The use of Poller screws as blocking screws in stabilising tibial fractures treated with small diameter intramedullary nails

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Intramedullary nailing of metaphyseal fractures may be associated with deformity as a result of instability after fixation. Our aim was to evaluate the clinical use of Poller screws (blocking screws) as a supplement to stability after fixation with statically locked intramedullary nails of small diameter.

We studied, prospectively, 21 tibial fractures, 10 in the proximal third and 11 in the distal third in 20 patients after the insertion of Poller screws over a mean period of 18.5 months (12 to 29).

All fractures had united. Healing was evident radiologically at a mean of 5.4 ± 2.1 months (3 to 12) with a mean varus-valgus alignment of -1.0° (-5 to 3) and mean antecurvatum-recurvatum alignment of 1.6° (-6 to 11). The mean loss of reduction between placement of the initial Poller screw and follow-up was 0.5° in the frontal plane and 0.4° in the sagittal plane. There were no complications related to the Poller screw.

The clinical outcome, according to the Karström-Olerud score, was not influenced by previous or concomitant injuries in 18 patients and was judged as excellent in three (17%), good in seven (39%), satisfactory in six (33%), fair in one (6%), and poor in one (6%).

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Unlike intramedullary fixation of diaphyseal fractures of the tibia, nailing of metaphyseal fractures with a short proximal or distal fragment is associated with an increase in malalignment, particularly in the coronal plane. The cause has been attributed both to displacing muscular forces and residual instability.1 As there is a large difference between the size of the implant and the metaphyseal diameter with no nail-cortex contact, the nail may translate laterally along coronally placed locking screws. Poller screws2-5 acting as blocking screws, placed adjacent to the nail, have been proposed as a possible solution by preventing translation in both the tibia2,4 and the femur.3,5 The term ‘Poller’ is derived from small metal devices placed in roads to block or guide traffic. These Poller screws decrease the width of the medullary cavity, physically block the nail, and increase the mechanical stiffness of the bone-implant construct.6 The efficacy of blocking screws, in terms of clinical outcome, has not been described.

Our aim was to evaluate the use of Poller screws as a supplement to the fixation of fractures of the proximal and distal third of the tibia treated with intramedullary nails of small diameter.

Patients and Methods

We studied prospectively 23 fractures of the tibial shaft in 22 patients between July 1993 and July 1996; two patients were lost to follow-up leaving 21 fractures in 20 patients (12 men and 8 women) with a mean age of 44 ± 17 years (18 to 76). The patients’ mean Injury Severity Score7 was 5.6 ± 4.7 (2 to 13). In ten patients the fracture was the only injury; in ten there were additional injuries.

Poller screws were selected for use by the surgeon for one or more of the following reasons: 1) to correct alignment after insertion of the nail (7 fractures); 2) to maintain alignment or to improve the stability of the bone-implant complex (21); and 3) to control the nail during insertion (4). The indications for intramedullary nailing included acute fractures (13), delayed unions (3) and malaligned fractures (5) treated previously with external fixation (2) or intramedullary nailing (5). A total of 31 Poller screws was used. In 15 fractures, the screws were placed during the nailing procedure, and in six, they were added during a revision procedure within 28 days of nailing. In 13
fractures a single Poller screw was used, placed on the concave side of the deformity. In the rest of the cases, either two (6) or three (2) Poller screws were placed.

The patients selected for placement of Poller screws had displaced fractures of the proximal (10) or distal (11) third which were either extra-articular or had a non-displaced intra-articular extension. The mean length of the proximal fragment was 93 ± 30 mm (33 to 135) and that of the distal fragment 62 ± 36 mm (27 to 140). The mean length of the fracture was 87 ± 68 mm (3 to 305). We used the AO classification for the fracture pattern (A, 5; B, 9; C, 7), the Tscherne classification for soft-tissue injuries in closed fractures (10), and the Gustilo classification for soft-tissue injuries in open fractures (11).

