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A new interlocking dynamic compression nail for tibial shaft fractures

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Abstract The Clos tibial nail is a cannulated cylindrical nail that permits static, dynamic as well as in-compression mounting by the insertion of locking screws into distal and proximal holes. From September 1998 to March 1999 we treated 16 tibial shaft fractures with CLOS tibial nails. All fractures were managed with calcanear traction, closed reduction, reaming and fixation. Patients were followed for at least 1 year. The mean time to full weight bearing was 11 (10–14) weeks. There were no cases of delayed union or dynamization. All patients returned to their previous activity levels.

Key words Tibial fracture • Intramedullary nailing compression

Introduction

Tibial fractures are the most frequently occurring fractures of the lower leg in adults and children. In the majority of cases they are associated with fractures of the fibula.

Conservative treatment of tibial shaft fractures necessitates a lengthy period of immobilization; osteosynthesis with plates and screws requires a long incision involving soft tissue lesions, and thus the increased risk of skin necrosis and deep wound infection. Most authors agree that locked intramedullary osteosynthesis is the treatment best suited for unstable shaft fractures, while conservative treatment is ideal for stable fractures [1–4].

The indications for this treatment have been increased to include exposed type III-b fractures and closed fractures with severe soft tissue damage [5]. The obvious biomechanical limitations of nailing have caused a certain percentage of delayed consolidation, indicating a need for dynamic implants. Our institute has thus developed an intramedullary nail that enables four different mounting configurations depending on fracture type. We report the results of our preliminary experience.

Materials and methods

The Clos tibial nail is a cannulated cylindrical nail. The undersized nail is implanted after reaming of the intramedullary canal. There are two holes at the proximal segment end where locking screws can be inserted: a proximal hole provides access to the internal runner and a distal hole corresponds to the bending point. The internal runner is free to slide longitudinally in correspondence to the stem eyelet by acting on a special bolt in the proximal end of the nail. Insertion of the proximal screw into the internal runner and of the distal screw into the spherical hole permits compression of the fracture fragments when necessary. Beginning about 60 mm from the proximal end, a section of the nail is bilobed to enable better adaptation to the anatomy of the medullary canal. The proximal bending point of 12° on the lateral plane starts at 45 mm from the proximal end of the nail; the distal bending point is 3° on the lateral plane. There is a distal spherical hole for static mounting, and an eyelet for dynamic mounting. The eyelet permits the screw to slide along the longitudinal axis of the nail, enabling dynamic mounting without rotational forces. Nail lengths vary from 255 to 400 mm, with diameters of 9, 10, 11, or 12 mm.

Depending on positioning of the blocking screws, the system can be mounted in four different configurations:

1. Static configuration obtained by positioning one or two proximal screws and one screw in the spherical distal hole. If a second distal screw is used, it must be inserted in the upper part of the oval hole. This configuration is indicated for unstable fractures.
2. Dynamic configuration obtained by positioning one or two proximal screws and one screw in the lower part of the distal oval hole. This configuration is indicated for stable fractures and permits the distal screw to side along the axis of the oval hole during weight bearing: this enables controlled dynamism of the fracture.
3. Configuration in static compression, obtained by positioning one proximal screw in the hole inside the runner and one screw in the distal spherical hole. The second distal screw must be inserted in the upper part of the oval hole. Compression is obtained by acting on the bolt. This configuration is indicated for fractures in which reduction is difficult to maintain or for pseudoarthrosis.
4. Configuration in dynamic compression, obtained by positioning a proximal screw in the runner hole and a distal screw in the lower part of the oval hole. Compression is obtained by acting on the bolt. This configuration is indicated for stable fractures that are difficult to reduce.

From September 1998 to May 1999, 15 tibial shaft fractures (Fig. 1, 2) and 1 nonunion were treated at our institution with the Clos interlocking nail. There were 11 male and 5 female patients, average age 42 years (range, 22–83 years). A traffic accident was the cause in 7 cases, falls from heights in 3 cases, slipping in 3 cases, and trauma from skiing in 2 cases. Tibial fracture type was classified according to the AO/ASIF Long Bone Comprehensive Classification [6]. There were 9 simple fractures (64% A1:4, A2:2, A3:3), 5 multifragmentary fractures (46% B1:1, B2:2, B3:3). The fibula was intact in two cases, fractured at the same level in 12 cases, and fractured at another level in 2 cases. Intramedullary nailing was done 3–7 days after injury. In 7 cases we used a static configuration, in 4 cases a dynamic configuration, in the case of nonunion a configuration in static compression, and in 2 cases (intact fibula) a configuration in dynamic compression.

