ABSTRACT

Aim To evaluate the management of aseptic non-unions of the distal third of the tibial diaphysis, using static interlocking intramedullary nailing.

Methods Between January 2005 and November 2012, a total number of 42 patients who underwent surgery at our hospital for aseptic non-unions of the distal third of the tibial diaphysis, were included in our study. Preoperatively, all the patients were tested for the presence of infection of non-union. The post-operative follow up was based on clinical and radiological findings.

Results Union was achieved in 41 (98%) patients, at a mean time of 5.8 months (four-eight months). One (2%) patient developed infection of the wound four weeks after the operation. A small decrease of the tibial length, of about one cm was seen in three (7%) patients. Pain of the patellar tendon, at the entry point of the nail, was observed in six (14%) patients, without impacting the range of motion of the knee. In two (5%) patients, a decrease in dorsiflexion of the ankle joint occurred, of about ten degrees angle.

Conclusion Static interlocking intramedullary nailing is the preferable technique in the management of aseptic non-unions of the distal third of the tibial diaphysis, because it provides high union rate and few postoperative complications. A good preoperative evaluation for infections, use of proper surgical technique with respect to soft tissues, use of autogenous bone grafts and early mobilization of patients, are the keys to success of this method.

Key words: pseudarthroses, tibial fractures, therapy
INTRODUCTION

The management of non-unions of fractures of the distal third of the tibial shaft represents a great challenge for every orthopaedic surgeon. The incidence of non-unions after tibial shaft fractures has been reported to be the highest compared to other long bone fractures (1-2). The tibia is an important weight-bearing bone and non-healing of its fractures is considered to be a serious complication which can lead to constant pain, stiffness of the knee and ankle, muscular atrophies, disability and deformities (3). Thus, serious problems can occur in everyday life and professional career of the patient (4).

Possible reasons that can cause non-union of fractures of the tibial shaft are the initial fracture displacement, poor coverage of soft tissues, inadequate blood flow to the bone, older age, smoking, diabetes, malnutrition, alcohol, some medications (such as corticosteroids) and inadequate reduction and stabilization of the fracture (5-11).

The diagnosis of tibial non-unions can be based on clinical symptoms such as persistent pain at the fracture site that lasts for months after the time of initial injury (12) and on imaging tests which include x-rays, computed tomography and magnetic resonance imaging (12-13). In case that an infection is considered to be a cause of non-union we can also use blood tests like complete blood cell count, erythrocyte sedimentation rate, c-reactive protein and microbiological examinations like Gram staining and cultures (2).

The treatment of non-unions of fractures of the tibial shaft can be non-surgical or surgical. Non-surgical treatment can be achieved by simple functional cast bracing or by the use of bone stimulators (14-17). Surgical treatment is needed when non-surgical treatment fails and can include stable internal fixation with plates and screws, with or without bone grafting (17-20), exchange nailing (17), external fixation (21) and sometimes two-stage procedures (22). The aim of this study was to evaluate the management of aseptic non-unions of the distal third of the tibial diaphysis, using static interlocking intramedullary nailing. The purpose of the study was to compare successfulness of this method with the results in other previous studies.

PATIENTS AND METHODS

This study was carried out from January 2005 to November 2012 at the Department of Orthopaedics of Argos General Hospital in Greece and included 42 patients. There were 37 (88%) males and five (12%) females with a mean age of 32 years (17-58 years old). Permission for this study was obtained from the Local Medical Studies Ethics Committee.

The study included patients with aseptic non-unions of fractures of the lower third of the tibial diaphysis and excluded patients with infected non-unions of the lower tibial third, or patients with aseptic non-unions of fractures in other parts of the tibial shaft. All of them underwent x-ray examinations in the frontal and sagittal plane of the tibia. Non-unions of the tibial shaft were defined as radiologically confirmed unhealed shaft fractures at least nine months following the injury and osteosynthetic treatment (23). Causes for initial fractures were traffic accidents for 29 (69%) patients, sport injuries for five (12%) patients and drops from height for eight (19%) patients, where 12 (29%) of these fractures were open and 30 (71%) fractures were closed. According to the classification of Gustilo, two (17%) of the 12 open fractures were classified as type II, seven (58%) of them as type IIIA, and three (25%) of them as type IIIB. From the initial 42 fractures, 20 (48%) fractures were treated with closed reduction and simple functional cast bracing, ten (24%) fractures with open reduction and internal fixation using plates and screws and 12 (28%) fractures with external fixation. Non-union was atrophic in 18 (43%) patients and hypertrophic in 24 (57%) patients.

All of the patients were screened for the presence of infection by clinical signs and laboratory evaluation that consisted of complete blood cell count, erythrocyte sedimentation rate, c-reactive protein and C-reactive protein levels. Additionally, during the operation samples from the medullary canal at the site of the non-union were obtained. All of them underwent Gram staining immediately and were sent for microbiological culture. In all patients the results of Gram staining and cultures were negative. None of the patients was discharged from the hospital until the final results of the cultures were obtained.
The surgical technique that was used in all non-union included reamed static intramedullary nailing of the tibia and additionally osteotomy of the fibula which enabled easier reduction (open or closed) of fragments and elimination of the gap between them. In 20 (48%) patients, an open approach was applied at the site of the non-union and resected widely non-viable bone and fibrous soft tissue, in order to achieve adequate reduction of the fracture. In 12 of these 20 patients, great bone defects were created and autogenous bone grafting from the iliac crest was required in order to prevent shortening of the bone length (20). In the remaining 22 (52%) patients, intramedullary nailing was performed under closed reduction with an intact fracture site. The mean operative time was 94 minutes (75-140 minutes).

