Bridge plate osteosynthesis using dynamic condylar screw (DCS) or retrograde intramedullary supracondylar nail (RIMSN) in the treatment of distal femoral fractures: comparison of two methods in a prospective randomized study

Distal femoral kırıkların tedavisinde dinamik kondiler vida ve retrograd intramedüller suprakondiler çivi kullanan köprü plak osteosentezi: İki yöntemin prospektif randomize bir çalışma ile karşılaştırılması

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BACKGROUND
The treatment of distal femoral fractures remains a significant surgical challenge. With the rigid fixation of the distal femoral fractures, bone grafting is frequently needed. Biological osteosynthesis using dynamic condylar screw (DCS) and retrograde intramedullary supracondylar nail (RIMSN) preserve the blood supply and limit the need for bone grafting.

METHODS
From September 2002 to December 2004, 68 closed fractures of the distal femur were treated by bridge plate osteosynthesis using DCS in 31 and RIMSN in 37. The patients were allocated to one of the two groups randomly and followed for 24-36 months (average: 30 months).

RESULTS
With respect to operation time, the DCS group presented significantly better results than the RIMSN group (p=0.000). However, the blood loss was significantly more in the DCS group (p=0.000). There were no significant differences in terms of cumulative rate of union (p=0.855), range of motion of the knee (p=0.727), overall results (p=0.925) and complications (p=0.927) between the two groups.

CONCLUSION
No implant or surgical technique is superior to any other under all circumstances for distal femoral fracture. RIMSN is standard care, yet the biological osteosynthesis using DCS is a very good alternative for the treatment of distal femoral fractures.

Key Words: Bridge plating; distal femur, fractures; dynamic condylar screw; retrograde intramedullary nail.

AMAÇ
Distal femoral kırıkların (DFK) tedavisi önemli bir cerrahi sorundur. Distal femoral kırıkların rijit fiksasyonu ile birlikte kemik greftlemesine genellikle gereksinim duyulmaktadır. Dinamik kondiler vida (DKV) ve retrograd intramedüller suprakondiler çivi (RİSÇ) kullanan biyolojik osteosentez, kan akımını korur ve kemik greftlemesine yönelik gereksinimi sınırlandırır.

GEREÇ VE YÖNTEM
Eylül 2002'den Aralık 2004 tarihine kadar, 68 adet kapalı distal femur kırığı, 31 tanesinde DKV ve 37 tanesinde de RİSÇ kullanılan köprü plak osteosentezi ile tedavi edildi. Hastalar, rasgele yöntemle iki gruba ayrıldı ve 24-36 ay (ortalama 30 ay) süreyle takip edildi.

BULGULAR
Operasyon zamanı ile ilgili olarak, DKV grubu RİSÇ grubuna göre anlamlı şekilde daha iyi sonuçlar gösterdi (p=0,000). Bununla birlikte kan kaybı, DKV grubunda anlamlı şekilde daha fazla oldu (p=0,000). Kümülatif kırık oranı (p=0,855), diz hareket genişliği (p=0,727), genel sonuçlar (p=0,925) ve komplikasyonlar (p=0,927) bakımından iki grup arasında bir fark saptanmadı.

SONUÇ
DFK'yla ilgili olarak, implant veya cerrahi tekniğin hiçbiri, her koşulda, bir diğerine üstün değildir. DFK'nın tedavisinde, RİSÇ uygulanması standart tedavidir ancak dinamik kondiler vida kullanan biyolojik osteosentez de çok iyi bir alternatiftir.

Anahtar Sözcükler: Köprü plaklama; distal femur, kırıklar; dinamik kondiler vida; retrograd intramedüller çivi.

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The treatment of distal femoral fractures remains a significant surgical challenge.[1] These fractures are usually complex and their management is fraught with a wide range of potential complications.[2] Improved implants, instrumentation and extensive surgical experience have made operative treatment the standard care for the management of these fractures. With the rigid fixation of supracondylar femoral fractures, bone grafting has been used liberally.[3] The slow rate of healing of the supracondylar fractures and extensive need for bone grafting have led to the clinical need for improved soft tissue handling around fractures.[1] Open reduction disturbs the natural process of fracture healing and is associated with a high rate of nonunion and infection. Biological internal fixation leaves the fragments untouched, preserves their blood supply, limits the need for bone grafting and accelerates union.[4]

The retrograde intramedullary supracondylar nail (RIMSN) is the standard care for fractures of the distal femur. However, the unknown adverse effects on the knee and difficult removal of the nail are its disadvantages.[5-7] Indirect reduction techniques using dynamic condylar screw (DCS) provide favorable results in distal femoral fractures.[8-10]

Controversies between the proponents of different implants and operative techniques have occupied the attention of most of the reports.[5-10] Consequently, the present study was undertaken to compare the results of bridge plate osteosynthesis using DCS and RIMSN by patellar tendon splitting technique in the treatment of distal femoral fractures.

