Evaluation of the technique of blocking screw on treatment of fractures of the distal third of the tibia

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Background

Treatment of fractures of the distal third of the tibia is still controversial. Open reduction and internal fixation with plates and screws allow axial stability but may increase the risk of soft-tissue complications and lead to loss of the fracture hematoma, which is valuable in fracture healing. Closed interlocking nailing avoids soft-tissue complications and preserves the fracture hematoma, but the wide and short distal metaphyseal segment makes the fracture amenable to varus and valgus deformity.

Patients and methods

Twenty patients with 20 closed fractures of the distal third of the tibia underwent closed interlocking nailing and application of a blocking screw in Misr University for Science and Technology Hospital from January 2006 to January 2009. Their ages ranged from 20 to 55 years. The cause of injury was road traffic accidents in 12 cases and falls in eight. The time from injury to operation varied from 2 to 21 days. The patients were evaluated clinically and radiologically and the results were evaluated according to the Olerud and Molander scoring system.

Results

All patients revealed bone union at the final follow-up period; one patient underwent a second procedure for bore grafting and a sound union was achieved. Dynamization by removing the two proximal locking screws was performed in two cases to facilitate bone union. According to the Olerud and Molander scoring system, 10 cases were excellent, nine cases were good, and one case was fair; no cases of poor results were observed. No cases of limb-length discrepancy, malalignment, nail propagation into the ankle, or screw breakdown were found. All patients returned to routine daily activities after fracture healing.

Conclusion

Closed interlocking nailing with the application of a blocking screw is an effective method for the treatment of fractures of the distal third of the tibia; it provides axial stability, prevents shortening, varus, or valgus deformity, and avoids soft-tissue complications.

Keywords:

blocking screw, distal tibia, interlocking nail

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Introduction

Distal metaphyseal fractures of the tibia are rare, accounting for 13% of all tibial fractures [1]. The optimal treatment for fractures of the distal third of the tibia has not been well defined. Options for treatment include conservative treatment with the possibility of unacceptable deformity and ankle stiffness, open reduction and internal fixation using plates and screws, which allows direct reduction of the fracture with axial stability and primary bone healing but with excessive soft-tissue stripping, loss of fracture hematoma, and soft-tissue complications as disadvantages [2].

The minimally invasive approach and application of locked plates for fixation through indirect reduction techniques provided a better alternative; yet, the poor contouring of the plates with the higher possibility of malalignment reduced the reliability of this choice [3].

External fixation may be used for temporary or definitive fixation of distal tibial fractures with frames spanning the ankle joint, allowing restoration of the length and alignment; however, the possibility of axial instability and pin tract infection are complications of this technique [4].

Interlocking nailing is accepted as a method for stabilizing diaphyseal tibial fractures. It prevents shortening and rotational deformities. Some studies had successfully demonstrated that interlocking nailing could be used in treating fractures of the distal third of the tibia [5,6]. Canale [7] stated that locked intramedullary nailing could be used to manage axially unstable fractures located 7 cm below the knee joint to 4 cm above the ankle joint.

In contrast to intramedullary nailing of a diaphyseal tibial fracture, nailing of a diametaphyseal fracture with a short distal fragment is associated with an increase in frontal and sagittal plane malalignment as well as with a risk for nail propagation or fracture augmentation at the ankle joint [8–10]. Translation of the distal fragment occurs because of the free space between the screws and nail holes, as the nail does not contact any cortical bone [11]. Some surgeons shortened the interlocking nail by removing the distal 1 cm to facilitate locking by two distal screws in distal tibial fractures [5–12].

In 1999, Krettek *et al.* [13] introduced the concept of placing screws around an intramedullary nail, the so-called poller screws. These screws were used in association with interlocking nailing of tibial fractures, either proximal or distal, to facilitate alignment and prevent late loss of the achieved reduction.

The objective of this study was to evaluate the outcome of the closed interlocking nailing and the application of the blocking screw technique in the treatment of fractures of the distal third of the tibia.

Patients and methods

Twenty patients (15 male and five female), with 20 fractures of the distal third of the tibia, were included in the study. The inclusion criterion for this study was the presence of a closed fracture of the distal third of the tibia, mainly a fracture at the junction of the distal third and the proximal two-thirds. The exclusion criteria were pilon fractures, open fractures, pathological fractures, skeletal immaturity, and failed treatment by other techniques.

