

Treatment of Complex Supracondylar Fractures of the Femur with External Fixation

Hyung-Ku Yoon, M.D., Kwang-Pyo Jeon, M.D., Dae-Eun Jung, M.D.,
Ho-Seung Jeon, M.D., Kye-Sung Lee, M.D.

Department of Orthopedic Surgery, Sung-Ae General Hospital, Seoul, Korea

= Abstract =

The authors report the clinical results of ten cases of complex supracondylar fractures treated by external fixation with a mean follow up of 21 months. Six cases were closed comminuted fracture, and four cases were open fractures. By AO classification six cases were type C2, two type C3, one type A1, and one type A3. Four cases had associated vascular injury. Reduction was performed by closed method in eight cases, and two cases were reduced through open wound. All cases healed at average of 142 days. Final healing of all cases occurred with an average range of motion of 3°-119° except one case which required reapplication due to infected nonunion with a gap. In nine cases of the ten functional results were rated as "good", and one case was "fair" by Iowa Knee Rating Scale. In conclusion, definitive external fixation can be a good alternative treatment modality despite previous recommendations to limit external fixation to temporary application in cases of limb salvage, such as severe comminution or pre-existing infection

Key Words : Femur, Supracondylar fracture, External fixator

INTRODUCTION

Prior to 1970 the majority of the cases of supracondylar fracture were treated conservatively, but the trend in the last two decades has been towards

open reduction and internal fixation by the AO principle. This has resulted from the greater acceptance of such treatment with improvements of surgical skill, rehabilitation, and implants, such as dynamic condylar plate, compression plate, blade plate, and rarely interlocking IM nail^{11,15,17,18,23}.

However, the extensive dissection required for placement of these implants may be problematic in cases associated with severe open wounds, vascular injury, elderly and polytraumatized patients. In

※ Correspondence author : Hyung-Ku Yoon
Department Orthopedic, Sung-Ae General Hospital, Shinkil-1 Dong, Young Deung Po Ku, Seoul, 150-051 Korea
Sung-Ae General Hospital

addition the extensive stripping may lead to infection, delayed healing and non-union^{12,16}. External fixation can be repeatedly applied through a percutaneous technique without additional stripping or wide operative approaches. External fixation has been reported as definitive treatment for severe articular fractures of the tibial plafond and plateau^{5,10,18}.

External fixation has been recommended for supracondylar fractures of the femur only for temporary stabilization of grossly contaminated or infected fractures, fractures with accompanying severe soft tissue injuries, and cases of polytrauma requiring early mobilization. In such cases definitive treatment was subsequently performed with one of the aforementioned modalities^{1,14,20}. To the best of our knowledge, few reports of the use of external fixation as definitive treatment in cases of complex supracondylar fractures exist in the literature.

The authors will review the technical method, advantage, disadvantages, efficiency, complications, and outcome in ten cases of complex supracondylar fracture treated with external fixation in order to evaluate the possibility of definitively treating these fractures in this way.

MATERIALS AND METHODS

Ten cases of fresh complex supracondylar and intraarticular fractures of the femur were treated with Orthofix® external fixators at Sung -Ae General Hospital from 1988 to 1992. One surgeon performed the operation and the fixator was used as definitive treatment until healing. The indication for external fixation were 3 cases of vascular injury, 4 cases of open fracture (Type II : 1, Type IIb : 2, Type IIc : 1), 2 cases of multiple injury (ISS : 25, 41) and one case of closed fracture with morbidity and obesity. The patients were followed up at a mean period of 21 months with a range of 12-42 months. There were eight males

and two females with a mean age 41.5 yrs (range 20-76 years). Seven cases were the left side and three cases were the right side. The mechanism of injury was motor vehicle accident in eight cases, gunshot wound in one case, and fall in one case. Six cases were closed including three cases resulting in vascular compromise. There were four open fractures with one type II, two type IIb, and one type IIc. All four cases of vascular compromise involved laceration and thrombosis of the superficial femoral artery which required emergency bypass grafting. Eight cases involved multiple injuries : three cases with tibial fractures (one case of ipsilateral and two cases of contralateral), three cases with chest injuries, three cases with closed cranial injuries, and one case each with ankle injury, spine injury, abdominal injury, acetabular injury, patellar injury, and cardiac contusion. The injury severity score²) ranged from 9 to 41 with an average of 21.9. By AO classification¹³) there were six cases of C2, two cases of C3, one case of A2, and one case of A3.

