Technique for precise placement of poller screws with intramedullary nailing of metaphyseal fractures of the femur and the tibia

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Intramedullary nailing of metaphyseal fractures could be technically difficult, especially in obtaining a satisfactory reduction in both the coronal and sagittal planes. The incidence of malalignment is reported to be as high as 58% for proximal tibia fractures,1 14% for distal tibias,6 30% for proximal femurs and 10% for distal femoral fractures.4

Poller screws, originally described by Krettek et al.,2 aid in obtaining satisfactory alignment during surgery and provide additional stability.3,5 When strategically placed, these screws guide the reamers and the nail to a suitable trajectory, thereby achieving indirect reduction. They also reduce the size of the medullary canal and increase the stiffness of the bone-implant construct.2 We describe a technique, which uses Steinman pin localisation for optimum placement of poller screws in the intramedullary nailing of metaphyseal fractures of the femur and tibia.

Surgical technique for retrograde femur nailing

Retrograde femoral nailing is done with the patient supine on a radiolucent operation table. Folded blankets rolled into a bump are placed under the knee. The knee should be flexed to 45–60° as too little flexion will make passage of the guide wire and reamers difficult, and too much flexion will pull the patella down. The reduction manoeuvres are studied before the skin incision. The flexion and extension of the distal fragment can be adjusted by changing the size or the position of the bump, moving it either proximally or distally. Varus or valgus stress and traction may be needed to get a good fracture reduction. In some cases, Schanz screws can be inserted to the distal fragment and can be used as a joystick. Percutaneous reduction clamps can often be used to achieve and maintain reduction.

A 2-cm vertical skin incision is made just medial to the patellar tendon, and the soft tissues are spread with a straight haemostat. Under fluoroscopic guidance, the entry for the retrograde nail is made using the guide wire. An accurate starting point both in the anteroposterior (AP) and lateral views is critical for the proper placement of the nail and reduction of the fracture. The entry should be in the centre of the intercondylar notch in the AP view and 2 mm anterior to Blumensaat’s line in the lateral view. The guide wire should be in the centre of the medullary canal, both in the AP and lateral image.

In most cases, fracture configuration and reduction strategy will determine the most appropriate site for the poller screw. A Steinman pin of 3.9-mm (5/32 in.) diameter with a diamond tip (Plain Point Type B, Smith and Nephew, Memphis, TN, USA) is inserted with a drill at the chosen site for the poller screw. This pin has sufficient thickness to prevent any bending or breakage during surgery. In addition, the hole created is ideal for inserting a 5-mm interlocking screw that functions as a poller screw.

In metaphyseal fractures, the guide wire tends to exit where there is less bone (obtuse angle of the fracture line) or more comminution. In posterior comminution, the guide wire tends to exit posterior; whereas in lateral comminution, it tends to exit laterally. Therefore, a poller screw placed at this location helps to guide the reamers along the central axis of the canal. A useful tip is to insert the Steinman pin into the short bone segment on the concave side approximately 1 cm away from the fracture line and 6...
or 7 mm from the centre of the canal. If the Steinman pin is correctly placed, it will spin whilst reaming with 10–11 size reamers as the reamer comes in contact with the Steinman pin. Further, actual reduction of fragments can be seen in the fluoroscopy whilst the reamers pass across the Steinman pin. More than one pin may be required in some cases.

If the position of the Steinman pin is not satisfactory, it is changed to a more accurate position. The Steinman pin is held with a Kocher clamp to prevent it from spinning during the reaming process. Fluoroscopic images during the reaming process are performed to confirm the correct trajectory of the reamers. The canal is reamed to 1.5 mm above the size of the nail, and the nail is introduced atraumatically. Proximal and distal locking is performed in the usual fashion. The Steinman pin is then removed and a 5-mm interlocking poller screw is inserted in its place.

**Surgical technique for tibial nailing**

For tibial nailing, a radiolucent triangle (Innomed, Savannah, GA, USA) is used to flex the knee beyond 90° and apply manual traction. Fracture reduction is achieved by applying manual traction and appropriately directed forces. The entry site for the nail is obtained using an awl under fluoroscopic guidance. For proximal tibia fractures, a more proximal and lateral (medial to lateral tibial spine) entry site is used, whilst for distal tibia fractures, a midline entry site is selected. The location for the poller screw is determined as described above, and the Steinman pin is inserted. At the end of the nailing procedure, the Steinman pin is exchanged for a 5-mm interlocking screw that functions as a poller screw.

**Case example**

A 19-year-old male was admitted with a Grade I open fracture of the right distal femur (OTA 32A2.3) following an injury from a tank turret (Fig. 1). He was treated with wound debridement, antibiotic bead insertion and retrograde intramedullary nailing of the femur fracture. A 5/32-in. Steinman pin was inserted on the lateral side of the distal fragment in the antero-posterior plane to prevent valgus angulation and to guide the nail to the centre of the distal fragment (Figs. 2 and 3). An 11 mm × 380 mm T2 supracondylar femoral nail (Stryker, Mahwah, NJ, USA) was inserted after sequential reaming to 13.5 mm. Distal and proximal interlocking of the femoral nail was completed. The Steinman pin was removed, and a 5-mm screw of appropriate length was inserted, which functioned as a poller screw (Fig. 4). Satisfactory fracture reduction was achieved and has been maintained at 6-month follow-up.