The metaphyseal fractures were stabilised with a statically locked tibial nail of small diameter placed using an unreamed technique, on a standard radiolucent table with manual traction. The implants used were stainless steel or titanium solid tibial nails (Stratec, Oberdorf, Switzerland) of diameter 8 (3), 9 (14) or 10 mm (4). Depending on the amount of correction needed, the screws used for ‘blocking’ were locking screws of different sizes (18), 3.5 mm cortical screws (11), or other types of screw (4.5 mm cortical screws or 6.5 mm cancellous screws). The introduction of the nail was carried out within 48 hours of the injury in 13 cases and delayed in eight (mean, 48 days; 7 to 270). The mean time for the operation was 113 ± 51 minutes (50 to 220).

Operative technique. The Poller screws were placed on the concave side of the deformity between the cortex and nail (Fig. 1). In all cases, placement was carried out using image intensification and a radiolucent drill. A drill bit with a shortened fluted tip reduced nail damage (Fig. 2). In cases of malalignment and instability, the screw holes were drilled with the nail in place while applying manual over-correction. For fractures which were stable, but malaligned, the nails were temporarily removed, the Poller screws were placed, and the nails re-inserted (Fig. 3). This technique was also used in those fractures (5) in which the previous path of the removed nail caused malalignment of the fracture (Fig. 4).

Postoperative treatment. After operation, patients were partially weight-bearing (15 to 20 kg) for six to eight weeks. Thereafter, weight-bearing was increased based on the absence of pain and a study of the radiographs on follow-up. Two patients were unable to bear partial weight because of concomitant injuries. In four patients with proximal fractures, a long-leg cast was applied for up to six weeks. In one, high-energy ultrasound was given to stimulate healing of the fracture.

Complications. Complications were divided into those which were related to the Poller screws and those which were not. Potentially related complications included mechanical instability leading to nonunion, new fracture lines through the holes for the Poller screws, nail failure due to damage by the drill and breakage of the Poller screws. Nerve, tendon or vascular injury would be considered related, whereas all other complications related to the fracture or intramedullary nail such as compartment syndrome, infection, rotational malalignment, breakage of the locking screw and nerve or vascular injuries, present before insertion of the Poller screws, were not considered to be related to them.

Follow-up. Patients were followed through to union of the fracture with clinical and radiological examinations at intervals of six or eight weeks and always at a year after...
Radiographs and photographs of an open segmental fracture of the proximal tibia. Figure 3a – Radiograph showing the oblique fracture line of a proximal metaphyseal fracture. Figure 3b – The image intensifier radiograph shows a lateral shift and valgus deformity after the insertion of an unreamed tibial nail of small diameter. An intraoperative stress test showed a large amount of instability. Figure 3c – Temporary removal of the nail and insertion of a Poller screw in the previous nail path. Figure 3d – During reinsertion of the nail, the blocking screw prevents the nail from re-entering the previous nail path. Figure 3e – After insertion of the nail there is correct alignment and a clinically significant increase in stability. Figure 3f and 3h– A postoperative radiograph shows maintenance of the correct alignment in both planes (3f) and uneventful fracture healing (3h). Figure 3i – Photograph showing correct alignment. The soft-tissue dissection for the insertion of the blocking screws is minimal.
surgery. The mean period of follow-up was 18.5 months (12 to 29); two patients were lost to follow-up. One patient, with a grade-IIIB open segmental fracture, developed an infected nonunion caused by oxacillin-resistant *Staphylococcus aureus* which was refractory to several surgical debridements and intravenous antibiotics. He was recommended to have a below-knee amputation but was then lost to follow-up. The second patient moved to an unknown address.

Follow-up assessment included neurovascular examination, evaluation of the axial alignment and a functional analysis. The functional outcome was quantified using the Karlström-Olerud score. The radiographs obtained preoperatively, postoperatively and at each follow-up included anteroposterior and lateral views of the whole tibia with the knee and ankle. In the 15 fractures in which the Poller screws had been placed at the initial fixation, the postoperative and follow-up radiographs were analysed for coronal and sagittal alignment. Varus and antecurvatum angulation were expressed as positive values and valgus and recurvatum as negative values. The radiographs were also analysed for correction, maintenance of position or loss of reduction. A fracture was defined as healed when the patient was able to bear full weight on the limb without pain and without support, and when radiographs showed callus bridging three of four cortices.

