The use of locked plate as a definitive fixation for open supracondylar fracture of the femur with partial bone loss in polytraumatized patients

Mootaz F. Thakeb, Wael Samir

Department of Orthopedic Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Mootaz Thakeb, MD, Department of Orthopedic Surgery, Faculty of Medicine, Ain Shams University, 66 Abul Attaheya Street, Abbas Akkad Extension, Cairo, Egypt Tel: + +20 111 121 8237; e-mail: mootaz.thakeb@gmail.com

Received 23 October 2013
Accepted 20 November 2013

The Egyptian Orthopaedic Journal
2017, 52:13–17

Background
Open supracondylar fractures of the femur are complex injuries usually presenting in a polytraumatized patient. Partial circumferential bone loss may result at the time of injury or during debridement. The way in which the fracture is treated has a substantial influence on the local mechanical and biological environment, which in turn will influence the quantity and quality of the osteogenic response. Although early skeletal stabilization can stop the cycle of injury, remove nidus for infection, and halt ongoing hemorrhage, it may be prudent to delay definitive surgery until the patient's general condition is optimized. Meanwhile, debridement and a preliminary spanning external fixator is used to stabilize the fracture. The use of a locked plate for the fixation of supracondylar fracture of the femur with partial bone loss creates a rigid biomechanical environment needed for healing and maintenance of alignment until fracture healing.

Patients and methods
Eighteen patients with open supracondylar fracture of the femur were treated between January 2009 and June 2011. All patients were treated surgically within the first 24 h. Radical soft tissue and bone debridement was performed. Thirteen patients underwent definitive fracture fixation using a laterally placed locked distal femur plate. Five patients had their fractures primarily stabilized by an external fixator until improvement of their general condition.

Results
Bone healing was obvious on follow-up radiographs in 10 patients without the need for supplementary surgical procedures at a mean of 16 (12–20) weeks. Seven patients with no progressive radiologic healing by 20 weeks' follow-up underwent an iliac crest cancellous bone graft; healing was then realized radiologically after a mean of 12 (8–18) weeks. Using the IOWA knee functional score for final patient assessment, we found excellent results in 14 patients, good results in three patients, and fair results in one patient.

Conclusion
Generally stable polytraumatized patients should be treated with thorough initial debridement, local antibiotics, and early definitive fracture fixation using a locked distal femur plate. Critically unstable patients with hemorrhagic shock are to be treated with damage control until improvement in their general condition. Bone graft is to be delayed for 20 weeks as many fractures would successfully heal by that time, even with partial bone loss.

Keywords:
locked distal femur plate, open supracondylar femur fracture, polytraumatized patient

Egypt Orthop J 52:13–17

1110-1148

Introduction

Open supracondylar fractures of the femur are complex injuries, especially when accompanied by bone loss, contamination, and compromised soft tissue envelope. These high-energy fractures are usually seen in a polytraumatized patient. Partial circumferential bone loss may result at the time of injury or during debridement. Defects involving more than half of the bone circumference, with no signs of progressive radiologic healing by 20 weeks' follow-up, often require additional procedures to restore volume and strength [1]. The way in which the fracture is treated will have a substantial influence on the local mechanical and biological environment, which in turn will influence the quantity and quality of the osteogenic response. Management factors to consider include the scope of open fracture care, type of skeletal stabilization, soft tissue coverage, and bone grafting [2]. Although early skeletal stabilization can stop the cycle of injury, remove nidus for infection, and halt ongoing hemorrhage, it may be prudent to delay definitive surgery until the patient's

general and local soft tissue conditions have become optimal. Meanwhile, debridement and a preliminary spanning external fixator are used to stabilize the fracture [3]. The use of locked plate in the fixation of supracondylar fracture of the femur with partial bone loss creates a rigid biomechanical environment needed for healing and maintenance of alignment until fracture healing [4,5].

The aim of this work is to propose a treatment option for these challenging fractures especially in polytraumatized patients.