Charts and radiogram were reviewed for all patients to determine figure of external fixation, healing and complication of treatment. On radiogram initial reduction, changes during treatment and alignment of final healing were determined.

Pin tract problems were classified as type 0 if they required no treatment, type A if they resolved with local pin care and antibiotics, type B if they required pin change or removal, type C if they resulted in failure of method and type D if they resulted in late osteomyelitis. Late arthrosis changes of the knee were evaluated by grade 0 (no arthritic changes), grade 1 (minimal narrowing), grade 2 (moderate narrowing and osteophyte formation), grade 3 (marked joint space narrowing, bony collapse and marked bony deformity)¹⁹).

All functional results were evaluated using the Iowa Knee Rating Scale. This 100 points scale assigns a possible score of 35 points for function, 35 points for pain, 10 points for gait, 10 points for

ROM, and 10 points for deformity or stability. The sum is then applied to the rating scale with good score of 81-100, fair 65-80, and poor score of 25-65 points.

For purposes of this study, malunion was defined as angulation greater than 14° valgus, and 5° varus, 10° in lateral plane, and shortening was defined as greater than 1 inch of shortening.

OPERATIVE TECHNIQUE

The external fixator was applied in the operating room in conjunction with other procedure. Arterial repairs, debridements and surgery on other systems often preceded the fixator application.

The anterior screw is inserted at the junction of the middle and anterior third of the condyle. The posterior screw is inserted in the posterior third of the condyle through the template. Screws are always placed from lateral to medial with cancellous screws distally cortical screws proximally under biplane fluoroscopic aid.

After fixator application, the reduction can be finely tuned with reduction forceps and the compression/distraction apparatus. When adequate reduction is confirmed fluoroscopically, both ball joints are locked as a usual method. Fluoroscopic assessment of bone loss, comminution and contact determines whether bone grafting should now be done.

Postoperatively the knee joint was splinted. Gentle knee range of motion exercises are begun, but these are not forced, and performed only within patient tolerance. The patient is taught screw care consisting of cleansing with alcohol solution, followed by a bulky tight sterile dressing.

Partial weight-bearing is begun at a variable time depending on fracture configuration but most commonly at 8th week. Full weight-bearing is usually possible by three months. All patients remain in the external fixator until the ambulate pain-free and there is evidence of fracture consoli-

dation on AP and lateral radiogram. Further protection with a knee immobilizer is sometimes prescribed.

RESULTS

Details of clinical data in each case are summarized in Table 1. The duration of external fixation ranged from 123-153 days with a mean of 142 days. Nine of 10 cases healed with initial application and one failure occurred in the case of the injury by gunshot wound which resulted in a large gap after debridement and curettage. This case required a free flap to replace his distal quadriceps which were lost from the injury and bone graft on 6cm bone defect. The graft failed to consolidate and required repeated external fixation and bone graft prior to consolidation. This healed with subsequent external fixation but should be considered one case of failure treatment (Fig. 1). No other cases required repeated external fixation or other procedure to obtain union. Two cases required remanipulation to improve alignment after recovery in general condition and after swelling at the pin site led to soft tissue impingement. Bone grafting was performed as part of original treatment (4 cases) to expedite the bone healing in case of severe comminution and osteoporosis or poor contact (Fig. 2). The other cases healed without bone graft.

Average ROM at the time of partial weight bearing at 6-8 weeks was 6°-50°, and at the time of full weight bearing at 3 months, it was 3°-76°. Seven of the ten cases had discharge from a pin tract with 5 cases of the most proximal and 4 cases of the most distal screw. Of all 54 total screws applied, 14 had pin tract infection (26%). One pin developed pin site lysis and required removal 150 days postoperatively after bone union had been completed. Three cases of type 0 and four cases of type A pin tract complication resulted. Two cases demonstrated alignment changes during treatment.

