>III</td>
<td>-</td>
<td>Piriformis</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Middle one-third</td>
<td>B</td>
<td>II</td>
<td>-</td>
<td>Retrograde</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Middle one-third</td>
<td>B</td>
<td>III</td>
<td>Femoral neck fracture</td>
<td>Retrograde</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>Proximal one-third</td>
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<td>I</td>
<td>-</td>
<td>Piriformis</td>
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</tr>
<tr>
<td>9</td>
<td>Proximal one-third</td>
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<td>10</td>
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<tr>
<td>11</td>
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<td>-</td>
<td>Piriformis</td>
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<tr>
<td>12</td>
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<td>-</td>
<td>Retrograde</td>
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<tr>
<td>13</td>
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<td>II</td>
<td>-</td>
<td>Retrograde</td>
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</tr>
<tr>
<td>14</td>
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<td>-</td>
<td>Piriformis</td>
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</tr>
<tr>
<td>15</td>
<td>Proximal one-third</td>
<td>C</td>
<td>IV</td>
<td>-</td>
<td>Retrograde</td>
<td>No</td>
</tr>
</tbody>
</table>

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**Figure 1:** Intraoperative fluoroscopy in the anteroposterior plane showing use of the nail as a reduction aid after “push-past” reaming. Translational malalignment of a femoral shaft fracture (A). The tapered end of the nail is used to cross the fracture site by manipulating the fracture into a valgus position (B). The valgus force is removed and the nail is again central in the distal femoral canal (C).
8.5- or 9-mm flexible reamer (Zimmer, Warsaw, Indiana). As the reamer passes toward the fracture site, fluoroscopy is used to ensure it remains centrally positioned in the canal. If necessary, manipulation of a fragment with a Richardson retractor, mallet, or percutaneously placed Schanz pin or ball-spike device can be used. Reaming is stopped just before encountering the fracture site. The reamer is then pushed across the fracture site with gentle impaction of the drill by the surgeon’s hand; sometimes, quick “bursts” of reaming are necessary with the maneuver. Once the reamer is on the other side of the fracture, the authors ensure that it is again centrally located within the femoral canal prior to resumption of reaming. As the reamer is brought out of the femoral canal, it is important to ensure that the reamer is pulled back across the fracture site in a similar fashion. In some cases, especially with transverse fracture patterns, the fracture will reduce around the flexible reamer after pushing past the fracture site. The authors continue this technique and ream in 0.5-mm increments until they have reamed 1.5 to 2.0 mm over the diameter of the selected nail.

The nail is then advanced over the guidewire. As the nail approaches the fracture site, manipulation of the nail can allow its tapered end to further facilitate reduction (Figure 1). Once the nail is across the fracture with appropriate reduction, it is impacted to an appropriate level and locking screws are placed proximal and distal to the fracture. For fractures extending in the metadiaphyseal bone, blocking screws can also be placed before or after the insertion of the nail to limit motion in the metadiaphyseal segment around the nail and increase stability of the construct.

**Case Example**

A 23-year-old man sustained a right transverse femur fracture from a bull riding accident. Push-past reaming was used to obtain excellent postoperative alignment of the femoral shaft fracture, even though the fracture had significant translational malalignment prior to reaming (Figure 2).

**RESULTS**

Immediate postoperative alignment was excellent in all fractures, with no angulation more than 5° in the coronal or sagittal planes. Blocking screws were used distally in 5 fractures, all of which were treated with retrograde nails, to increase stability of the construct.

**DISCUSSION**

This technique facilitates obtaining excellent alignment after reamed nailing of femoral shaft fractures. Traditionally, maintaining perfect alignment
while reaming across the fracture site has been suggested to prevent eccentric reaming of cortical bone. This often requires an experienced surgical assistant or additional instrumentation. Various minimally invasive techniques have been described to properly align fracture ends during reaming, including the use of an AO femoral distractor or percutaneously placed Schanz pins on each side of the fracture. If all closed or percutaneous methods fail, open reduction is sometimes necessary.

Using this technique, a flexible guidewire is passed across the fracture site after it is brought out to length with manual traction or a fracture table and flexible reamers are then used to ream centrally both proximal and distal to, but not at, the fracture site. Excellent postoperative alignment can be achieved without maintaining perfect reduction during reaming. The authors find this technique especially helpful for transverse fracture patterns, which are often the most difficult to reduce with closed methods. Although this technique does not change the predictably good results of reamed intramedullary nailing of femoral shaft fractures, the authors find that it makes the surgery easier by not requiring perfect reduction of these fractures during reaming. Although this technique has likely been employed for some time with reamed intramedullary nailing of femur fractures, the authors have not found published descriptions of it.

REFERENCES