Regardless of the method used (closed or open), after the operation the same physiotherapy protocol was followed in all the patients. Postoperatively, partial weight bearing was instructed after the fifth postoperative day, which was switched to full weight bearing two weeks after the operation upon healing of the wounds. Passive and active exercises of both ankle and knee joints and muscular strengthening were performed for six weeks. The mean follow up was 3.2 years (one-five years) and was based on clinical (painless full weight bearing) and radiological (bridging callus on three or four cortices on radiographs) findings. The follow-up protocol included interval assessments at two, six, 18, 42 weeks after the operation and every year thereafter.

RESULTS

Union was achieved in 41 (98%) patients, at a mean time of 5.8 months (four-eight months). One (2%) patient, with a non-union of the IIIB type open fracture, developed a wound infection four weeks after the operation. In that case the intramedullary nailing was removed and a hybrid external fixation system was applied. For those patients who underwent closed reduction before the intramedullary nailing, union was achieved at a mean time of 5.4 months (four-seven months) after the operation, while for patients who underwent open reduction, union was achieved at a mean time of 6.3 months (four-eight months) (Figure 1, 2).

Three (7%) patients showed a decrease in length of the tibia, of about one cm. All of these patients had open reduction and bone grafting. None of the 42 patients had any other serious tibial deformity, such as valgus or varus mal-union, anterior or posterior angulation, or mal-rotation compared to the contra-lateral healthy tibia. Pain of the patellar tendon was observed in six (14%) patients, at the entry point of the intramedullary nail, without impact on the range of motion of the knee. In two (5%) patients a decrease of dorsiflexion of the ankle joint, about ten degrees, was observed. Generally, the majority of patients were completely satisfied with the results of the surgical operation and returned to work and their daily activities without problems.

DISCUSSION

The main priorities of every orthopaedic surgeon in the management of non-unions of the distal third of the tibial shaft are the achievement of union, avoidance of axial or rotational mal-union, and of bone shortening, prevention and treatment of infections, quick mobilization of patients and functional restoration of the lower limb,
without residual restrictions on the movement of joints of the knee, ankle and foot (3,24).

In our study, the use of reamed static intramedullary nailing in the treatment and achievement of union was very important. Compared with other studies that were carried out in the past and the use of other techniques (21, 25-27), the union rate of 98% that we achieved, was very high. Reaming increases periostal circulation and callus formation, it provides stable fixation, higher union rate and less complications, compared with non-reamed nailing (28-30). Additionally, static interlocking intramedullary nailing results in a very stable fixation, quick mobilization and full weight bearing of the leg, and much fewer complications, such as muscle atrophies and stiffness of the joints (31).

Of interest, in those patients where intramedullary nailing was carried out under closed reduction and the fracture site remained intact, union was achieved in quicker (mean of about a month), than in those who underwent open reduction and bone grafting. The basic characteristic of all these 22 patients, was that their non-unions were of hypertrophic type (32). This can be explained by the fact that hypertrophic non-unions are well vascularized but they lack the adequate immobilisation needed. In that case, static interlocking intramedullary nailing, enabled the achievement of stable fixation and union of the fractures (17). On the other hand, the majority of the 20 patients who underwent open reduction and bone grafting, had atrophic type of non-union. Atrophic non-unions, are characterized by poor vascularization and disability of bone healing (32). By the application of open reduction, after the resection of non-viable bone and fibrous tissue, along with the reaming of the bone canal, we achieved the improvement of the local vascularization and stimulation of new bone formation. Additionally, fibular osteotomy enabled easier reduction of the fragments (33). In case of significant bone loss of the tibia, bone grafting ensured restoration of bone length and alignment (20). Under these conditions, the use of static interlocking intramedullary nailing provided stable fixation, high union rate of the bone and significantly reduced number of complications compared with the results and complications of other studies (23, 34-35).

Particular attention should be given when creating the portal of the nail in the tibia. The cross section of the patellar tendon may later lead to pain and restriction of the extension of the knee. Six of our patients complained of pain in this area of the knee postoperatively. We think that a small cross-section of the patellar ligament, along with the least possible injury during reaming of the bone canal and careful stitching during the closure of the wound, are necessary measures that must be taken in order to avoid these complications (36).

The limitation in mobility of the ankle and knee joints should also be avoided. Restriction of dorsiflexion in the ankle joint of about ten degrees angle was observed in two of our patients. Both of them had undergone open reduction of the fracture and wide excision of the non-viable bone and fibrous tissue. The basic principles for the prevention of such complications is to minimize damage to the surrounding soft tissues during the excision of non-vital tissue, early mobilization of patients and their integration in an intensive rehabilitation program (37).

Importantly, infection prevention measures must be taken before reamed intramedullary nailing. There are reports in the literature that emphasize that point (38-40), while other authors suggest to avoid the application of this procedure in patients with non-infected non-unions of the tibia, which came from open fractures of the Gustilo type IIIB classification (35). All patients should undergo preoperatively rigorous clinical, hematological, biochemical and microbiological tests (38). In our study, one of the patients with a non-union of an open fracture of IIIB type developed wound infection four weeks after the surgery, although we enforced the above protocol tests. We believe that there is always a small possibility of failure in the preoperative diagnosis of a deep, silent infection, which can become active after the operation.

Consequently, we consider that static interlocking intramedullary nailing is the preferable technique in the management of aseptic non-unions of the distal third of the tibial diaphysis, because it provides high union rate and few postoperative complications. A thorough preoperative evaluation for infections, use of a proper surgical technique with respect to soft tissues, appropriate use of autogenous bone grafts and early mobilization of patients are the keys to success of this method.
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REFERENCES


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TRANSPARENCY DECLARATIONS

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