Patients and methods

Eighteen patients with open supracondylar fracture of the femur were treated between January 2009 and June 2011. This study approved by the Ethical committee of Faculty of Medicine, Ain Shams University, Cairo, Egypt. All patients were polytraumatized: 13 were stable or borderline and responded well to resuscitation, and five patients were unstable with hemorrhagic shock (Table 1). There were 14 male and four female patients, of a mean age of 33.3 (19–62) years. The mechanism of injury was road traffic accident in 15 patients and fall from height in 3. Twelve patients had type III-A and six had type III-B open fractures according to the Gustillo and Anderson classification [6]. According to the AO/OTA system [7], six fractures were classified as 33-A3, five as 33-C2, and seven as 33-C3.

All patients were treated surgically within the first 24 h. Radical soft tissue and bone debridement was performed. The articular surface was anatomically fixed with lag screws in 12 patients. Thirteen patients underwent definitive fracture fixation using a laterally placed locked distal femur plate (Fig. 1). Five patients had their fractures primarily stabilized by an external fixator until improvement was seen in their general condition; and after a mean of 8 (5–14) days

Table 1 Patient's data

Age (years)	Sex	AO/OTA classification	Gustilo/Anderson type of open fracture	Other injuries	Primary treatment
20	Male	33-A3	III-A	Head injury, ipsilateral fracture clavicle, chest injury	Debridement, temporary external fixation
45	Male	33-C2	III-A	Head injury, ipsilateral humerus fracture	Debridment, definitive internal fixation
30	Male	33-C3	III-B	Burst fracture L1, contralateral calcaneum fracture	Debridment, definitive internal fixation
62	Female	33-C2	III-A	Contralateral pilon fracture	Debridment, definitive internal fixation
30	Male	33-C2	III-B	Head injury, ipsilateral fracture distal radius	Debridment, definitive internal fixation
28	Male	33-C3	III-A	Ipsilateral humerus fracture, chest injury	Debridment, definitive internal fixation
19	Female	33-C3	III-A	Head injury, ipsilateral clavicle fracture	Debridment, definitive internal fixation
44	Male	33-C3	III-A	Head injury, fracture pelvis	Debridment, definitive internal fixation
38	Male	33-A3	III-B	Blunt abdominal injury, head injury	Debridement, temporary external fixator
52	Female	33-C3	III-B	Head injury, ipsilateral humerus fracture	Debridment, definitive internal fixation
20	Male	33-C3	III-A	Head injury, fracture ribs	Debridment, definitive internal fixation
26	Male	33-C2	III-A	Head injury, contralateral posterior column acetabulum fracture	Debridment, definitive internal fixation
24	Male	33-A3	III-A	Blunt abdominal injury, ipsilateral shaft tibia fracture	Debridement, temporary external fixation
37	Male	33-A3	III-B	Contralateral radius fracture, contralateral tibial fracture, chest injury	Debridment, definitive internal fixation
42	Female	33-A3	III-B	Head injury, maxillofacial fractures	Debridement, temporary external fixation
27	Male	33-C3	III-A	Head injury, contralateral calcaneum fracture	Debridment, definitive internal fixation
33	Male	33-C2	III-A	Head injury, fracture mandible	Debridment, definitive internal fixation
24	Male	33-A3	III-A	Blunt abdominal injury	Debridement, temporary external fixation

Figure 1

Comminuted supracondylar intercondylar fracture left femur (33-C3) with partial bone loss on the medial side.

they were brought back to the operating room for definitive fixation with a locked plate. Antibiotic (gentamicin)-impregnated sheets were placed in the wounds in all patients. We were able to close all wounds primarily with no need for plastic coverage.

Knee range-of-motion exercises started 2 weeks after definitive fracture fixation. Patients were non-weight-bearing for 8–12 weeks, and then gait training started; partial to full weight-bearing was allowed as per radiologic signs of healing and if not otherwise contraindicated because of other injuries.

Union was defined as bridging bone on three of four cortices and resolution of pain in the supracondylar region. Alignment was determined by measuring the mechanical lateral distal femoral angle in relation to the normal contralateral side or using the normal average range of 87° [8]. This angle was measured on immediate postoperative radiographs and at final follow-up.