Table 1. Clinical data

CASE	AGE / SEX (YRS)	MECHANISM OF INJURY TYPE	FRACTURE CLASSIFICATION	VASCULAR INJURY	PIN TRACT PROBLEM
#1	27 / M	MCA	C3 closed	Y SFA	N
#2	63 / M	MVA	C2 closed	N	N
#3	20 / M	MVA	A2 closed	Y SFA	Y
#4	53 / M	Pedi. Ta	C3 IIb	N	Y
#5	20 / M	MVA	C2 closed	N	Y
#6	76 / F	MVA	C2 II	N	Y
#7	55 / M	MVA	C2 IIc	Y SFA	Y
#8	43 / F	Fall	C2 closed	N	N
#9	34 / M	MVA	A3 closed	Y SFA	Y
#10	24 / M	Gunshot	C2 IIb	N	Y

DURATION OF FIXATOR (DAYS)	ALIGNMENT CHANGES	FINAL ROM (DEGREES)	FINAL RESULT	COMPLICATIONS
125	6° valgus 5° varus	0-135	Y	malunion
142	N	0-120	Y	
150	9° - 24° ant angul	8-140	Y	malunion
123	N	0-120	Y	
150	N	0-119	Y	
150	N	7-85	Y	
142	N	0-119	Y	
142	N	0-119	Y	
153	N	0-120	Y	
140	N	12-75	Y	nonunion

SFA : Superficial femoral artery Y : yes N : no

One of these was reduced in 6° valgus but finally healed with 5° varus angulation. The other case was reduced in 9° anterior angulation but healed with 24° anterior angulation(Fig. 3).

At most recent follow-up, functional results as assessed by the Iowa Knee Rating Scale showed a range of 75-93 points with an average of 88 points. Nine of ten cases evaluated by Resnick's criteria¹⁹⁾ were not seen in any follow-up radiogram(all grade 0) even in type C2 and C3.

The final ROM of knee joint was 3°-119° in average. One case of malunion and one case of shortening more than 1 inch(Fig. 4) with 5 cases of shortening less than 1 inch were noted.

DISCUSSION

Internal fixation is generally accepted as the treatment of choice for the supracondylar fracture of femur with various implants^{21,22,24)}. However there are potential problems with internal fixation such as delayed and non-union, difficulty in vascular repair, prolonged operation time, more blood loss, bone graft in nearly all cases, soft tissue stripping, increase of infection rate especially in complicated supracondylar fracture²⁰⁾.

Many orthopaedic surgeons agree that external fixators can be used as temporary stabilization in

Fig. 1. A. Initial pre-op angiography shows patency of femoral artery.
 B. Infected non-union with gap after external fixator application.
 C. Post-trauma 3 years shows good union state at last follow-up.

cases of extensive soft tissue injuries, infected fractures, polytraumatized patients, and severe comminution^{1,11,14,20}.

The advantage of external fixator have been applied to articular involving fracture for plafond fracture and tibial plateau fracture. Despite few study, Bone(1990) and Bonar(1993) reported good result with combined external fixation and limited internal fixation on severe plafond fracture^{4,5}. These studies provided somewhat encouraging reports of decreased complication rates of the intraarticular and periarticular fracture with external fixation.

External fixation specific to the supracondylar fracture has the following advantages. First, reduction by closed method and fixation through percutaneous pinning without soft tissue stripping. Second, sturdy unilateral frame allows more earlier vascular surgery and ease of debridement. Third, there are less need for bone graft and manipulation of fragment is easily performed. Fourth, early mobilization with rehabilitation enable short hospital stay. Finally infection control is more easily accessed compared to internal fixation.

Fig. 2. Post-op 6months radiogram shows good union stage with bone fraft.

Fig. 3. A. Post-reduction 2 months 9° anterior angulation was noted
B. Post-reduction 8 months 24° anterior angulation was noted.

However external fixation has few indications limited to extensively traumatized extremities, massive comminution, severe osteoporosis, pre-existing infection, severely contaminated soft tissue that require debridement such as limb salvage procedure^{1,11} because it presents several disadvantages in applying such as delayed or non-union, pin tract problem, alignment changes due to frame instability, possible knee stiffness due to pins.

The major problems of external fixation are delayed union and nonunion in severe open comminuted fractures. Bony union can be promoted by the rigidity of the fixating frame, accuracy of reduction, and adequate amount of physiologic load, which are somewhat dependent of the fracture character. These factors are especially important in the early stages of bone healing⁶. The basic process of bone healing with external fixators is achieved by the formation of lamellar bone and

secondary osteon growth linking areas of contact or bridging of a gap^{3,6,8}.

