ACTA
ORTHOPAEDICA
et
TRAUMATOLOGICA
TURCICA

Acta Orthop Traumatol Turc 2004;38(2):104-109

# A comparison between locked intramedullary nailing and plate-screw fixation in the treatment of tibial diaphysis fractures

## *Tibia diafiz kırıklarının tedavisinde intramedüller kilitli çivi ve plak-vida yöntemlerinin karşılaştırılması*

**Hasan BOMBACI, Bülent GÜNERİ, Mücahit GÖRGEÇ, Adnan KAFADAR**

*Haydarpaşa Numune Education and Research Hospital Orthopedics and Traumatology Department*

**Amaç:** Tibia diafiz kırıklarının plak-vida ve intramedüller kilitli çivi ile tedavi sonuçları değerlendirildi; iki yöntemle ortaya çıkan kaynama süresi ve komplikasyonlar karşılaştırıldı.

**Çalışma planı:** Tibia diafiz kırığı olan 44 hasta (31 erkek, 13 kadın; ort. yaş 38; dağılım 14-64) çalışmaya alındı. Kırıklar 23 hastada sol, 20'sinde sağ tarafta, birinde iki taraflı idi. Yirmi beş hastanın 26 tibiasına intramedüller kilitli çivi, 19 hastada ise plak-vida ile osteosentez yapıldı. İntramedüller kilitli çivi uygulanan grupta ameliyata kadar geçen süre ortalama 9 gün, plak-vida uygulanan grupta 10 gün idi. Hastalar ameliyat süresi, hareket açıklığı, kaynama süresi ve komplikasyonlar açısından değerlendirildi. Ortalama izlem süresi 23 ay (dağılım 18-46 ay) idi.

**Sonuçlar:** Ameliyat süreleri, diz ve ayak bileği ortalama hareket açıklığı değerleri iki grupta birbirine yakın değerlerde bulundu. Kaynama süresi, intramedüller çivi grubunda ortalama beş ay, plak-vida grubunda 3.5 ay idi. Plak-vida grubunda hiçbir olguda kısalık görülmezken, intramedüller çivi uygulanan iki hastada kısalık (2 ve 2.5 cm) saptandı. İntramedüller çivileme ile tedavi edilen, tip III açık kırığı olan hastaların birinde osteomiyelit gelişti. Düz grafilerde, intramedüller çivi grubunda dört hastada, plak-vida grubunda üç hastada açılı kaynama görüldü; bu kırıkların hepsi tibianın distal 1/3'ünde idi.

**Çıkarımlar:** Çok parçalı olmayan tibia diafiz kırıklarında plak-vida osteosentezi tatminkar sonuç vermektedir. Çok parçalı kırıklarda periosteal dolaşımı daha az bozan, bunun sonucunda daha düşük oranda komplikasyona neden olan intramedüller kilitli çivi tercih edilmelidir.

**Anahtar sözcükler:** Kemik plakları; kırık fiksasyonu, internal; kırık fiksasyonu, intramedüller; kırık, kapalı/tedavi; kırık, açık/tedavi; tibia kırıkları/tedavi/cerrahi.

**Objectives:** The results of treatment with plate-screw or locked intramedullary nailing were evaluated for tibial diaphysis fractures, with a comparison of time to union and complications.

**Methods:** The study included 44 patients (31 males, 13 females; mean age 38 years; range 14 to 64 years) with 45 tibial diaphysis fractures. The fractures were on the left side in 23 patients and on the right side in 20 patients. One patient had bilateral involvement. Twenty-six fractures were treated by intramedullary nailing and 19 fractures by plate-screw fixation after a mean time of nine days and 10 days from injury, respectively. The patients were evaluated with regard to operation time, range of motion, time to union, and complications after a mean follow-up of 23 months (range 18 to 46 months).