Seven patients with no radiographic signs of progressive fracture healing had iliac crest cancellous bone graft at 20 weeks' follow-up.

Patients were followed up for 1 year after complete fracture healing. Final assessment was done using the IOWA knee functional score [9].

Results

Bone healing was obvious on follow-up radiographs in 10 patients without the need for supplementary surgical procedures at a mean of 16 (12–20) weeks.

Seven patients with no progressive radiologic healing by 20 weeks' follow-up underwent an iliac crest cancellous bone graft. Healing was then realized radiologically after a mean of 12 (8–18) weeks. One patient had a broken plate with varus malalignment at 15 weeks' follow-up due to uncontrolled early weight-bearing, for whom a revision fixation with locked plate was performed together with a cancellous iliac crest bone graft; fracture healing was evident at 16 weeks' follow-up.

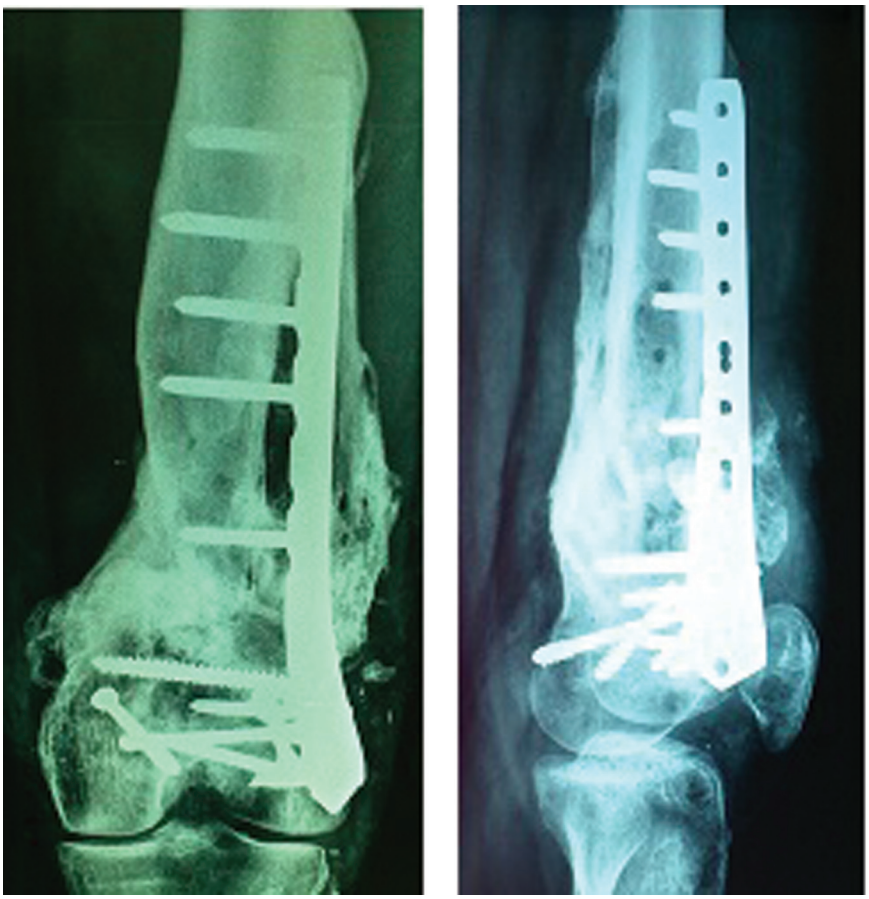
No infection was identified in any of the patients. Knee stiffness was encountered in five patients with mean arc of motion 0°–90°.

Final radiologic evaluation carried out 1 year after complete fracture healing revealed no change in the mechanical lateral distal femoral angle compared with within-normal average of the immediate postoperative values (Fig. 2). Using the IOWA knee functional score for final patient assessment, the results were found to be excellent in 14 patients, good in three, and fair in one patient.

