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Evaluation of interlocking intramedullary nailing in distal tibial fractures and nonunions

Distal tibia kırıklarının ve kaynamamış kırıkların tedavisinde kilitli intramedüller çivilemenin değerlendirilmesi

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Objectives: The aim of this study was to evaluate the results of interlocking intramedullary nailing in the treatment of extra-articular distal tibial fractures and nonunions.

Methods: The study included 45 patients (mean age 42 years; range 27 to 52 years) who were treated with interlocking intramedullary nailing for distal tibial fractures (n=35) and nonunions (n=10). Of 35 fractures, 31 were closed and four were open. The fractures were AO A1 (n=27), A2 (n=6), and A3 (n=2). In addition, two patients had medial, and 14 patients had lateral malleolus fractures. A Gross-Kempf (Howmedica) nail was used in 38 patients and an Expert nail (Synthes) was used in seven patients. Dynamic nailing was performed in 22 patients and static nailing was performed in 23 patients. No grafting was used. The patients were assessed clinically and radiographically within a mean follow-up period of 37 months (range 24 to 60 months).

Results: Union was achieved in all the patients within a mean of 4.6 months (range 3 to 7 months). Dynamization was required in three patients. The mean time to union was 4.4 months (range 3 to 6 months) with dynamic nailing and 4.8 months (range 3 to 7 months) with static nailing. Complications were not serious. Transient peroneal nerve palsy developed in one patient (2.2%). Knee pain was seen in four patients (8.9%) due to the protrusion of the nail and it disappeared after removal of the nail. Five patients (11.1%) had limitation of ankle movements in a range of 5 to 10 degrees. None of the patients had restriction in knee motion.

Conclusion: Intramedullary interlocking nailing is a reliable method of treatment for distal tibial fractures and nonunions, with a high rate of union and low complication rate.

Key words: Bone nails; fracture fixation, intramedullary/methods; tibial fractures/surgery.

Amaç: Eklemi etkilemeyen distal tibia kırıklarında ve kaynamamış kırıkların tedavisinde kilitli intramedüller çivilemenin sonuçları geriye dönük olarak değerlendirildi.

Çalışma planı: Çalışmaya, distal tibia kırığı (n=35) veya kaynamamış kırık (n=10) nedeniyle kilitli intramedüller çivileme ile tedavi edilen 45 hasta (ort. yaş 42; dağılım 27-52) alındı. Kırıkların 31'i kapalı, dördü açık kırık idi. AO sınıflamasına göre, 27 kırık A1, altı kırık A2, iki kırık A3 idi. Ayrıca, iki hastada medial malleol, 14 hastada lateral malleol kırığı vardı. Tedavide 38 hastada Gross-Kempf (Howmedica) kilitli intramedüller çivisi, yedi hastada Expert (Synthes) çivisi kullanıldı. Yirmi iki hastada dinamik çivileme, 23 hastada statik çivileme yapıldı. Hiçbir hastada greft kullanılmadı. Hastalar ortalama 37 aylık (dağılım 24-60 ay) takip süresi içinde klinik ve radyografik olarak değerlendirildi.

Sonuçlar: Tüm hastalarda ortalama 4.6 ay içinde (dağılım 3-7 ay) kaynama elde edildi. Üç hastada kaynama için dinamizasyona başvuruldu. Ortalama kaynama süresi dinamik çivileme uygulanan hastalarda 4.4 ay (dağılım 3-6 ay), statik çivileme uygulanan hastalarda 4.8 ay (dağılım 3-7 ay) bulundu. Hiçbir hastada ciddi komplikasyon görülmedi. Bir hastada (%2.2) geçici peroneal sinir felci gelişti. Dört hastada (%8.9) çivinin taşmasından dolayı ortaya çıkan diz ağrısı çivinin çıkarılmasından sonra kayboldu. Beş hastada (%11.1) ayak bileği hareketinde 5-10 derece arasında değişen azalma görüldü. Hiçbir hastada diz eklemi hareketlerinde sınırlılık gelişmedi.