MATERIALS AND METHODS

From September 2002 to December 2004, 73 closed fractures of the distal femur were treated by RIMSN and DCS. The patients were allocated to two groups randomly one after the other. Sixty-eight patients completed the follow-up of 24-36 months (average: 30 months). Thirty-eight were right- and 30 were left-sided fractures. The mean age was 47 years in the RIMSN group and 49 years in the DCS group. There were 41 males (23 in RIMSN group; 18 in DCS group) and 27 females (14 in RIMSN group; 13 in DCS group) (Table 1). The mechanism of injury was road traffic accident in 39, minor slip in 18 and fall from height in 11 patients (Table 1). The patients were operated within 5 to 11 days of injury (average: 5.7 days).

Thirty-seven fractures were operated using RIMSN. The patellar tendon was split by a 5 cm longitudinal incision over the midline of the tendon. Insertion was made with a sharp awl entry point 3-4 mm anterior to the posterior cruciate ligament. The nail was inserted over a guide wire after reaming of the canal and statically locked at both ends.

Thirty-one fractures were operated using DCS. Through a small incision, the guide wire was inserted 1.5 mm to 2 mm proximal to the joint line and at the junction of the anterior one-third and posterior two-thirds of the lateral condyle parallel to the anterior and inferior planes of the condyles. After reaming and tapping, the DCS screw was advanced over the guide wire. Intercondylar fractures were fixed with 6.5 mm cancellous bone screws. The condylar complex and femoral shaft were reduced indirectly without opening the fracture site. The plate was inserted retrogradely beneath the vastus lateralis muscle and fixed to the femoral shaft by cortical screws through a limited proximal incision.

Before locking the nail or fixing the barrel plate with the proximal fragment, the proper placement of the implant and alignment of the condylar complex with the shaft were verified clinically and radiologically (under fluoroscopic control). Primary bone grafting was not done in any of our patients. Active- and passive-assisted exercises of the knee joint were started on the second day of operation and patients were ambulated on the third postoperative day with the help of crutches. Full weight-bearing was permitted only after the clinical and radiological union of the fracture. Patients were followed weekly for three months, monthly for 12 months and then every three months for 24-36 months.

Table 1. Demographics and fracture pattern in the two groups

Parameters	RIMSN	DCS
No. of patients	37	31
Gender (M/F)	23 / 14	18 / 13
Side (R/L)	21 / 16	17 / 14
Mean age in years (range)	47 (21-75)	49 (23-75)
Fracture type (Muller et al.)		
A1	6	4
A2	11	9
A3	16	12
B	0	0
C1	2	3
C2	2	3
C3	0	0

RIMSN: Retrograde intramedullary supracondylar nail; DCS: Dynamic condylar screw.

RESULTS

Union rates of 89% and 87.5% were achieved in the patients treated with RIMSN and DCS, respectively. Table 1 presents the age, gender, side and fracture type in each group. In Tables 2 to 5, we compared the perioperative parameters, postoperative parameters, overall results and complications. With respect to operation time, the DCS group presented significantly better results than the RIMSN group (p=0.000). However, the blood loss was significantly more in the DCS group (p=0.000). There were no significant differences in terms of cumulative rate of union (p=0.855), range of motion of the knee (p=0.727), overall results (p=0.925) and complications (p=0.927). One nonunion in the DCS group was due to unstable fixation and implant failure. The patient was reoperated by change of barrel plate and bone grafting, which united with poor results. The other nonunion was due to deep infection (diabetic patient). The implant was removed and the fracture was treated in Ilizarov ring fixator. In the RIMSN group, one nonunion was seen in an obese patient in whom a smaller size nail was used. The patient started to bear weight prematurely, which led to breakage of the nail. The other nonunion was again because of the deep infection, in which the nail was removed and treated with ring fixator. The nail was exchanged and union was achieved. Protrusion of the nail in the knee joint was a major problem, seen in three patients. Two nails were unlocked and countersunk. One patient refused reoperation and united with restricted motion of the knee. No intraoperative or immediate postoperative complications were seen in any patient.