Discussion

The polytraumatized patient may be classified as stable, borderline, or unstable. Early definitive fracture fixation is recommended for the stabilized polytraumatized patient. However, in the patient who presents with severe hemorrhagic shock or any other life-threatening condition, prolonged surgical procedures should be avoided, and staged fracture fixation should

Figure 2



Antero-posterior and lateral X-rays at final follow up showing full fracture union with good alignment.

be performed. The damage control approach, which uses external fixation as a primary tool, may be applied in such cases [3,10,11].

In our work, 13 patients were stable or borderline on presentation in the emergency room. After being resuscitated and stabilized they were managed by early total care with radical debridement and definitive fixation using a laterally placed locked distal femur plate. The other five patients with hemorrhagic shock were brought to the operating room together with the trauma team for control of other surgical emergencies (abdominal exploration in three and brain decompression for extradural hemorrhage in two patients). These five patients were treated with damage control by thorough debridement and fracture stabilization with an external fixator, which was later converted to internal fixation at a mean of 8 days.

The use of locking plates for internal fixation of distal femur fractures has largely replaced intramedullary nails, blade plates, and condylar buttress plates. Reported clinical nonunion rates after treatment of distal femur fractures with locking plates vary between 0 and 10% [12–14]. Difficulties with fracture healing in the distal femur fractures may present clinically as delayed union, hardware failure, loss of alignment, or established nonunion. The importance of stabilizing medial column to prevent varus malalignment with either bone graft or bicolumnar plate fixation was demonstrated by some authors when using nonlocking conventional plates [15,16]. The use of a locked plate for the fixation of supracondylar fracture of the femur with partial bone loss creates a rigid biomechanical environment needed for healing and maintenance of alignment until fracture healing [4,5].

In our series seven patients with delayed healing required an iliac crest cancellous bone graft by 20 weeks' follow-up. Despite the importance of medial column buttressing, only one patient had a broken plate by 15 weeks' follow-up due to a deficient medial column; for this patient revision fixation with a bone graft was performed to fill the medial gap; this is directly related to the biomechanical advantage of locked plate fixation for such fractures.

The use of local antibiotic therapy in open fractures with partial bone loss treated with early internal fixation prepares the site of the bone defect with a

vascularized pouch and a useful biomembrane ideal for cancellous autograft that may be needed later [17–19]. Also the usefulness of local antibiotic therapy was evidenced by a decrease in chronic infection rates from 12 to 3% in a large heterogenous population of Gustilo and Anderson type I–III-B open fractures [20].

The use of ring fixators has long been successful in the treatment of such complex fractures but with the drawback of significant loss of knee range of movement; moreover, the frame poses difficulties for most of the patients [21–23]. Internal fixation of distal femoral fractures gives greater comfort, especially for polytraumatized patients, with better rehabilitation outcome; in our study, knee stiffness in the form of limited flexion was encountered in five patients with a mean of 90° (60°–120°).

Conclusion

Our results are encouraging for the use of a locked distal femur plate as a definitive management for open supracondylar femur fractures with partial bone loss, especially in polytraumatized patients. For generally stabilized patients, thorough initial debridement, local antibiotics sheet, and definitive fracture fixation were useful as we removed any nidus for infection and stopped ongoing injury to an already tenuous soft tissue. Critically unstable patients with hemorrhagic shock are to be treated with damage control until improvement in their general condition. Bone graft is to be delayed for 20 weeks as many fractures would successfully heal by that time even with partial bone loss.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Keating JF, Simpson AH, Robinson CM. The management of fractures with bone loss. J Bone Joint Surg Br 2005; 87:142–150.

2 Sands S, Siska PA, Tarkin IS.Reconstructive strategies for skeletal complications in the polytrauma patient. In: Pape HC, Sanders R, Borrelli J Jr. editors. The poly-traumatized patient with fractures. Heidelberg, Berlin: Springer-Verlag; 2011.

3 Pape HC, Tornetta III P, Tarkin I, Tzioupis C, Sabeson V, Olson SA. Timing of fracture fixation in multitrauma patients: the role of early total care and damage control surgery. J Am Acad Ortho Surg 2009; 17:541–549.