Çıkarımlar: Kilitli intramedüller çivileme, distal tibia kırıkları ve kaynamamış kırıklarda, kaynama oranı yüksek, komplikasyon oranı düşük güvenilir bir tedavi yöntemidir.

Anahtar sözcükler: Kemik çivisi; kırık tespiti, intramedüller/yöntem; tibia kırığı/cerrahi.

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Distal tibial extra-articular fractures are caused by falls from height, car accidents, or ski injuries. The prevalence of these fractures increase in parallel with increases in car accidents and participation in snow sports.[1] AO classification is the most acceptable system for these fractures[2] and includes three types. Type A: extra-articular fractures, type B: partial intra-articular fractures, and type C: intra-articular fractures. Type A is divided into three subtypes: simple fractures (A1), fractures with partial comminution (A2), and fractures with large comminution (A3). They are due to high-energy trauma by torsional or compression forces. Sometimes these fractures are associated with lateral or medial malleolar fractures. Clinical examination usually shows pain, swelling, and deformity of the distal tibia. Passive and active ankle movements are painful and restricted. The patient is not able to walk and we should always check the neurovascular bundle. Anteroposterior and lateral radiographs of the distal third of the tibia are of great importance for the diagnosis. The management of these fractures is usually operative. Patient-related predisposing factors of nonunion are metabolic status, diabetes, smoking, and alcohol abuse.[3-8] Another factor is the disturbance of regional blood flow due to high-energy violence, damage to surrounding soft tissues, comminution of the fracture, and open insertion of the guide. Instability due to osteoporosis of the area or inappropriate intraoperative technique predisposes to pseudarthrosis.

The aim of this retrospective study was to evaluate the results of interlocking intramedullary nailing in distal tibial fractures and nonunions.

Patients and methods

Between 1998 and 2007, 45 patients (32 males, 13 females; mean age 42 years; range 27 to 52 years) were treated with interlocking intramedullary nailing at our institutions for distal tibial fractures (n=35) and distal third tibial nonunions (n=10). Involvement was on the right side in 38 patients, and on the left side in seven patients. Of 35 fractures, 31 were closed and four were open (3 Gustilo-Anderson grade I, 1 grade II). According to the AO classification, the fractures were A1 (n=27), A2 (n=6), and A3 (n=2). There were three atrophic and seven hypertrophic nonunions without bone defect. Associated fractures involved medial malleolus in two patients and lateral malleolus in 14 patients. Initial treatment of nonunions included bracing (n=1), intramedullary nailing (n=1), and external fixation (n=8). The mean time between the first and second operation was 9.8 months (range 9 to 14 months). Closed insertion of the guide was achieved in 41 patients.

A Gross-Kempf (Howmedica, Rutherford, NJ, USA) locked intramedullary nail was used in 38 patients and an Expert nail with multiple holes near the distal tip (Synthes, West Chester, PA, USA) was used in seven patients (Fig. 1). The latter has multiple holes near the distal tip to increase the stability of the distal fragment. The diameter of the reamed nail was usually 11 mm (range 9 to 12 mm). In three cases, the nail was shortened distally to the distal screw to achieve the insertion of two distal screws (Fig. 2). Dynamic nailing was performed in 22 patients and static nailing was performed in 23 patients. Dynamic nailing was performed in AO type A1 fractures and in hypertrophic nonunions, whereas static nailing was performed in type A2 and A3 fractures and in atrophic nonunions, taking into account not only poor vascularity of the distal third of the tibia but also damage to the surrounding soft tissues at the site of the fracture. To prevent varus, valgus, anterior or posterior angulation, a guide with a precurved distal tip was inserted and checked radiographically in two planes to ensure the central position of the tip. In case of eccentric positioning, the guide was rotated to the opposite side. One of the two medial malleolar fractures was treated conservatively, and the other was fixed with two K-wires. The majority of lateral malleolar fractures (10/14) were fixed with a plate and screws. In the presence of pseudarthrosis, fibular osteotomy was always performed. No grafting was performed. In eight nonunions whose initial treatment was external fixation, first the external fixator was removed, the leg was immobilized in a brace, cultures were taken, and antibiotic treatment was initiated. In seven patients whose cultures were negative, antibiotic treatment was administered for 10 days, after which intramedullary nailing was performed. One patient with a positive culture received antibiotic treatment for four weeks till the eradication of the infection. All patients received low-molecular weight heparin for 30 days postoperatively. The patients were discharged within 8 to 10 postoperative days. In patients with dynamic nailing, weight bearing was allowed after the fifth postoperative day. In