**Results**

All fractures eventually united. Healing was seen at a mean of 5.4 ± 2.1 months (3 to 12). In one patient extracorporeal lithotripsy and, in one other, an autogenous bone graft, were additional treatments. In 18 patients, the Karlström-Olerud score was not influenced by pre-existing or concomitant injuries. The outcome was excellent in three patients (17%), good in seven (39%), satisfactory in six (33%), fair in one (6%) and poor in one (6%).

Radiologically, the mean postoperative varus-valgus alignment in the 15 fractures initially treated with intramedullary nails and Poller screws was -0.7 ± 3.1° (-6 to 3). The mean postoperative varus-valgus alignment in the six fractures with delayed placement of the Poller screw was -8.1 ± 3.7° (-15 to -4) initially and -0.2 ± 2.1° (-3 to 3) after the revision procedure to insert the Poller screws. At the time of follow-up, the mean varus-valgus alignment, for all 21 fractures was -1.0 ± 2.4° (-5 to 3). The mean loss of reduction between initial placement of the Poller screw and follow-up examination was 0.5 ± 1.7°.

The mean postoperative antecurvatum-recurvatum alignment in the 15 fractures treated with a nail and a primary blocking screw was 1.3 ± 4.8° (-6 to 9). The mean postoperative antecurvatum-recurvatum alignment in the six fractures with delayed placement of the Poller screw was
The stabilisation of fractures of the proximal and distal tibia is associated with a high incidence of malalignment. This has been attributed to muscular forces which displace the fracture and to instability which results from the play of a nail along the interlocking screws. Contributing factors include poor bone-nail contact in the metaphysis and nails with locking screw holes placed in a single plane. Since the locking screws are usually orientated in the coronal plane, varus-valgus malalignment may follow. Deformities in the sagittal plane, usually better tolerated, are less common if the fracture is reduced at the time of initial locking.

Poller screws, placed adjacent to the nail and perpendicular to the interlocking screw holes, usually in an antero-posterior direction, have been suggested as one possible method for improving the stability of metaphyseal fractures and have been described as a reduction tool used to overcome the displacing forces at the time of introduction of the intramedullary nail. The screws functionally decrease the width of the metaphyseal medulla and are particularly useful with nails of smaller diameter. To the authors’ knowledge, the clinical results of the use of Poller screws have not been described. In 1983, Donald and Seligson referred to a “blocking screw” for “fractures predisposed to bending”, but appeared to describe locking screws across the intramedullary nail. In 1994, Krettek et al. described the clinical application of blocking screws, termed ‘Poller screws’, as a tool for the prevention of axial deformities of proximal and distal fractures of the tibia during intramedullary nailing. The same technique described here for the tibia has been used for the femur.

All the fractures in our series treated by blocking screws, healed with a mean varus-valgus alignment of -1.0° (-5 to -3) and a mean antecurvatum-recurvatum alignment of 1.6° (-6 to 11). These results appear to be superior to others reported for the stabilisation of metaphyseal fractures with intramedullary nails. Ahlers and von Issendorf analysed 386 fractures of the tibia; in 32 fractures of the proximal third there was an incidence of 59% of varus-valgus malalignment greater than or equal to 2° and in 138 fractures of the distal third 47% showed this deformity. In both proximal and distal groups, less than one-third had alignments less than 3° and one-quarter to one-third had varus-valgus deformities greater than 4°. Anatomical alignment was observed in 40% of fractures of the shaft, but only in 31% of the proximal and 30% of the distal fractures.

In six of our cases, Poller screws were applied during revision surgery when malalignment or mechanical instability had been diagnosed after nailing. For this reason, the authors recommend a stress test of any stabilised fracture intraoperatively. Similarly, the alignment of the fracture should be examined radiologically in two planes during the operation after placement of the nail to ensure proper alignment. If the mechanical stability of the limb is inadequate, application of a Poller screw can be carried out in the same procedure.

The current study has several limitations. It is a non-randomised, non-controlled clinical trial. There were several different surgeons carrying out the technique, although, given the good results of our study, the relative simplicity of the techniques is demonstrated. We conclude that Poller screws can correct and maintain alignment, improve the primary stability of the bone-nail complex, and enhance the surgeon’s ability to perform effective nailing of fractures of both proximal and distal thirds of the tibia.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


