



## A comparison of locking versus no locking plates in distal femur fractures

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### Abstract

**Background:** Comminuted distal femur fractures are associated with a high complication rate and their treatment is difficult. This type of fracture is more common in young people with major trauma and following motor vehicle accidents. In old patients with osteoporosis the fractures are often closed and occur following a minor trauma. The aim of our study was to compare the outcomes and complications of treatment of intra-articular distal femur fractures using locking and nonlocking condylar buttress plates.

**Methods:** In this retrospective study, 79 patients undergoing surgery due to type C distal femur fractures (T or Y condylar fracture) from 2008-2010 were included. Patients with comorbidities such as diabetes or end stage diseases and patients with other lower extremity fractures on the same side were excluded. For each patient demographic data including age, sex, mechanism of injury, and type of injury was collected. All patients were followed for at least one year postoperatively for complications such as infection, non-union, and malunion.

**Results:** In this study 58 patients (73%) were male and 21 (23%) female. The mean age of the locking group was  $37.4 \pm 17.3$  years and the nonlocking group  $40.6 \pm 17.3$  years. There were no significant differences between the two groups in age and sex. In the locking group 36 patients (80%) had closed fractures and 9 (20%) open fractures and in the nonlocking group 25 patients (73.4%) had closed fractures and 9 (26.6%) open fractures. In both groups 5 patients had infections (11.1% in the locking group and 14.7% in the nonlocking group) and two patients each had nonunion (4.4% and 5.9% respectively). In the locking group 4 patients (8.9%) and in the nonlocking group 6 patients (17.6%) had plate failure.

**Conclusions:** In our study the effects of treatment with both locking and nonlocking condylar buttress plates regarding infection and nonunion were similar but malunion and plate failure were higher in the nonlocking group. Nonetheless, this difference was not statistically significant.

**Keywords:** Complication, Fractures of the distal femur, Locking plate, Nonlocking plate.

### Introduction

In Europe the incidence of distal femur fracture has been found to be ten times less frequent than fracture of proximal femur (1). In approximately 34000 femoral fractures only 6% (2165) involved the distal femur (1). Distal femur fracture can result from

high-energy trauma in young patients or low-energy trauma in older patients. High-energy trauma such as motor vehicle accidents, sport injuries, and pedestrian accidents are most common in men aged 15-50, and low energy trauma such as falls from standing at home are most common in women aged 50 years and over (1). Osteoporosis may also play a role in distal femur fracture in this age group.

Many classifications are used for distal femur fractures, but the most commonly used is the AO-Müller/Orthopedic Trauma Association (AO/OTA) classification system (2).

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Distal femur fractures may be treated by operative or nonoperative methods. Nonoperative methods are indicated in nondisplaced fractures, nonambulatory patients, and patients with significant comorbidities (3).

Almost all distal femur fractures need operative treatment and fixation. Implant selection is determined by the fracture pattern, patient age, bone density, and other injuries to the patient. Implants which can be used are retrograde intramedullary (IM) nail, blade plate, dynamic condylar screw (DCS), condylar buttress plate (locked or nonlocked) (4-8).

Retrograde IM nail is suitable for supracondylar fractures without significant comminution (there must be enough intact distal femur to allow distal locking screw fixation) (9-11). The main indication for IM nail is AO/OTA type A fractures.

Blade plates are not commonly used, they are technically difficult and contraindicated in C3 fractures (T condylar with intra-articular comminution) (12-13).

Dynamic condylar screw (DCS) is identical to 95-degree angled blade plate except that technically it is easier because sagittal plane alignment is not necessary. A large amount of bone can be removed with DCS (13).

Condylar buttress plates (anatomical plate) provide improved fixation in short distal femoral block. These anatomical plates are useful for intercondylar fractures and help to obtain anatomic reduction of the joint (14).

In the locking plate the screw head has threads which lock into the plate, and the combination of screws and plate create a stable construct for comminuted and osteoporotic fractures. Biomechanical studies have demonstrated the advantage of locking plate in osteoporotic bone but in young bone there was no difference between locking or nonlocking plates (18). Our objective for this study was to compare clinical results of locked and nonlocked condylar buttress plate in the intercondylar fractures (Type C) of distal femur.

## Methods

This retrospective study examined records of patients attending our hospital with type C distal femur fracture from 2008 to 2010. Patients treated by three surgeons with locking or nonlocking plate were included. Patients' records had to include a minimum 12 months follow-up and an evaluation of outcome including nonunion, infection, malunion, and device failure. Patients were invited for a final examination for this study. Healing was evaluated by radiographic criteria; malunion was defined as more than 10 degrees of angulation, more than 20 degrees of rotation or more than 2cm shortening (15). If the device did not function normally (for example if there was plate bending or breakage, screw loosening, breakage or pull-out from bone) this was defined as device failure (16).

Seventy nine patients with type C distal femur fracture were included in this study. Our inclusion criteria was type C intra-articular distal femur fractures (closed and open), at least 12 months follow-up. Patients with less than 12 months follow-up or comorbidities such as diabetes or other lower extremity fractures were excluded from the study.

Statistical analysis was performed with SPSS V.16 software using chi-square and independent t-test.

## Results

Because of incomplete follow-up period, comorbidity or associated fracture in the same extremity, 42 of 121 patients were excluded, and 45 patients in locking group and 34 patients in nonlocking group remained for statistical analysis.

