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ORIGINAL ARTICLE

DUAL PLATE FIXATION OF DISTAL FEMORAL FRACTURES

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Abstract. Introduction: *Distal femur fractures have high risk of delayed union and poor functional results. The traditional lateral locking plate fixation can lead to non-union. Biological and mechanical augmentation is needed in some cases.* ***Objective:*** *The aim of our study is to present our experience with double plate fixation, to clarify when it is necessary, which is the optimal plates configuration and the ideal surgical approach.* ***Materials and methods:*** *Twelve distal femoral fractures (AO types C2 and C3) stabilized with dual plates for a period of 6 years (2017-2023). Nine female patients, three male, average age 57 years. Eight high energy fractures (traffic accidents, falls from height), four low energy fractures. Two open fractures – Gustilio-Anderson type 2. One extensile anterolateral approach used in six cases. Six fractures treated through a combination of a lateral and a mini invasive medial approaches. Clinical and functional recovery assessed according to the criteria of the Knee Society Clinical Rating System (KSCRS).* ***Results:*** *All fractures healed for a medium period of 4,5 months. Three of the functional results were graded as excellent, 6 as good, 2 as average and one as poor. The X-ray results were rated as excellent in nine fractures and good in three. There were 2 delayed healings. Distal medial screw loosening was reported in 5 cases. Flexion contracture was reported in four cases.* ***Conclusion:*** *The advantages of medial plate augmentation outweigh the risks and is indicated in certain complex distal femur fractures.*

Key words: *distal femur fracture, dual plating, anterolateral approach, mini invasive medial approach*

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INTRODUCTION

Distal femur fractures are challenging injuries that are relatively common. They consist of around 6 % of all femoral fractures [1]. There is a distinct bimodal separation. The majority of the young patients present with comminuted fractures and soft tissue damage, after a high energy trauma. The second group of patients are usually osteoporotic older women [2]. Treatment of both varieties can be problematic. The current standard for fixation relies on single lateral locking plate (LCP). It does not always provide enough stability for enough time for the bone to heal. Complications like non-union can reach as much as 14,8%, malunion 13%, fixation failure 5% and deep infection up to 3,7% [3]. The addition of a medial plate support is a logical solution, at the cost of an increased surgical trauma and complexity.

The aim of our study is to present our experience with double plate fixation, to clarify when is it neces-

sary, which is the optimal plates position and surgical approach.

MATERIALS AND METHODS

We operated twelve distal femoral fractures (AO types C2 and C3) for a period of 6 years (2017-2023). Nine of the patients were female, three were male. The average age of the participants was 57 years. Eight of the fractures resulted from a high energy trauma (traffic accidents, falls from height), while the rest four resulted from a low energy domestic trauma. Two of the fractures were open – Gustilio-Anderson type 2. All of the fractures were stabilized with two plates. One extensile anterolateral approach was used in six cases. The rest 6 fractures were treated through a combination of a lateral and a mini invasive medial approaches.

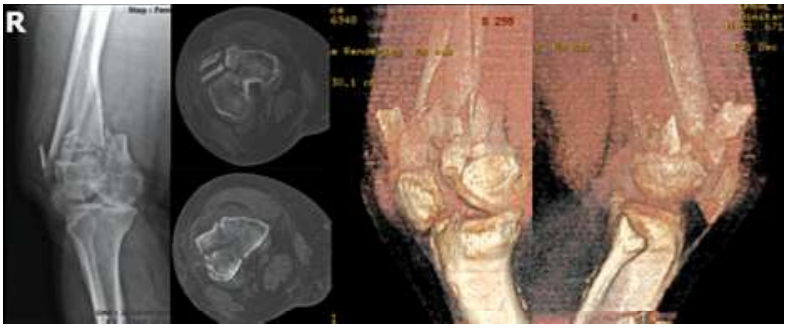
Patients were followed on a monthly basis till X-ray evidence of fracture healing. Fracture union was determined by painless weight bearing, combined with radiographic analysis of at least 3 healed cortices and/or callus formation.

Clinical and functional recovery was assessed according to the criteria of the Knee Society Clinical Rating System (KSCRS). Well aligned, stable and painless knee with a range of motion at least 125° received the maximal amount of 100 points [4].

X-ray assessment was done according to the modified Rasmussen criteria. We measured the articular congruency, condyle widening and the axial alignment of the lower limb.