All patients underwent closed reduction and interlocking nailing with the use of the blocking screw technique from January 2006 to January 2009 in Misr University for Science and Technology Hospital. The follow-up period ranged from 8 months to 2 years. The right side was affected in 13 cases (65%) and the left side in seven cases (35%). The cause of injury was road traffic accidents in 12 cases (60%) and falls in eight cases (40%). The fibula was fractured in 14 cases and four of them were fixed with plates and screws.

Their ages ranged from 20 to 55 years with an average of 33.5 years. The time from injury to operation varied from 2 to 21 days with an average of 5.1 days. All patients were subjected to prophylactic antibiotics and antithrombotic measures.

Operative technique

All operations were performed under general, spinal, or epidural anesthesia using an image intensifier. The first step was fixation of the fibula, if fractured near the ankle, by a one-third tubular plate. This facilitates reduction of the tibia and maintains the length of the leg. An olive tip guide wire was introduced by the transtendinous approach of the patellar tendon and the fracture was reduced manually, which is usually easy to achieve by normal traction. Position of the blocking screw was determined. The screw should be at a position that keeps the wire central and maintains the achieved reduction. The blocking screw was then introduced, which was followed by gradual reaming of the medulla, which, at all stages, should be stopped before the blocking screw and the wide metaphyseal area.

After the desired reaming size is achieved, the olive tip guide wire should be replaced by a nonolive-tip one. The wire should be centered in the distal tibial metaphysis to avoid displacement and angulation at the fracture site. The length of the nail should then be measured. The diameter of the nail should be 1 mm smaller than the last reamer. The nail is introduced and the two distal locking screws should be fixed, followed by the two proximal locking screws. With the use of the image intensifier the length of the nail and the position of the locking screws are assessed, as well as reduction.

Postoperative care

After surgery, the active range of motion of the ankle and knee was evaluated and stitches were removed after 2 weeks. Patients were followed up every month until bone union was achieved. Patients were clinically and radiologically evaluated for bone union and malalignment and functionally evaluated by the Olerud and Molander scoring system using the parameters of pain, stiffness, and swelling, ability to climb stairs, run, jump, and squat, requirement for support, and ability to carry out work and activities of daily life.

Statistical analysis

Data were analyzed using SPSSwin statistical package version 15 (SPSS Inc., Chicago, Illinois, USA). Numerical data were expressed as mean, SD, and range. Qualitative data were expressed as frequency and percentage. The χ^2-test (Fisher's exact test) was used to examine the relationship among qualitative variables. For quantitative data, comparison between two groups was made using the Mann–Whitney U-test. The Spearman ρ method was used to test the correlation between numerical variables. A P-value less than 0.05 was considered significant.

Results

All the fractures had healed at the final follow-up period, with an average follow-up period of 15.7 ± 3.2 weeks. One case underwent a secondary procedure for bone grafting