**Results:** The mean operation time and the mean range of motion of the ankle and knee were found similar in both groups. The mean time to union was five months with intramedullary nailing, and 3.5 months with plate-screw fixation. Length discrepancy occurred in only two patients (2 and 2.5 cm) in whom intramedullary nailing was performed. One patient treated by intramedullary nailing for a type III open fracture developed osteomyelitis. Plain radiographs showed angulation in four patients and in three patients following intramedullary nailing and plate-screw fixation, respectively, all of whom had distal-third tibial fractures.

**Conclusion:** Plate-screw osteosynthesis yields satisfactory results in uncomminuted fractures of the tibial diaphysis, whereas locked intramedullary nailing is more appropriate in comminuted fractures because of better preservation of periosteal circulation, and thus lower complication rates.

**Key words:** Bone plates; fracture fixation, internal; fracture fixation, intramedullary; fractures, closed/therapy; fractures, open/therapy; tibial fractures/therapy/surgery.

**Correspondance to:** Dr. Hasan Bombacı. Haydarpaşa Numune Education and Research Hospital Orthopedics and Traumatology Department, ÜsküdarPhone: +90 - 216 - 414 45 02 / 1592 Fax: +90 - 216 - 346 05 82 e-mail: bombacih@hotmail.com
**Received:** 11.12.2003 **Accepted:** 08.04.2004

Diaphyseal fractures of tibia are most commonly treated by conservative methods (1,2). However, increase in the use of surgical treatment is a matter of debate in the last years (3,4). Besides, locked intramedullary nailing is frequently preferred for comminuted tibia diaphysis fractures. Excluding comminuted fractures, plate-screw fixation achieves high success rates. Both of these surgical procedures have advantages and disadvantages.

In our clinic, the preferred method for tibia diaphysis fractures is conservative methods (closed reduction and casting). On the other hand, comminuted fractures, fractures that cannot be reduced by closed methods, fractures of politraumatized patients, fractures displaced on follow-up, fractures showing delayed-union are treated by locked intramedullary nailing or plate-screw fixation. In this study, we evaluated the results of treatment of tibia diaphysis fractures by locked intramedullary nailing and plate-screw fixation retrospectively and searched the reasons for the differences.

## Patients and Methods

Forty-five tibia diaphyseal fractures of forty-four patients (thirty-one male, thirteen female; mean age thirty-eight; range fourteen to sixty-four years) who were treated by surgical methods and followed up for sufficent period were included in the study. The reasons for the fractures were simple fall in ten patients (23 %), fall from a height in five (11 %), intra-vehicle traffic accident in three (7 %), pedestrian accident in eighteen (41 %), falling object in four (9 %), assault in one (2 %) and gunshot in three (7 %). The fractures were on the left side in twenty-four patients, on the right side in nineteen patients and bilateral in one patient.

Twenty-six fractures in twenty-five patients were treated by locked intramedullary nailing whereas nineteen fractures were treated by plate-screw fixation. In intramedullary nailing group three patients had type I, one patient type II, two patient type III; in plate-screw fixation group two patients had type I, four patient type II, and one patient type III open fracture according to Gustilo's open fracture classification. In the first group one patient had scapula and pelvis, one patient fibular head, one patient carpal navicular, one patient clavicula and temporal bone fracture and one patient had proximal tibiofibular subluxation. In the second group one patient had ankle, one patient femur and one patient had calcaneus and talus fracture.


**Fig 1:** Forty-seven years old male patient treated by locked intramedullary nailing for tibia diaphysis fracture. **(a)** preoperative antero-posterior and **(b)** lateral radiographs. At the last follow-up twenty-seven months after locked intramedullary nailing **(c)** antero-posterior and **(d)** lateral radiographs.

Fractures were assessed according to degree of severity and comminution. Considering the shape of the fractures, they were classified as transverse and oblique. Also they were classified as mild, moderate and severe according to degree of displacement. These two groups of patients were compared using mean operation time, knee and ankle joint range of motion, mean time to union, anterior knee pain, limb length discrepancy and complications. Time to union was evaluated clinically (painless weigt-bearing) and radiographically (cortical continuity in plain radiographs). More than five degree angulation in antero-posterior or lateral radiographs was accepted as malunion.