SURGICAL TECHNIQUE

Extensile anterolateral approach was used in most of the cases with articular comminution (Figure1). The patient was positioned supine with the knee flexed to 30°. The skin incision was placed slightly lateral to the midline of the knee. The quadriceps



A. High energy (motor vehicle crush) 33 C 3.3 fracture articular and metaphyseal comminution (sagittal (Hoffa) fractures of medial and lateral condyle

B. Extensile anterior lateral parapatellar approach. Longitudinal quad split. 90-90 plate placement. Bridging of the medial comminution

C. X-ray and functional result

Fig. 1

fascia was then incised in line with the skin incision. Flexor retinaculum was incised 10 mm lateral from the patella. Dissection continued proximally by dividing m. vastus lateralis from m. rectus femoris in the first three cases. Later in the study the quadriceps muscle was not split, but was elevated instead. The iliotibial band was bluntly retracted from the vastus lateralis muscle. The muscle was then detached from lateral intermuscular septum, thus allowing elevation and displacement of the whole quadriceps muscle medially. Collateral and perforating vessels were ligated. The patella was then displaced medially, allowing formal reduction of the articular fragments. After compressing the fracture with lag screws, two plates were placed in orthogonal position, one on the lateral aspect of the femur, one on the anterior side. The proximal lateral screws were placed through a separated limited approach.

The combination of a lateral and a mini invasive medial approach was mainly used to treat osteoporotic fractures with no particular comminution (Figure 2). Distally the medial incision was centered over the

A. Low energy 33 C2 fracture with some metaphyseal comminution, poor bone quality

B. Conventional lateral and less invasive medial approach

C. Fracture consolidation at 4th month. Medial screw loosening with no total debricolage. Good functional result

Fig. 2

femoral epicondyle. It started approximately 1 cm above the joint line and 1 cm anterior to the adductor tubercule and then followed the anterior border of the sartorius muscle. The bone was reached by lifting vastus medialis off the medial intermuscular septum, 5 cm over the adductor tubercule. Care was taken to avoid articular branch of descending geniculate artery and the last branch of the femoral nerve to vastus medialis. The proximal part of the incision was placed on the line connecting spina iliaca anterior superior with the medial margin of the patella. The chosen plate length determined the height of the incision. The interval between m.sartorius and m.rectus femoris was then explored. The sartorius was retracted medially to protect the neurovascular structures. The bone was reached after splitting m.vastus intermedius. Both incisions were connected through an extra periosteal tunnel, where the implant was placed.

The open fractures were treated in a staged fashion. Debridement and spanning external fixator were followed by definitive fixation after 7 to 14 days. Autologous bone graft was used in two fractures. The lateral plate was universally an angle stable one. Conventional buttress (in 11 cases) or dynamic compression plates were utilized medially.

Passive and active assisted movements were started as soon as the pain subsided. Touch weight bearing was allowed after the second post-operative month. Progression to full weight bearing was allowed after X-ray evidence of fracture healing.

RESULTS

All fractures healed for a medium period of 4,5 months. According to the criteria of the KSCRS 3 of the results were graded as excellent, 6 as good, 2 as average and one as poor. The X-ray results were rated as excellent in 9 fractures and good in three.

There were no deep infections or deep venous thrombosis. Two fractures healed for a prolonged period of 6 months with no secondary surgical intervention. The most common complication was distal medial screw loosening that was reported in 5 cases. All of those fractures healed. In four cases the loose screws had to be removed. The second most common complication was flexion contracture, reported in four cases (Table 1).

DISCUSSION

At present the lateral locking compression plate (LCP) is the preferred implant for distal femoral fracture fixation. Zlowodzki et al established it had a clear advantage when compared to a conventional plate, or intramedulary nail, especially when fixing osteoporotic bone [5]. LCP could also be inserted in a less invasive fashion without disturbing the soft tissue envelope and blood supply. In spite of the initial enthusiasm, later studies established that the latter had its own set of complications. Lujan et al. reported insufficient and asymmetric callus formation in up to 37% of the fractures at 6th month. The authors attributed this finding to the excessive rigid-