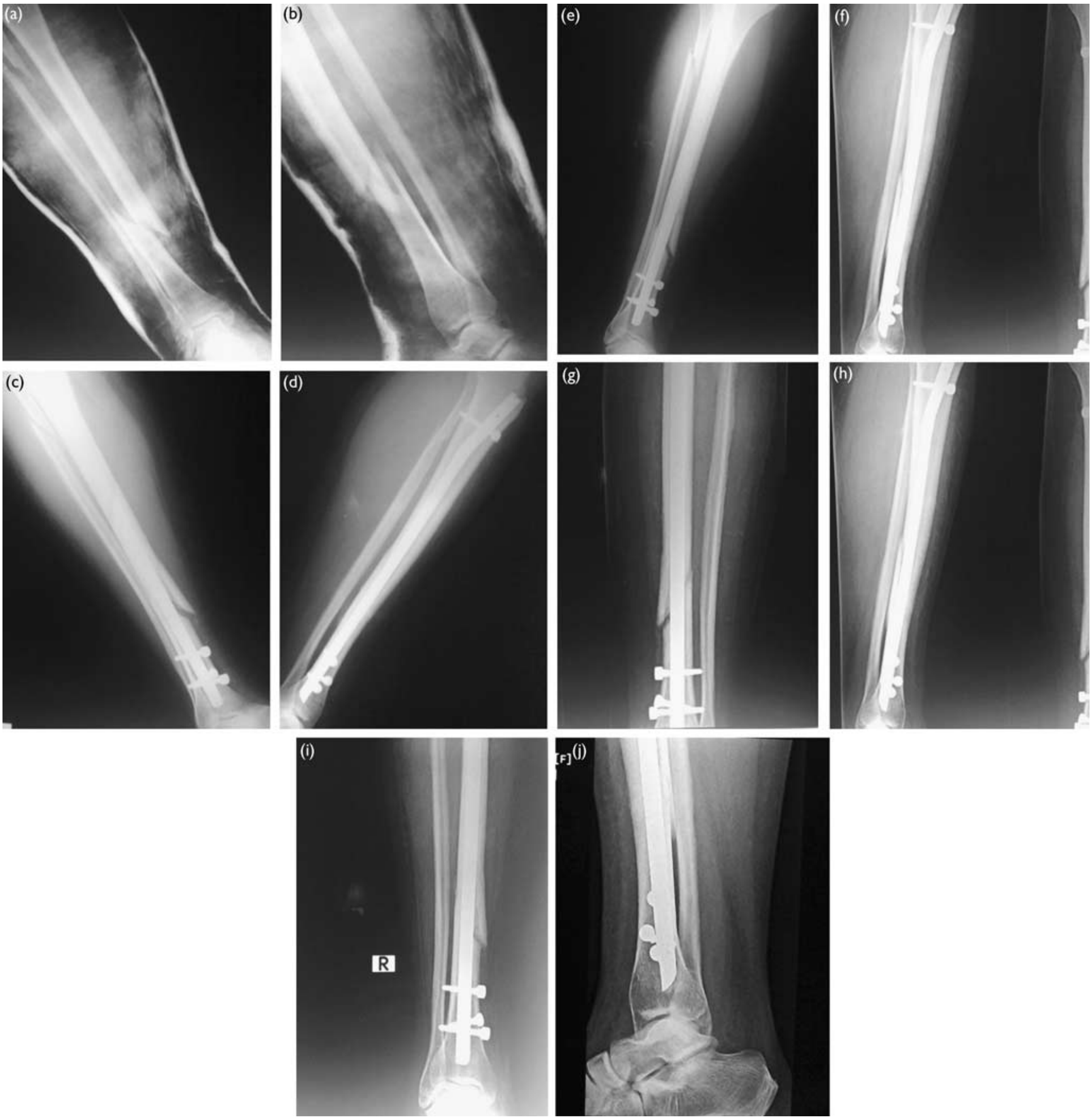
Table 1 Characteristics of the patients in the studied group

	Mean ± SD	Range
Age	33.5 ± 9.3	20.0–55.0
Time to surgery (days)	5.1 ± 4.2	2.0–20.0
Time to union (weeks)	15.7 ± 3.2	12.0–24.0
Follow-up period (months)	16.6 ± 5.5	8.0–24.0

Table 2 Average results of the studied group in terms of Olerud and Molander scores with its detailed items

	Mean ± SD	Range
Total Olerud and Molander score	84.5 ± 14.3	50.0–100.0
Pain	22.5 ± 2.6	20.0–25.0
Stiffness	8.0 ± 4.1	0.0–10.0
Stair	8.0 ± 2.5	5.0–10.0
Running	4.5 ± 1.5	0.0–5.0
Jumping	3.3 ± 2.4	0.0–5.0
Swelling	6.5 ± 3.3	0.0–10.0
Squatting	3.3 ± 2.4	0.0–5.0
Supports	8.5 ± 2.9	0.0–10.0
Work	20.0 ± 0.0	20.0–20.0

Figure 1



Case 1: A 40-year-old man with a fracture of the distal third of the tibia. (a) Preoperative AP view, (b) lateral view, (c) postoperative AP view, (d) lateral view, (e) AP after 1 month, (f) lateral after 1 month, (g) AP view after 2 months, (h) lateral view after 2 months, (i) AP view after 4 months, (j) lateral view after 4 months. AP, anterior–posterior.