The mean time to operation in intramedullary nailing group was nine days whereas it was ten days in plate-screw fixation group. Plate-screw fixation was performed using anterior approach in all patients. Incisions were placed on anterior edge of the tibia over the muscle mass to avoid problems in soft tissue healing and skin irritation due to hardware. In patients with possible soft tissue healing problem and crural oedema, plates and screws were placed on the lateral side of the tibia. Parapatellar incision was used for locked intramedullary nailing. Closed reduction was method of choice in this procedure. However, it was unsuccessful in fifteen cases so mini-incision over the fracture site and open reduction were performed. With the help of the fluoroscope alignment was verified. In plate-screw fixation group, fluoroscopy was not used for verification of alignment. The mean follow-up was twenty-three months (range eighteen to forty-six months). Results were compared statistically using unpaired t-test.

## Results

The location of the tibia diaphysis fractures was as follows: five (11,1 %) in proximal one-third, nineteen (42,2 %) in middle one-third, and twenty-one (46,7 %) in distal one-third. Fourteen (31,1 %) were transverse, twenty-four (53,3 %) were oblique and seven (15,6 %) were comminuted. On application eleven (24,4 %) were mildly, twenty-one (46,7 %) were moderately, and thirteen (28,9 %) were severely displaced in plain radiographs. Five of the seven severely displaced fractures were treated by intramedullary nailing whereas two of them were treated by plate-screw fixation.

The mean operation time was 127 minutes in


**Fig 2 :** Fifty-one years old female patient treated by plate-screw fixation for tibia diaphysis fracture. **(a)** preoperative antero-posterior and **(b)** lateral radiographs. At the last follow-up twenty-two months after plate-screw fixation **(c)** antero-posterior and **(d)** lateral radiographs.

intramedullary nailing group. On the other hand, it was 140 minutes in plate-screw fixation group. The mean knee joint flexion was 133 degrees in the first group whereas it was 130 degrees in the second group. Only one patient in the first group had five degrees flexion contracture. All the patients in the second group had full extension.

The mean dorsal-flexion of the ankle joint in intramedullary nailing group and plate-screw fixation group were thirteen degrees (range 0 to twenty degrees) and eleven degrees (range 0 to twenty degrees), plantar-flexion were forty-one degrees (range thirty to fifty degrees) and thirty-seven degrees (range ten to fifty degrees) respectively.

The mean time to union was 5±2,5 months and 3,5±1,2 months in intramedullary nailing group and plate-screw fixation group respectively. In intramedullary nailing group, the mean time to union was 5,3 months for fractures applied mini-incision and open reduction while it was 4,6 months for fractures reduced by closed methods. However, this difference was not found statistically significant ($p>0,05$). There was anterior knee pain in six (23 %) of twenty-six tibia treated by locked intramedullary nailing. Besides, osteomyelitis developed in one patient who had type III open fracture according Gustilo's open fracture classification in intramedullary nailing group. While no limb length discrepancy was seen in plate-screw fixation group, it was detected in two patients (two and 2,5 cm) treated by locked intramedullary nailing.

In intramedullary nailing group, there were three antero-posterior angulations and one lateral angulation whereas in plate-screw fixation group, there were two antero-posterior angulations and one lateral angulation. All of these deformities occurred in fractures located in the distal one-third of the tibia. Malalignment in all of these cases were detectable in early postoperative radiographs. Besides, in intramedullary nailing group one delayed-union, one synostosis and two end cup problems occurred.