Fig. 1 A 40-year-old man injured in a motor vehicle accident

Fig. 2 Anteroposterior and lateral view three months after intramedullary nailing

Results

All patients were evaluated clinically and radiographically at 4-week intervals. The mean partial weight-bearing time was 6 weeks (range, 5–10 weeks). The mean time to full weight bearing was 11 weeks (range, 10–14). The mean time to radiographic union was 16 weeks. There were no cases of delayed union or dynamization. At follow-up, one year after trauma, there were no cases of varus, valgus or sagittal malalignment greater than 10°. Range of movement (ROM) was complete in all cases. All patients returned to their previous activity level. One patient had anterior knee pain, and the nail was removed.

Discussion

Not all tibial fractures can be considered to be comparable injuries. The complications of intramedullary tibial nailing (e.g. delayed consolidation, defective consolidation, infection) are generally due to the lack of muscle covering the bone. Complications also arise because of the poor stability provided by some osteosynthesis techniques. In the case of shaft fractures or pseudoarthrosis, most authors agree that blocked-nail osteosynthesis is necessary: it provides for immediate muscle and joint recuperation, early weight bearing, and a minimum incidence of infection and pseudoarthrosis [7, 8].

Intramedullary nailing techniques have evolved significantly in recent years. One of the most important developments has been the introduction of blocked nails in compression, able to provide active interfragmentary compression. The mobilization and early weight bearing enabled by blocked nails in compression offers advantages not only for the treatment of fractures but also for osteotomies and bone transplants in the case of pseudoarthrosis or defective consolidation [2]. Another indication for the use of nailing in compression is tibial fracture with an intact fibula, a case in which reduction is difficult and there is a greater probability of pseudoarthrosis and varus consolidation [9]. In fact, intraoperative compression permits reduction of the fracture, and blocking in compression guarantees stability of the system and maintenance of the anatomic axis. The Clos nail permits mounting in both static compression, which we did in two cases of fracture with an intact fibula, and mounting in dynamic compression. Dynamic compression is useful when the fracture is stable but diathesis occurs after the nail is inserted. By acting on the runner, it is possible to bring the fracture fragments together with a simple and non-traumatic maneuver, and, at the same time, to guarantee dynamism of the system thanks to the insertion of the distal screw in the oval hole.

The utility of reaming the canal before nail insertion has recently come under great discussion [10, 11]. At present, reaming is advised due to the greater stability it provides for the implant, but most of all because it has been demonstrated that consolidation time is shorter after surgery in reamed cases with respect to cases of nailing without reaming [12, 13]. On the other hand, reaming is not advised for type III-B fractures, probably because the disruption of the endosteal blood supply is not as great as when reaming is done [14, 15].

The blocked nail prevents rotation and flexion movement, guaranteeing that fracture reduction will be maintained. Such a static situation that the system creates can, however, cause delayed consolidation, resulting in breakage of the distal screw or the nail and consequent pseudoarthrosis. When this occurs, further surgery is required.

Numerous revision procedures have been carried out for these cases. They include removal of the blocking screw to allow compression of the fracture site, exchange nailing with reaming, open autogenous bone grafting, and fibular osteotomy, alone or in combination [13, 16]. Dynamization shortens consolidation time and permits eventual compactness of the fracture site, but it does involve a second surgery to remove the most distal screw [15, 17].

Dynamic mounting with the Clos nail in order to obtain controlled dynamism is carried out by insertion of the screw into the distal oval hole in order to permit dynamism of the fracture while at the same time impeding torsion movements that could be a hazard to callus formation. The capacity to obtain controlled dynamism enhances the indications for dynamic mounting, thus shortening consolidation time.

Our preliminary experience with the CLOS tibial nail, begun in September 1998 presently comprises 16 implants. We believe that different mounting configurations offer valid alternatives to the orthopedic surgeon to treat this type of fracture. In fact, with a single synthesis device, it is possible to provide numerous solutions to deal with the diverse variables that arise in the treatment of tibial fractures and pseudoarthroses.

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