4 Barei DP, Beingessner DM. Open distal femur fractures treated with lateral locked implants: union, secondary bone grafting, and predictive parameters. Orthopedics 2012; 35:e843–e846.

5 Kregor PJ, Stannard JA, Zlowodzki M, Cole PA. Treatment of distal femur fractures using the less invasive stabilisation system, surgical experience and early clinical results in 103 fractures. J Orthop Trauma 2004; 18:509–520.

6 Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analysis. J Bone Joint Surg Am 1976; 58A:453–458.

7 [No authors listed]. Fracture and dislocation compendium. Orthopaedic Trauma Association Committee for Coding and Classification. J Orthop Trauma 1996; 10(Suppl 1):V–XI; 1–154

8 Paley D, Tetsworth K. Mechanical axis deviation of the lower limbs. Preoperative planning of uniapical angular deformities of the tibia or femur. Clin Orthop Relat Res 1992; 280:48–64.

9 Merchant TC, Dietz FR. Long-term follow-up after fractures of the tibial and fibular shafts. J Bone Joint Surg Am 1989; 71A:599–606.

10 Bone LB, Johnson KD, Weigelt J, Scheinberg R. Early versus delayed stabilization of femoral fractures: a prospective randomized study. J Bone Joint Surg Am 1989; 71:336–340.

11 Taeger G, Ruchholtz S, Waydhas C, Lewan U, Schmidt B, Nast-Kolb D. Damage control orthopedics in patients with multiple injuries is effective, time saving, and safe. J Trauma 2005; 59:409–416.

12 Kayali C, Agus H, Turgut A. Successful results of minimally invasive surgery for comminuted supracondylar femoral fractures with LISS: comparative study of multiply injured and isolated femoral fractures. J Ortop Sci 2007; 12:458–465.

13 Fankhauser F, Gruber G, Schippinger G, Boldin C, Hofer HP, Grechenig W, Szyszkowitz R. Minimal-invasive treatment of distal femoral fractures with the LISS (Less Invasive Stabilization System): a prospective study of 30 fractures with a follow up of 20 months. Acta Orthop Scand 2004; 75:56–60.

14 Markmiller M, Konrad G, Sudkamp N. Femur-LISS and distal femoral nail for fixation of distal femoral fractures: are there differences in outcome and complications? Clin Orthop Relat Res. 2004; 426:252–257.

15 Wang JW, Weng LH. Treatment of distal femoral nonunion with internal fixation, cortical allograft struts, and autogenous bone-grafting. J Bone Joint Surg Am 2003; 85-A:436–440.

16 Chapman MW, Finkemeir CG. Treatmnet of supracondylar nonunion of the femur with plate fixation and bone graft. J Bone Joint Surg Am 1999; 81:1217–1228.

17 Masquelet AC, Begue T. The concept of induced membrane for reconstruction of long bone defects. Orthop Clin N Am 2010; 41:27–37.

18 Gardner JM, Mehta S, Barei DP, Nork SE. Treatment protocol for open AO/OTA type C3 pilon fractures with segmental bone loss. J Orthop Trauma 2008; 22:451–457.

19 Donegan DJ, Scolaro J, Matuszewski PE, Mehta S. Staged bone grafting following placement of an antibiotic spacer block for the management of segemental long bone defects. Orthopedics 2011; 34:E730–E735.

20 Ostermann PA, Seligson D, Henry SL. Local antibiotic therapy for severe open fractures. J Bone Joint Surg Br 1995; 77-B:93–97.

21 Marsh JL, Jansen H, Yoong HK, Found EM Jr. Supracondylar fractures of the femur treated by external fixation. J Orthop Trauma 1997; 11: 405–411.

22 Ali F, Saleh M. Treatment of isolated complex distal femoral fractures by external fixation. Injury 2000; 31:139–146.

23 Hutson JJ Jr. Reconstruction of distal intercondylar femoral fractures with limited internal fixation and Ilizarov tensioned-wire external fixation. Tech Orthop 1996; 11:182–195.