## Discussion

It is still a matter of debate whether tibia diaphyseal fractures should be treated conservatively or not. Oni et al stated that surgery is rarely required for the treatment of tibia fractures (1). Van der Linden and Larson compared the results of tibia diaphysis fractures treated conservatively and by plate-screw fixation. They reported longer hospital stay and higher complication rates in the latter. On the contrary, time to union was shorter and alignment was better in this treatment modality (5). Littenberg et al reported similar results (6). In our clinic, conservative methods are prior to other methods if suitable. In comminuted and irreducible spiral, long oblique fractures and fractures of politraumatized patients, surgical procedures are performed. Most commonly performed surgical procedures are locked intramedullary nailing and plate-screw fixation.

Although mean operation time was a little bit shorter for locked intramedullary nailing in this study, it was similar in both of the groups. In intramedullary nailing radiolucent table is a time-conserving facility. While using C-armed fluoroscopy, we detected two time-consuming stages. First stage was the passage of the guide-wire to the distal part of the fracture under closed reduction. For this reason -especially in late cases- we did not hesitate using mini-incision and open reduction. The other time-consuming stage was distal locking. To avoid losing time in this stage, every surgeon should use the technique he or she is accustomed to. The most commonly preferred ones are "free-hand technique" and "external guide". We prefer the latter because of high success rates we achieved in distal locking.

In the group which intramedullary nailing was performed especially if closed reduction was achieved, less soft tissue was needed and consequently less fibrosis and less ROM loss was expected. Mini-incision and open reduction were applied in more than half of the patients treated by intramedullary nailing although we limited their application to facilitate passage of the guide-wire distal to the fracture site. This limitation provided less soft tissue dissection. We suggest the better results of ankle and knee joint ROM in intramedullary nailing group is due to limited soft tissue dissection in this technique.

The mean time to union in intramedullary nailing with reaming was reported 15,4 weeks by Court-Brown et al, five months by Aydin et al, 16,6 weeks by Ates et al (2,7,8). In this study the mean time to

union is similar to that of Aydin et al (average five months). In plate-screw fixation group this time period was shorter compared to both intramedullary nailig in the present study and the studies stated above (2,7,8). There may be two reasons for longer time to union in locked intramedullary nailing. Firstly, because of the period till operation was rather long open reduction had to be resorted in most of the cases in which locked intramedullary nailing used. In addition to disturbed intramedullary circulation due to intramedullary reaming, open reduction causes additional damage to the periosteal blood circulation. Consequently the mean union time was lengthened. Secondly, locked intramedullary nailing was mostly preferred method in comminuted fractures. Longer mean time to union is expected in comminuted fractures. Johner and Wruhs reported 48 % complication rate in open reduction and internal fixation of severely comminuted fractures (9). In this study, in the patients treated with locked intramedullary nailing there was no non-union which usually occurs after periostal streaping in the communited tibia fractures treated with plate and screw. However, infection developed in one patient. We believe that high union rate in this series depends on our preference of intramedullary osteosynthesis in the fractures developed with high energy trauma. For this reason, in order to avoid damage to periosteum of small bone fragments in comminuted fractures, intramedullary nailing is more suitable (3). The mean time to union was shorter in plate-screw fixation group because comminuted fractures were less frequent in this group. These results demonstrate that it is possible to obtain good results by plate-screw fixation in simple fractures.

Anterior knee pain which is frequently stated in the literature, was seen in six of the twenty-four patients (7). In two patients it was due to irritation caused by proximal end of the intramedullary nail. We concluded the rest was due to dissection on the knee.

In this study malunion rate (15,5 %) was similar to that reported by Court-Brown et al (16 %) (7). Van der Linden and Larsson reported that malunion was more frequent in distal-thirds tibia fractures which were treated conservatively (5). In this study there was a close relationship between malunion and the level of the fracture. All of them were seen in tibia fractures located in distal-thirds. The reason of malunion in intramedullary nailing group was failure to centralize the nail in wide distal tibia metaphysis. In plate-screw fixation group malunion was due to effort not to release the bone fragments too much from the periosteum, ignoring perfect anatomical reduction. Suitable alignment must be ensured in distal tibia diapyseal fractues treated by any method. Fluoroscopic verification is generally not sufficent to provide it. If possible, especially in distal fractures, plain radiographs taken perioperatively is more reliable to avoid this complication.