A comparison of the two groups showed that they were similar with regard to the age and sex (Table 1).

A comparison of the two groups according to mechanism of injury ( $p=0.434$ ) and type of fracture ( $p=0.340$ ) showed no significant difference (Table 2).

According to the chi-square statistical test, there were no statistically significant difference between the two groups in complica-

Table 1. Comparison of groups by sex and age.

	Locking plate (N=45)	Nonlocking plate (N=34)	p
Male	32 (71.1%)	26 (76.5%)	0.403
Female	13 (28.9%)	8 (23.5%)	
Age (years) Mean $\pm$ SD	37.4 $\pm$ 17.3	40.0 $\pm$ 17.35	0.532
(range)	(18-73)	(18-75)	

Table 2. Comparison of groups according to mechanism of injury and type of fractures.

	Locking (n=45)	Nonlocking (n=34)	p
Car accident	17 (38%)	19 (56%)	0.434
Motorcycle	13 (29%)	8 (23%)	
Pedestrian	2 (4%)	1 (3%)	
Falling down	13 (29%)	6 (18%)	
Closed fracture	36 (80%)	25 (73%)	0.340
Open fracture	9 (20%)	9 (27%)	
Type C1	9 (20%)	8 (23.5%)	
Type C2	12 (26.7%)	9 (26.5%)	
Type C3	24 (53.3%)	17 (50%)	

Table 3. Comparison of groups by type of complications.

Complication	Locking plate	Nonlocking plate	p
Infection	5 (11.1%)	5 (14.7%)	0.634
Nonunion	2 (4.4%)	2 (5.9%)	0.773
Malunion	2 (4.4%)	4 (11.8%)	0.224
Device failure	8 (9%)	6 (17.6%)	0.246

tions such as infection, nonunion, malunion and device failure (Table 3).

Malunion and device failure were more frequent in the nonlocking group but this difference was not statistically significant.

### Discussion

There is no single surgical implant that can be used for all distal femur fractures.

Several biomechanical studies have compared conventional condylar buttress plate and DCS with the less invasive stabilization system (LISS) plate. They used locking condylar buttress plate and minimal invasive surgical approach. Locking plate had more reversible deformation when compared to the other two constructs (17-19).

Zlowdzki et al (19) compared the locking plate with unicortical locking screws to 95 degree blade plate in axial, torsional and cyclic axial loading in a cadaveric model with 1cm gap. They concluded that the LISS provided improved distal fixation in osteoporotic bone (19).

In a 4cm fracture gap model in a high bone density cadaveric specimen no significant differences was found between the locking plate with unicortical locking screws and the angled blade plate for axial load to failure, but the locking plate had significantly less axial stiffness (20).

The complications related to direct reduction techniques led to the development of indirect fracture reduction technique as reported by Mast et al (21). The concept of indirect reduction technique is preservation of soft tissue attachments and bone circulation and restoration of limb alignment, length and rotation, without direct exposure of the fracture. Minimally invasive plate osteosynthesis (MIPO) includes indirect fracture reduction techniques for metaphyseal and diaphyseal fractures, limited lateral dissection, passage of the plate sub-muscularly under vastus lateralis and proximal screw insertion through small incisions (22-24).

Evidenced based recommendations were given (25). A grade B recommendation was offered for operative versus nonoperative

treatment. Operative treatment reduced the risk of poor results by 32%. For the type of internal fixation used, a grade C recommendation was produced. There were no observed differences between implants for nonunion, fixation failure, infection and revision surgery. Subgroup analysis showed that submuscular plating may reduce the rate of infection when compared to compression plating (55% relative risk reduction,  $p=0.056$ ) but at the increased risk of fixation failure and revision surgery (22).

Krettek et al (22) used condylar buttress plate or dynamic condylar screw, and trans-articular approach with subcutaneous plate osteosynthesis technique in 8 distal femur fractures (2 open). No nonunion, secondary bone grafting procedure, infection or implant failure was reported (22). In this study absence of complication is related to preservation of soft tissue and bone circulation.

In our study we compared locking and nonlocking condylar buttress plates in type C (intra-articular fracture of distal femur). We evaluated clinical results of these two groups at least 12 months after surgery. In our locking group infection rate was 11.1%, nonunion 4.4%, malunion 4.4%, and plate failure 8.9%. In nonlocking group these complications were 14.7%, 5.6%, 8% and 17.6% respectively. Between the two groups there was no statistically significant difference.

In Moradi et al (26) which used only locking plate, infection rate was 19.1% (in our study 11.1% and 14.7% in locking and nonlocking groups, respectively), nonunion rate was 19.1% (in our study 4.4 and 5.6), and malunion rate was 21.3% (in our study 4.4% and 8%). In this study complications were more than our patients' and probably were related to their higher incidence (two times more than our study) of open fractures.

In Shahhoseini et al (27) a lower infection rate (7.9%) was related to a lower percentage of open fractures. In their study malunion was 31.6% which was seven times more than in our study.

## Conclusion

The locking plate is presented as a valuable advancement in fracture treatment. However clinical and biomechanical studies (e.g. 12, 16, 17) have shown that there is no advantage in locking compared to nonlocking plates in non-osteoporotic bone. In our study complications of infection and nonunion were similar in the two groups with a higher malunion and device failure in the nonlocking group, however this was not statistically significant.

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