DISCUSSION

Fractures of the distal femur are always regarded with great concern because of their proximity to the knee joint. These fractures demand superb skill and sound judgement on the part of the surgeon.[11] Confinement to bed for prolonged periods results in catastrophe in the form of malunion, shortening and stiffness of the knee joint.[1] Operative treatment attains anatomical reduction, early range of motion and avoids all the complications of non-operative treatment.

Conventional open reduction and internal fixation lead to complications because of excessive soft tissue stripping.[9] Change in the technique of surgical stabilization in the distal femur has decreased the number of nonunions and the need for bone grafting. Minimally invasive surgical techniques with a submuscular plate placement have replaced the emphasis on anatomical reduction in the shaft area. Biological internal fixation leaves the fragments

Table 2. Intraoperative parameters in the two groups

Parameters	RIMSN	DCS
Average operation time (range)	102.2 mins (80-120)	83.5 mins (70-100)
Average blood loss (range)	178.0 cc (150-250)	304.2 cc (250-350)

Table 3. Post-operative parameters in the two groups

Parameters	RIMSN	DCS
Average time for union (range)	18.5 weeks (12-25)	18.7 weeks (12-26)
Cumulative union rate		
12 weeks	1 (2.7%)	0
16 weeks	11 (29.7%)	9 (29%)
20 weeks	25 (67.5%)	20 (64.5%)
24 weeks	28 (75.6%)	23 (74%)
28 weeks	33 (89%)	27 (87.5%)
Range of motion (10-130°)		
8 weeks	0	0
12 weeks	14 (37.8%)	11 (35.4%)
16 weeks	27 (72.9%)	20 (64.5%)
20 weeks	29 (78.3%)	24 (77.4%)
24 weeks	33 (89%)	28 (90%)
Results		
Excellent	22 (59.4%)	18 (58%)
Good	8 (21.6%)	6 (19.3%)
Fair	5 (13.5%)	4 (12.9%)
Poor	2 (5.4%)	3 (9.6%)

Table 4. Complications in the two groups

Complications	RIMSN	DCS
Intra-operative	0	0
Deep vein thrombosis	0	0
Varus malalignment	1	1
P.O. infection		
(a) Superficial	1	2
(b) Deep	1	1
Implant failure	1	1
Hardware prominence	3	2
Nonunion	2	2
Delayed union	2	1
Stiffness (Flex <90°)	4	3
Shortening >1.5 cm	0	0

RIMSN: Retrograde intramedullary supracondylar nail; DCS: Dynamic condylar screw.

Table 5. Comparison of parameters between the two groups

Parameter	p
Operation time	0.000
Blood loss	0.000
Cumulative union rate	0.855
Range of motion	0.727
Complications	0.925
Overall results	0.972

untouched, preserves their blood supply, limits the need for bone grafting and accelerates union.[4]

All the accepted methods of treatment have their pros and cons and no single method of treatment can overcome all the problems associated with the management of distal femoral fractures. RIMSN inserted by closed technique has gained in popularity in the treatment of supracondylar fractures of the femur. Yet, little is known about the long-term adverse effects of trans-articularly inserted femoral implant, and the removal of the nail is difficult.[6] The DCS is an effective method of treating supracondylar and intercondylar fractures of the femur with a wide range of advantages.[10,12] However, extensive soft tissue dissection can lead to infection and frequent need for bone graft in comminuted fractures. Indirect reduction and bridge plating with DCS can produce favorable results in complex distal femoral fractures.[9,13]

A review of the literature reveals the controversy between the proponents of the different implants and operative techniques. To our knowledge, there are very few accounts in the literature that compare the results of biological osteosynthesis using DCS and RIMSN.

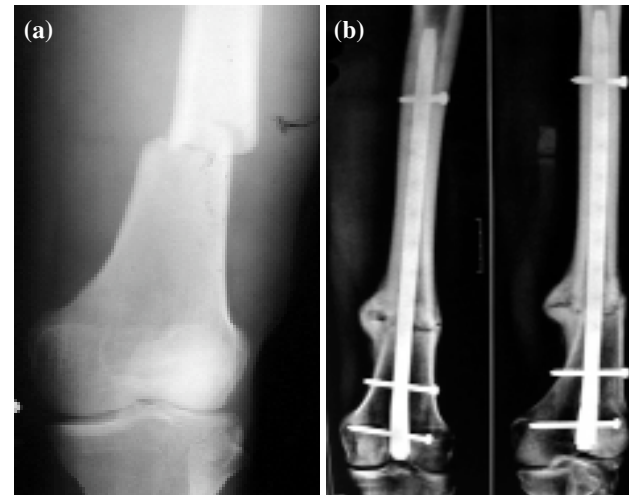

Fig. 1. (a) Pre-operative anteroposterior. **(b)** Radiograph after the union. Radiograph of Type A-1 fracture.