Though intramedullary nailing in open fractures is not widely accepted, good results are reported in some studies (10, 11, 12, 13). In this series, there was only one infection which developed in patients with open fracture. Although this finding supports the drawback for internal fixation in open fractures, it is possible to lower infection rates by taking preventive measures (13). For this reason, we believe locked intramedullary nailing can be performed in open fractures under suitable conditions.

To summarize, it is possible to obtain satisfactory results by plate-screw-fixation in simple tibia diaphyseal fractures. In comminuted fractures locked intramedullary nailing is a more suitable method because it does not disturb the periosteal circulation of small bone fragments. Because malunion is frequently seen in the distal tibia fractures treated by either of these two techniques, proper alignment must be verified during operation.

## References

1. Oni OO, Hui A, Gregg PJ. The healing of closed tibial shaft fractures. The natural history of union with closed treatment. J Bone Joint Surg [Br] 1988;70:787-90.
2. Ateş Y, Ömeroğlu H, Uçar HD, Korkusuz L. Tibia cisim kırıklarında farklı tedavi metodlarının karşılaştırılması. Acta Orthop Traumatol Turc 1994;28:90-3.
3. Perren SM. Evolution of the internal fixation of long bone fractures. The scientific basis of biological internal fixation: choosing a new balance between stability and biology. J Bone Joint Surg [Br] 2002;84:1093-110.
4. Kalenderer Ö, Reisoğlu A, Eryanılmaz G, Agüs H. Uzun kemik kırıklarında oymasız kilitli intramedüller çivi uygulama sonuçlarımız. Acta Orthop Traumatol Turc 2000;34: 260-6.
5. van der Linden W, Larsson K. Plate fixation versus conservative treatment of tibial shaft fractures. A randomized trial. J Bone Joint Surg [Am] 1979;61:873-8.
6. Littenberg B, Weinstein LP, McCarren M, Mead T, Swiontkowski MF, Rudicel SA, et al. Closed fractures of the

tibial shaft. A meta-analysis of three methods of treatment. J Bone Joint Surg [Am] 1998;80:174-83.
7. Court-Brown CM, Will E, Christie J, McQueen MM. Reamed or unreamed nailing for closed tibial fractures. A prospective study in Tscherne C1 fractures. J Bone Joint Surg [Br] 1996; 78:580-3.
8. Aydın E, Şimşek Ü, Solak Ş, Tandoğan R, Güder M. Tibia kırıklarında kilitli intramedüller çivileme. Acta Orthop Traumatol Turc 1995;29:217-9.
9. Johner R, Wruhs O. Classification of tibial shaft fractures and correlation with results after rigid internal fixation. Clin Orthop 1983;(178):7-25.
10. Bombacı H, Polat A, Türkmen İM. Açık tibia diafiz kırıklarının gecikmiş intramedüller kilitli çivi ile tedavisi. Artroplasti Artroskopik Cerrahi 2003;14:74-80.
11. Keating JF, Blachut PA, O'Brien PJ, Court-Brown CM. Reamed nailing of Gustilo grade-IIIB tibial fractures. J Bone Joint Surg [Br] 2000;82:1113-6.
12. Polat A, Bombacı H, Türkmen İM. Açık ve kapalı kırıklarda kilitli intramedüller çivi tedavisinin karşılaştırılması. In: Alpaslan AM, editör. XVII. Ulusal Ortopedi ve Travmatoloji Kongre Kitabı; 24-29 Ekim 2001; Antalya, Türkiye. İstanbul: Turgut Yayıncılık; 2001. s. 71-3.
13. Tornetta P 3rd, Bergman M, Watnik N, Berkowitz G, Steuer J. Treatment of grade-IIIb open tibial fractures. A prospective randomised comparison of external fixation and non-reamed locked nailing. J Bone Joint Surg [Br] 1994; 76:13-9.