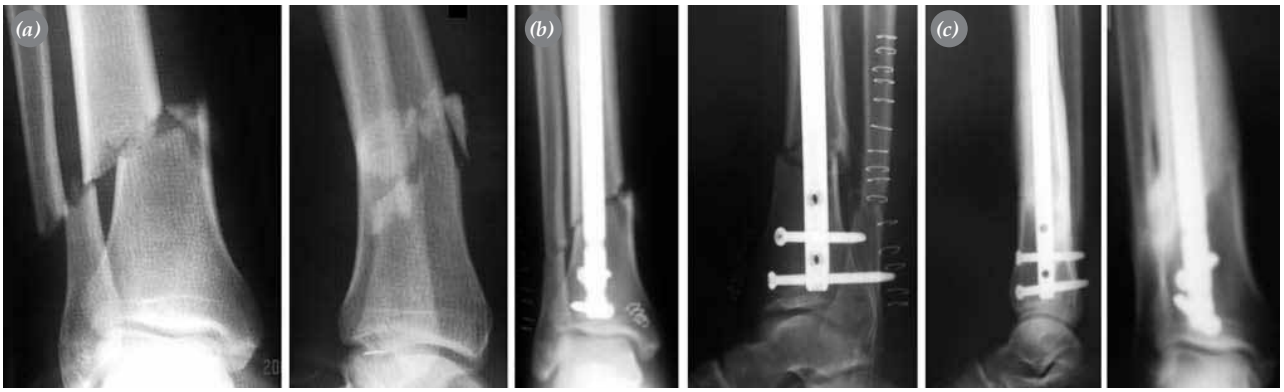

Fig. 1 **(a)** Distal tibial fracture. **(b)** Treatment with an Expert nail with multiple multidirectional holes next to the distal tip of the nail. **(c)** Healing of the fracture 1.5 years after surgery.

cases with a dynamic nail and a concomitant malleolar fracture, partial weight bearing was allowed after the third week and full weight bearing after 6 to 8 weeks depending on the progress of the union, the presence of osteoporosis, and the weight of the patient. In patients with static nailing, partial weight bearing was instructed after the fifth postoperative day which was switched to full weight bearing after 6 to 8 weeks. The existence of a malleolar fracture in patients with static nailing delayed partial weight bearing for four weeks.

The patients were assessed clinically and radiographically at four-week intervals until union was achieved. Radiographic evaluation included the progress of the union, axial alignment in the frontal and sagittal planes, and the existence of shortening and torsion. Clinical evaluation included the range of motion of the knee and ankle, and existence of pain in adjacent joints and at the fracture site. The mean follow-up period was 37 months (range 24 to 60 months).

Results

All fractures-nonunions healed within a mean of 4.6 months (range 3 to 7 months), being 4.4 months (range 3 to 6 months) and 5.3 months (range 3 to 7 months) for fractures and nonunions, respectively. Dynamization was performed in three patients two months after the operation and union was achieved in six months in two patients and in seven months in one patient. The mean time to union was 4.4 months (range 3 to 6 months) with dynamic nailing and 4.8 months (range 3 to 7 months) with static nailing. No intraoperative complications were observed. Peroneal nerve palsy developed in one patient (2.2%), which fully recovered after three months. No skin necrosis, superficial or deep infection occurred. Shortening greater than 1 cm or axial deviation more than 5° in two planes were not observed. Knee pain which was observed in four patients (8.9%) due to the protrusion of the proximal tip of the nail disappeared after removal of the nail. Nail or screw breakage did not occur. Five

Fig. 2. **(a)** Distal tibial nonunion eight months after external fixation. **(b)** The patient underwent dynamic nailing. The shortened distal tip of the nail can be observed. **(c)** Union was achieved four months postoperatively. Fibular osteotomy performed two months after surgery is visible.