Christodoulou et al.[8] compared RIMSN and DCS in a series of 80 elderly patients (average age: 73.2 years) with supracondylar femoral fracture. Good to excellent results were achieved in 82% in the RIMSN and 81% in the DCS groups. There were no differences between the two groups in terms of boney union, range of motion of the knee and complications; yet, the RIMSN showed better results than the DCS in terms of less blood loss and shorter operation time.

We achieved union rates of 89% and 87% in the RIMSN and DCS groups, respectively. The two

Fig. 2. (a) Pre-operative anteroposterior and lateral. **(b)** Radiograph after the union. Radiograph of Type A-3 fracture.

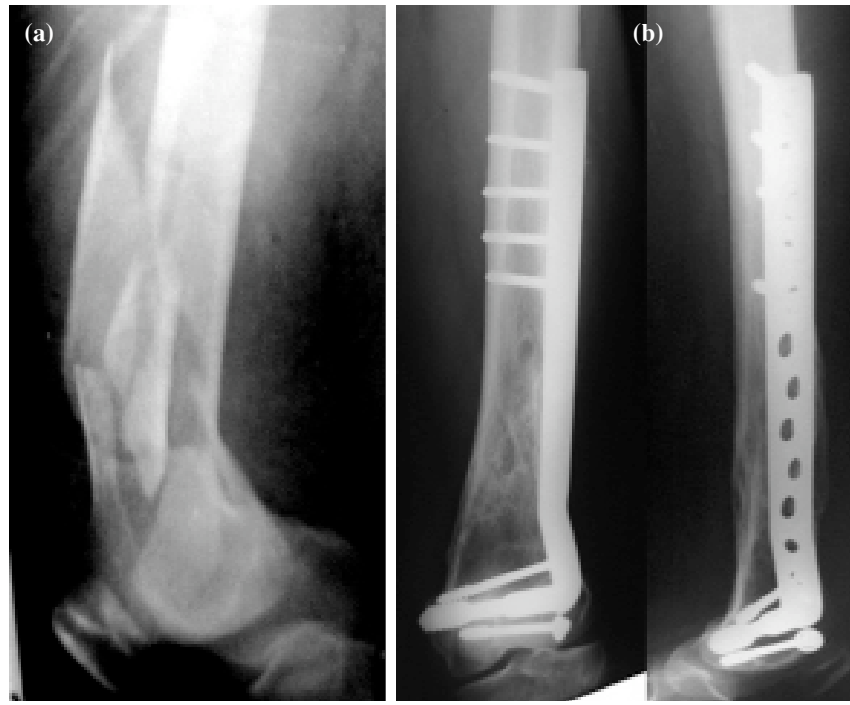

Fig. 3. **(a)** Pre-operative lateral. **(b)** Radiograph after the union. Radiograph of Type A-3 fracture.

methods did not differ when they were compared in terms of union, cumulative rate of union, range of motion and complications. However, RIMSN is a better option in terms of less blood loss and DCS is better as it takes less time to complete the surgery. Our familiarity with dynamic hip screw, which is analogous to it, can explain the shorter time taken to perform a procedure.

Union was achieved without primary or early secondary bone grafting in both groups (Figs. 1, 2, 3). The nonunions in our series were due to the inadequate fixation (one case in each group) and deep infection (one in each group). Our study revealed that both the implants, when used without disturbing the fracture site, can serve as good treatment options in distal femoral fractures with an advantage of no graft site morbidity.

Successful management of distal femoral fractures is possible with adherence to basic principles of fracture fixation. Implant selection is determined on the basis of characteristics of the fracture, bone quality and experience of the surgeon. Although internal fixation by open reduction of the fracture may result in anatomical reduction, it also carries extensive soft tissue dissection, risk of infection and nonunion. Biological osteosynthesis maintains the arterial vascularity by preserving the soft tissue envelope, minimizes surgical trauma to the zone of injury and results in high union and low complication rates. RIMSN serves as the treatment of choice in distal femoral fractures, with the disadvantages of more time to complete the procedure. DCS when used through a bridge plate osteosynthesis is an effective alternative with the disadvantages of more blood loss.

In conclusion, no implant or surgical technique is superior to any other under all circumstances in distal femoral fracture. RIMSN is standard care, yet the biological osteosynthesis using DCS is a very good alternative for the treatment of distal femoral fractures.

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