**Discussion**

The use of a poller screw (blocking screw) as first described by Krettek et al. was derived from small metal devices placed in roads to block or guide traffic. In Krettek's study of 21 tibial fractures (10 located in the proximal third, 11 in the distal third),
Poller screws were used in 20 cases. A single screw was used in 13 cases, and two or three screws were used in the rest of the patients. The screw diameter varied between 3.5 mm cortical, 4.5 mm cortical or 6.5 mm cancellous screws. The indications cited by these authors for a poller screw were to correct alignment after nail insertion, to maintain alignment and to improve stability of the bone-implant complex, and to control the nail during insertion. All of their fractures united with good alignment and there was only a minimal loss of reduction of approximately 0.5° in the frontal plane and 0.4° in the sagittal plane during the follow-up period.

In a mechanical study, Krettek et al. 3 concluded that the addition of a poller screw in the proximal tibial fracture decreased the deformation of bone-implant construct by 25%. In the distal tibial fractures, a poller screw reduced deformation by 57%. Their study demonstrated that insertion of a poller screw close to the osteotomy site improved the stiffness of the construct.

In a study by Ricci et al., 4 12 consecutive proximal-third tibia fractures were treated with intramedullary nailing and a poller screw. The screws were inserted before the reaming process, depending on the fracture alignment. In two cases, a 3.5-mm screw was used, whilst in the rest of the fractures, a standard interlocking screw was selected. In one patient in whom a 3.5-mm screw was used, the screw bent during the nailing procedure. All their patients in whom a poller screw was used had less than 5° of angular deformity. Only one patient, who did not have a poller screw inserted, had progression of valgus deformity from 6° to 10° valgus.

Stedtfeld et al. 5 designed a mechanical model to demonstrate the effect of a poller screw, which they termed a ‘transmedullary support screw’. The authors demonstrated that satisfactory axial alignment may be achieved with the nail in the central position and one blocking screw in the short fragment close to the fracture on the concave side of the axial deformity. The single screw establishes the third point of three-point fixation of the fragments. In the case where the nail has insufficient anchorage to the shorter segment, or if the entrance point of the nail is too large, three-point fixation may be achieved by using a second screw on the convex side of the deformity far from the fracture. The authors have used this technique for fractures of the proximal humerus, subtrochanteric femur and the distal femur, as well as the proximal tibia and distal tibia.

To our knowledge, the technique of using a Steinman pin before inserting the poller screw has not been previously described. Accurate placement of the poller screw is important for the screw to perform its function. Screws placed away from the desired location will not function as a poller screw and may cause damage to the reamers and the nail. There is also a risk of screw bending, breakage and difficulty in removal. To identify the exact location of a poller screw, a careful analysis of the preoperative and intra-operative imaging with traction is essential. As the aim is to centralise the nail in the medullary canal, the site of the poller screw should be chosen so that it guides the nail to the central axis of the canal. In metaphyseal fractures, the guide wire and the nail tend to displace out of the canal where there is more comminution or less bone (obtuse angle of the fracture). This commonly occurs on the concave side of the deformity as described by Krettek et al. 2 and hence the poller screw inserted at this location helps to direct the reamers to the centre of the canal. In some cases, more than one screw may be necessary to obtain the reduction in both the planes.

The advantage of using a Steinman pin at the initial step of poller screw placement is that the pin can be easily moved to a different location if the first position is not satisfactory. Our experience has been that the removal of a malpositioned screw and subsequent change of screw location are extremely difficult.
In addition, the Steinman pin has a smooth surface, so damage to the reamers and nail is minimal. The diameter of the Steinman pin is 3.9 mm (5/32 in.), which is ideal for a 5-mm locking screw. Because the poller screw is inserted at the end of the procedure, the risk of bending or breakage of the screws is also avoided. Using the standard interlocking screws as poller screws will not create the need for additional inventory.

Conclusion

Intramedullary nailing of metaphyseal fracture requires careful preoperative planning and application of multiple techniques to achieve fracture reduction. Obtaining and maintaining satisfactory alignment requires selecting the correct entry point, achieving satisfactory reduction of the fracture whilst reaming and nail insertion, ensuring proper trajectory of reamers, using a poller screw, and selection of appropriate supplemental fixation such as a plate or external fixation. Strategically placed poller screws help to add stability to the fixation and prevent postoperative malalignment.

We use poller screws for metaphyseal fractures with a long, oblique configuration or significant comminution that makes closed reduction difficult. Screws are ultimately inserted into the short segment on the concave side approximately 1 cm from the fracture line and 6 or 7 mm from the centre of the medullary canal, which will centralise the nail in the canal and achieve indirect reduction. Using a Steinman pin as an initial step in poller screw placement helps to change the location if necessary, reduces the damage to reamers and nail, and uses equipment readily available in the operating room. Risk of screw bending and breakage are also minimised. Although there are theoretical risks of stress riser effects of poller screws, our technique decreases the actual number of attempts at poller screw placement. This technique is fairly simple to apply and should be considered part of the surgeons’ armamentarium for nailing metaphyseal fractures of the tibia and femur. Nail-specific commercially available aiming devices for poller screw insertion may ultimately lessen the need for our technique.

Conflict of interest statement

The authors state there is no conflict of interest regarding this article.

References