Fig. 3. **(a)** Bipolar fracture. **(b)** Treatment with an intramedullary interlocking nail (static nailing). **(c)** Dynamization was performed three months postoperatively. **(d)** Union was achieved six months after surgery. **(e)** The patient underwent ankle fusion with a retrograde intramedullary nail due to ankle arthritis 6.5 years postoperatively.

patients (11.1%) had limitation of ankle movements in a range of 5 to 10 degrees. One of them developed serious post-traumatic ankle arthritis 6.5 years after injury and underwent ankle fusion with a retrograde intramedullary nail (Fig. 3). None of the patients experienced restriction in knee motion.

Discussion

Extra-articular fractures of the distal tibia account for 14.5% of all fractures of the distal third of the tibia.[9] The prognosis of these fractures depends on several factors including the presence of comminution, soft tissue damage, existence of osteoporosis, surgical technique, postoperative care, and whether the fracture is open or closed. Some authors advocate the use of a locking plate with minimally invasive percutaneous plate osteosynthesis. The plate is placed with a mini incision and the screws are placed using an aiming device, without devascularization of the fracture, decreasing the possibility of infection and development of nonunion.[10-13] Closed reduction can be achieved with the use of temporary external

fixation.[14] Other authors use external fixation with or without minimal internal fixation (screws and K-wires).[15,16] Another alternative is the use of interlocking intramedullary nailing. The technique is demanding in that the guide should be placed approximately 1 cm close to the joint of the ankle without causing damage to the articular surface.[17] Two screws should be placed to achieve fracture stability.[18] This technique may sometimes presuppose shortening of the nail distally to the distal hole or the use of an Expert nail with multiple multidirectional holes near the distal tip of the nail.[19-21] In our study, the nail was sawed off in three patients while an Expert nail was used in seven patients. Fibular fixation with plates is necessary because it increases rotational stability, allows early weight bearing, restores ankle mortise, and prevents the development of posttraumatic arthritis, permanent swelling, and limitation of movements of the ankle joint.[22-24] Fibular fixation can be performed before or after tibial fixation. In our study, we first fixed the fibular and then the tibial fracture, which facilitated alignment of the tibial fracture and nail insertion. A comparative study evaluating plate and nail fixation showed similar results.[25] Some authors argue that plate achieves better anatomical reduction whereas nailing has a shorter operation time, better functional results (ankle motion), and lower rates of skin necrosis.[26-28] There is no method without disadvantages. Plating is associated with relatively higher rates of skin necrosis, infection, and pseudarthrosis, while external fixation with or without minimal internal fixation (screws or K-wires) may result in pin infections, malunion, and nonunion. The use of nailing decreases these problems, but it is a demanding technique.[29,30] This method cannot be used in intra-articular fractures (pilon) because open reduction with restoration of the articular surface is required. There are few studies concerning the treatment of distal tibial nonunions. Nolting et al.[31] reported good results with the use of a percutaneously inserted locking plate. Lonner et al.[32] reported relatively good results with the Ilizarov technique. Nailing seems to be a reliable and effective method in the treatment of distal tibial factures-nonunions, with a low incidence of complications and high rate of union approaching 100%. Our findings are in accordance with the results reported in the literature.[21,33-35]

The results of our study, which are comparable to the results published in other series, reinforce our opinion that interlocking intramedullary nailing is an efficacious method of treatment for distal tibial fractures and nonunions, provided that there is no intra-articular fracture and incongruity. Good surgical technique is demanding, and close insertion of the nail, use of two distal screws, and early weight bearing are mandatory to achieve axial restoration, satisfactory functional outcome, high rate of union, and low incidence of complications.

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