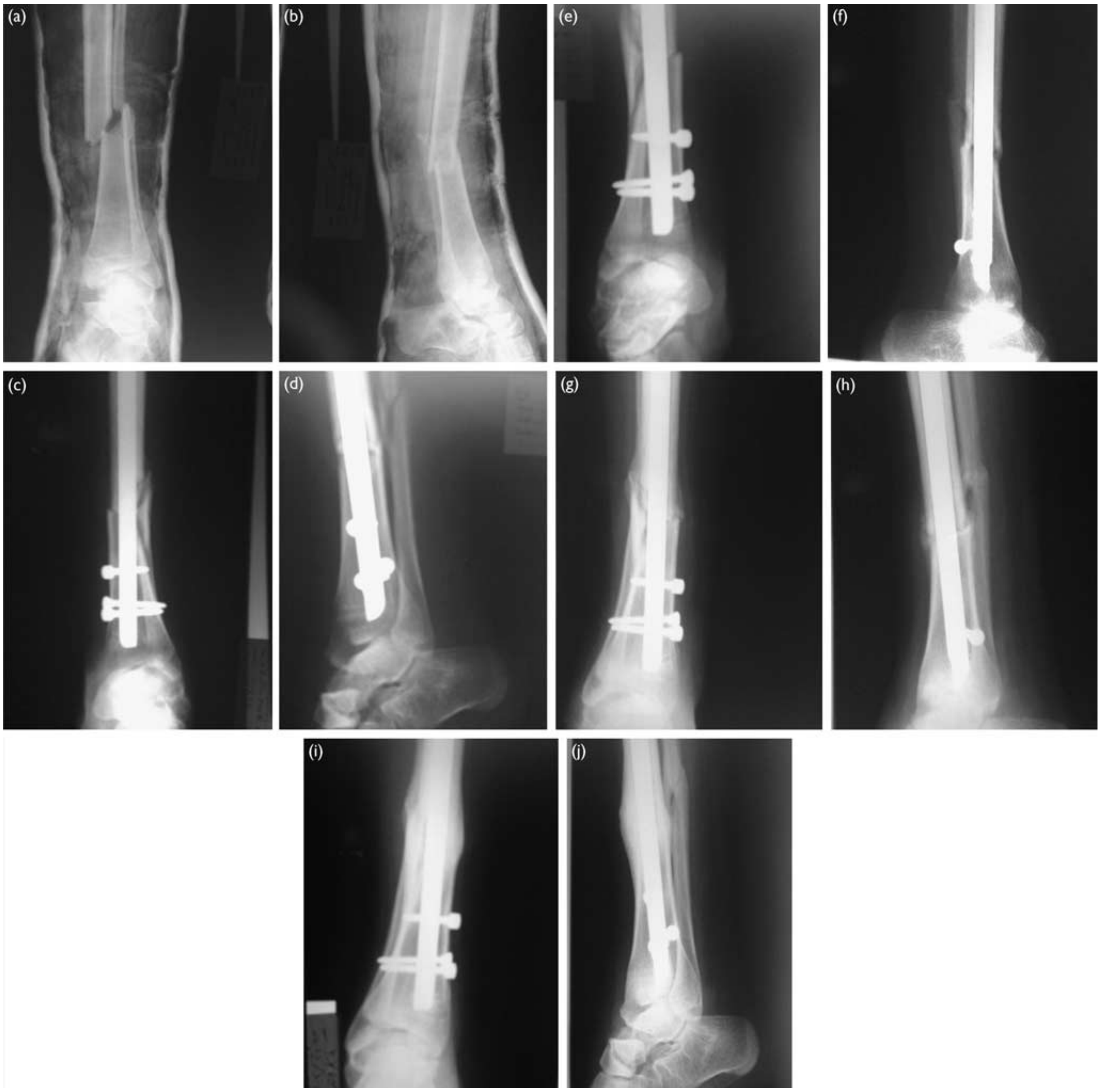
after 12 weeks; a solid union was achieved and the final outcome was not affected (Tables 1 and 2).

On the basis of the Olerud and Molander scoring system (poor 0–30%, fair 31–60%, good 61–90%, and excellent 91–100%), 10 cases were excellent, nine cases were good, and one case was fair. No cases had poor results. The total score was not correlated to age ($r = 0.144$) or to the time between injury and treatment ($r = -0.055$). Sex and cause of injury did not affect the final treatment result ($P = 1.000$ and 0.109, respectively).

No cases of limb-length discrepancy more than 1 cm, varus or valgus malalignment more than 5°, screw breakdown, or nail propagation into the ankle were reported. Five patients complained of anterior knee pain, which disappeared during the follow-up period.