The most common problems with external fixator are pin problems. Those problems of pin drainage, pin tract infection, pin loosening, and infected ring sequestrum are still common^{3,7}. The surgeon must be able to distinguish pin tract infection from pin tract granulation, because this is a common misjudgement resulting pin and fixator removal. In this series 14 pins among 54 pins had some uncomplicated drainage except one that loosened and required removal after bone healing. Thus, the possibility exists that the fracture can be managed until bone healing without significant problems despite some changes in the pins.

The third problems is changes in alignment during treatment. This may be ascribed to early removal of frame solely by clinical status, and carries a risk of malunion or delayed nonunion.

Fig. 4. A. Post-fixator setup radiogram shows good alignment and axis.
B. At last follow-up(18 months), radiogram shows 5° varus and 2.5cm shortening

Therefore removal of the device must be performed through radiological confirmation of solid union. The authors experienced two cases of change in alignment. In case of lack of frame stability, we used cementing on ball joint of frame to prevent loosening and motion. Finally, loss of knee ROM after bony union presents a more significant problem and must be considered when using external fixation. This is especially problematic in cases of type C fracture, severe soft tissue injury, and open injuries. The most important measure to prevent loss of knee ROM is early postoperative physical therapy with knee ROM exercise program. Eventual knee stiffness should always be anticipated if the frame is to be maintained until bony union is achieved⁹⁾. In this series average knee ROM was improved from 43° at partial weight bearing to 73° at full weight bearing and further to 119° at final follow up with strict reha-

bilitation program.

In summary, external fixation with sturdy unilateral frame connected to 2 - 3 proximal and 2-3 distal pins provides adequate stabilization for utility as supracondylar fractures of the femur. In cases of condylar extension, 2 cancellous screws may be effectively used to fix condyles after anatomic reduction using large reduction forceps under C-arm control and prior to external fixator application. This treatment offers a good surgical alternative not only in complicated supracondylar fractures of the femur but in isolated comminuted supracondylar fractures as well. Strict adherence to postoperative rehabilitation to prevent loss of knee ROM and careful pin tract care are requisite for good outcome.

Even if we consider the weaknesses of this study being a small treatment group, retrospectivity, and uncontrolled comparisons, the results cannot be

ignored. The fact that all cases had good results without complications of osteomyelitis, marked loss of knee ROM indicates that this alternative treatment of supracondylar fractures can be effective, especially in light of no previous report.

The authors suggest that external fixation can be a good alternative method of treatment not only in cases of severe trauma, polytrauma, soft tissue damage, but also in cases of isolated comminuted supracondylar fractures of the femur. However, careful pin care and strict postoperative rehabilitation is required to attain these good results.