N	AO type	GA type	Approach	Quality of reduction	Plate type and positioning	Functional score	complications
1.	AO 33 C 2	NA	Lateral+mini medial	excellent	LCP+ buttress plate parallel	excellent	distal medial screw loosening
2.	AO 33 C 3	GA 2	Extended antero-lateral	excellent	LCP+ buttress plate perpendicular	good	5° extension deficit, delayed bone healing
3.	AO 33 C 3	NA	Lateral+mini medial	good	LCP+ buttress plate parallel	poor	10° extension deficit
4.	AO 33 C 2	NA	Lateral+mini medial	excellent	LCP+ buttress plate parallel	excellent	distal medial screw loosening
5.	AO 33 C 2	NA	Lateral+mini medial	excellent	LCP+ buttress plate parallel	excellent	distal medial screw loosening
6.	AO 33 C 3	GA 2	Extended antero-lateral	good	LCP+ buttLCP+ buttress plate perpendicular	average	5° extension deficit, delayed healing
7.	AO 33 C 3	NA	Extended antero-lateral	excellent	LCP+ buttress plate perpendicular	average	5° extension deficit
8.	AO 33 C 3	NA	Extended antero-lateral	good	LCP+ LCDCP perpendicular	good	
9.	AO 33 C 3	NA	Modified Swashbuckler	excellent	LCP+ buttress plate perpendicular	good	
10.	AO 33 C 3	NA	Modified Swashbuckler	excellent	LCP+ buttress plate perpendicular	good	
11.	AO 33 C 3	NA	Lateral+medial	excellent	LCP+ buttress plate parallel	good	
12.	AO 33 C 2	NA	Lateral+mini medial	excellent	LCP+ buttress plate parallel	good	distal medial screw loosening

ity of the locking plate and to the unilateral fixation [6]. In a large prospective study Rodrigez et al. reported an alarming 10% nonunion rate. The authors analyzed their data and concluded that the main risk factors for this complication were open fracture, infection, obesity and fixation with a steel unilateral locking plate. They recommended special attention to these groups of fractures with early or preventative use of osteoinductive measures [7]. A different approach to reducing the nonunion rate is biomechanical augmentation by a medial plate or an intramedullary nail. The advantageous implant position closer to the mechanical axis provides higher axial and bending rigidity [8]. Todorov et al established that double plate construct also provides higher rotational stiffness [9].

The idea of double plating is not new. Sanders et al. used two conventional plates for the treatment of complex distal femoral fractures as early as 1991 [10]. Sain et al. advised double plating in all cases with medial bone loss, low transcondylar fractures, medial Hoffa fractures, periprostetic fractures, an established nonunion, low bone density, or comminution [11].

In a recent retrospective study of 82 distal femoral fractures Nam et al. compared one vs two plate fixation [12]. Patients treated with dual fixation had faster healing and better function at the cost of prolonged surgery and higher blood loss.

All distal femur fractures included in our study healed for a mean period of 4,5 months. The most common complication that we encountered was loosening of the most distal medial screws (Fig. 2). In all cases a non-locking plate was used to treat fractures with poor bone quality. Although no revision surgery was necessary, this complication suggests unstable fixation due to poor screw purchase. There isn't consensus as for the best plate type for medial fixation. Authors have used dynamic compression plate (DCP), reconstruction plate, semitubular plate, anatomical medial locking plate, proximal and distal tibial plate and straight locking plate countered to the medial side [13]. Our experience suggests that a locking plate with multiple distal screw options might lead to better fixation and is thus recommended.

A varying degree of flexion contracture was the second most common complication that we faced. It was recorded in four patients. These were all high energy comminuted fractures, treated in the beginning of the study. Initially proximal exposure was achieved by splitting the quadriceps muscle along the line of the parapatellar arthrotomy. We believe this caused excessive fibrosis that could explain the poor functional results. Later we switched to the modified swashbuckler exposure as described by Raja et al. [14]. We explored the interval between tractus iliotibialis and vastus lateralis and elevated the whole quadriceps muscle in mass, thus achieving distal exposure with less muscle dissection and trauma. This improved the functional results.

In fractures with no articular comminution a combination of a less invasive medial and lateral approach proved feasible. Fracture reduction and axial alignment was performed through the lateral window. The medial implant was slid below vastus medialis, leaving the periosteal sleeve intact. The plates were positioned in a parallel fashion, thus achieving optimal rotational stability. Most of the osteoporotic fractures were treated this way with excellent results and no major complications.

CONCLUSION

Distal femur fractures have high risk of delayed union and poor functional results. Optimal stability and soft tissue handling is needed to allow for early and aggressive rehabilitation. The advantages of medial plate augmentation outweigh the risks. We believe it is a valid solution for the complex distal femoral fractures.

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Consent for publication: *Consent form for publication was signed by the patient and collected.*

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