All patients returned to their preinjury job. In two cases dynamization was carried out after 3 and 4 months by removal of the two proximal locking screws to allow more compression at the fracture; bone union was then achieved (Figs 1 and 2).

Figure 2



Case 2: A 29-year-old woman with a poliomyelitis-sustained fracture of the distal third of the tibia and fibula. (a) Preoperative AP view, (b) preoperative lateral view, (c) postoperative AP view, (d) postoperative lateral view, (e) AP view after 1 month, (d) lateral view after 1 month, (g) AP view after 3 months, (h) lateral view after 3 months, (i) AP view after 8 months, (j) lateral view after 8 months. AP, anterior–posterior.

No limitation of knee movement was observed, but three cases had 5° of limitation in ankle movement. The case with a fair score was a 29-year-old woman, who had been suffering from poliomyelitis affecting the injured leg and had been unable to squat, run, or jump before the injury; this patient was satisfied by the result.

Discussion

The gold standard of treatment for diaphyseal tibial fractures is interlocking nailing because of the high rate of union and the low incidence of malunion and infection [14]. The success of interlocking intramedullary nailing for the treatment of all types of fractures of the tibial diaphysis has led orthopedic surgeons to extend the range of indications to address more distal fractures [15].

However, in fractures of the distal third of the tibia, the diaphyseal–metaphyseal mismatch, the short distal segment, and the wide medullary canal make the fractures amenable to varus or valgus deformity, especially in cases associated with fibular fractures. The short working length of the nail provides less stability for the bone implant construct, and delayed weight bearing is essential [16].

Malalignment or loss of reduction may occur after nailing mostly because of improper reduction, poor nail position, or loose fixation [17]. The placement of two distal screws increases the stiffness and strength of the bone implant construct, leading to enhanced mechanical stability of the fixed fracture [6,18–20]. Obtaining rigid and static nailing requires an intact bone at least 3–4 cm beyond the fracture [6,21]. Krettek *et al.* [13] used poller screws to orient the nail to prevent it from being introduced in the wrong place by reducing the metaphyseal space.

The choice of the position of the blocking screws is important. In this study we applied 12 screws posteriorly and eight screws anteriorly. The use of a transmedullary blocking screw does more than just narrow the medullary canal. Its role is neutralization of unbalanced soft-tissue tension by means of a three-point arrangement analogous to a tension band construct. If biplanar displacement is present, two screws can be used, one in each plane [22].

In this study, sound union was achieved in all cases, which is in agreement with the studies by Robinson *et al.* [8], Fan *et al.* [17], and Nork *et al.* [23], who reported no signs of malunion or nonunion. The high rate of excellent and good results was because of the criteria of patient selection, in which open, pathological, and polytrauma patients were excluded. Also, the closed reduction of the fracture maintains the fracture hematoma and there is no periosteal stripping or soft-tissue dissection. All these factors minimize the soft-tissue complications usually reported in the treatment of distal tibial fractures.

Several studies reported that a plated fibular fracture provides greater tibial fracture stability compared with intramedullary tibial nailing alone [13,19,24]. In this study, 14 cases sustained a fracture of the fibula and four of them were fixed by a one-third tubular plate.

Routine dynamization of nails used for distal tibial fracture treatment is not preferred by some studies because of the unacceptable degrees of shortening [25,26]. Some reports used dynamization in cases of delayed union or malunion without shortening of more than 1 cm [5,23]. In this study, dynamization was carried out in two cases only by removal of the two proximal locking screws, and bone union was achieved in both cases.

Anterior knee pain is one of the complications reported after intramedullary nailing; yet, the pain was reported after transpatellar and paratendinous approaches with no significant difference [27,28].

In this study, all cases were approached through the transpatellar approach, and five patients had complaints of anterior knee pain, which was relieved during the follow-up period.

Conclusion

Closed interlocking nailing of the fracture at the distal third of the tibia with the application of a transmedullary blocking screw provides a very good option for treatment of these fractures. We report a high rate of bone union and minimal complications, with no reported cases of malunion or shortening. The application of the blocking screw is simple and easy in combination with the standard interlocking nail, and fixation of the fibula if fractured near the level of the ankle joint adds to the stability of the construct.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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