REFERENCE

- 1) **Alonso J, Geissler W, Hughes JL.** External fixation of femoral fractures. *Clin Orthop*, 241:83-88, 1989.
- 2) **Baker Sp, O'Neil, Haddom, Long WB.** The injury severity score : a method for describing patients with multiple injuries and evaluating emergency cases. *J Trauma*, 14(3):187-196, 1974.
- 3) **Beherens F.** General theory and principles of external fixation. *Clin Orthop*, 241:15-23, 1989.
- 4) **Bonar SK, Marsh JL.** Unilateral external fixation for severe pilon fractures. *Foot & Ankle*, 14(2):57-64, 1993.
- 5) **Bone L, Stegemann P, McNamara K, Seibel R.** The use of external fixation in severe fractures about the ankle. *Orthop Trans*, 14(2):265, 1990.
- 6) **Chao YS, Aro HT, Lewallen DG, Kelly PJ.** The effect of rigidity on fracture healing in external fixation. *Clin Orthop*, 241:24-35, 1989.
- 7) **De Bastiani G, Aldegheri R, Renzi Brivio L.** The treatment of fractures with a dynamic axial fixator. *J Bone Joint Surg*, 66-B:538-545, 1984.
- 8) **Dabezius EJ, D'Ambrosia R, Shoji H, Norris R, Murphy G.** Fractures of the femoral shaft treated by external fixation with the Wagner device. *J Bone Joint Surg*, 66-A:360-364, 1986.
- 9) **Halpenny J, Rorabeck CH.** Supracondylar fractures of the femur; results of treatment of 61 patients. *Can J Surg*, 27:606-609, 1984.
- 10) **Marsh JL, Nepola JV, Meffet R.** Dynamic external fixation for stabilization of nonunions. *Clin Orthop*, 278:200-206, 1992.
- 11) **Mize C.** Surgical management of complex fractures of the distal femur. *Clin Orthop*, 240:77-86, 1989.
- 12) **Moore TJ, Watson T, Green SA, et al.** Complications of the surgically treated supracondylar fracture of the femur. *J Trauma*, 27:402-406, 1987.
- 13) **Muller ME, Nazarian S, Koch P, Schatzker J.** The comprehensive classification of fractures of long bones. 140-141, *Berlin, Springer*, 1990.
- 14) **Murphy CP, D'Ambrosia RD, Diabiezies EJ, et al.** Complex femur fracture : treatment with the Wagner device or the Grosse-kempf interlocking nail. *J Trauma*, 28(11):1553-1561, 1988.
- 15) **Newman JH.** Supracondylar fractures of the femur. *Injury*, 21:280-282, 1990.
- 16) **Olerud S.** Operative treatment of supracondylar-condylar fractures of the femur. *J Bone Joint Surg*, 54-A:1015-1032, 1972.
- 17) **Pritchett JW.** Supracondylar fractures of the femur. *Clin Orthop*, 184:173-177, 1984.
- 18) **Ries MD, Meinhard BP.** Medial external fixation with lateral plate internal fixation in metaphyseal tibia fractures : a report of eight cases associated with severe soft tissue injury. *Clin Orthop*, 256:215-224, 1990.
- 19) **Resnick D, Niwayama G.** Diagnosis of bone and joint disorders, 1276-1283, *Philadelphia, W.B. Saunders*, 1981.
- 20) **Rooser B, Bengtson S, Herrlin K, Immerfalt.** External fixation of femoral fractures; experience with 15 cases. *J Orthop Trauma*, 4(1):70-74, 1990.
- 21) **Seligson D, Kristiansen T.** Use of the Wagner apparatus in complicated fractures of the distal femur. *J Trauma*, 18:795-799, 1978.
- 22) **Shelbourne KD, Brueckmann F.** Rush-pin fixation of the supracondylar and intercondylar fractures of the femur. *J Bone Joint Surg*, 64-

- A:161-169, 1982.
- 23) **Wu CC, Shih CH.** Treatment of femoral supra-condylar unstable comminuted fractures. *Arch Orthop Trauma Surg*, 111:282-286, 1992.
- 24) **Zickel R, Fietti V, Lawsing J, Cochran G.** A new intra-medullary fixation device for the distal third of the femur. *Clin orthop*, 125:185-191, 1977.

= 국문 초록 =

복잡성 대퇴 과상부 골절에 대한 금속외고정 치료

성애병원 정형외과

윤형구 · 전광표 · 정대은 · 전호승 · 이계성

대퇴과상부 골절에 대한 치료는 1970년대 이전까지는 주로 보존적 요법에 의해서 그 이후는 AO원칙에 따른 관절적 방법에 따른 해부학적 정복 및 견고한 금속고정에 의한 치료방법이 시술되어 왔다.

1980년대부터 시술된 금속외고정에 의한 골절의 치료는 개방성, 감염성, 심한연부조직손상, 혈상 손상 동반 및 다발성 손상의 경우에 일시적으로 많이 도입되어 사용되어 왔다.

현재까지 대퇴과상부에 적용된 금속외고정장치는 대부분 일시적인 고정으로만 사용되어 왔으나, 최근 관절주변골절에도 금속외고정의 효과가 부분적으로 보고되고 있다.

이에 저자들은 보다 복잡성 대퇴과상부 골절의 치료에서 1988-92년까지 본 교실에서 금속외고정을 이용하여 치료한 10례를 평균 21개월간의 추시 후 이를 분석하여 이 방법의 유용성, 수술수기, 결과, 후유증 등을 비교 검토하고자 하였다.

10례중 남자가 8례이었으며, 6례는 분쇄성, 4례는 개방성이었으며 AO분류상C₂가 6례이었으며, 4례에서 혈관손상이 있었으며 평균 142일간의 외고정 장치를 하였다. 10례중 9례에서 1차적으로 골유합이 되었으며 마지막 평균운동범위는 3°-119°이었으며 1례에서 감염성 불유합으로 인하여 수차례의 수술적 가료한 것 이외에는 9례에서 좋은 유합 상태를 보여서 금속외고정 장치에 의한 대퇴과상부의 복잡성 골절 치료에서도 여러 치료 방법중 좋은 치료방법의 하나가 될 수 있다고 사료된다.