

11, 3, 1998 7

The Journal of the Korean Society of Fractures
Vol.11, No.3, July, 1998

= Abstract =

Treatment of Unstable Open Tibial Fractures with Ilizarov System

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The treatment of open comminuted tibial shaft fractures have a high incidence of complications and often result in poor outcomes. General principles of treatment are accepted throughout most surgeons, which include aggressive debridement, antibiotics, early stabilization, early soft tissue coverage, and prophylactic bone graft. But, recently there is a controversy on the bony stabilization methods; one group of authors favors external fixator, and the other group favors unreamed interlocking intramedullary nail.

In this paper, we carried out retrospective study of the 42 cases of open comminuted tibial shaft fractures managed with Ilizarov external fixator (minimum follow up of one year(average: 2.8 years)). The purpose of this study is to evaluate the results of treatment with an Ilizarov method for the patients with open comminuted tibia fractures (open type III-A and more by Gustilo and Anderson classification and, type B and more by AO classification).

The results were as follows;

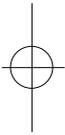
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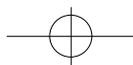
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1. It has taken 7.4 months to achieve bony union with relatively delayed healing time for the diaphyseal fractures and fractures with higher energy injury on AO classification.
2. Forty eight additional operations were needed for 27 patients; 24 bone grafts for 19 patients, 1 case of bone marrow injection, 4 cases of corticotomy and bone transport, 4 cases of sequestrectomy, 3 cases of internal fixation with plate, 2 cases of IM nailings, and 2 cases of Ilizarov correction in operating room.
3. Following complications were resulted in; delayed union 14 cases, nonunion 1 case, superficial infection 2 cases, deep infection 8 cases, chronic osteomyelitis 3 cases, refracture 2 cases, knee stiffness 6 cases, ankle stiffness 5 cases, subtalar stiffness 8 cases, lateral angulation 4 cases, anteroposterior angulation 4 cases, and leg length discrepancy 5 cases.
4. Twenty patients, at the final follow-up, could walk without limping and live their life with no activity limitation.
5. At the final follow-up, 19 patients complained intermittent pain on fracture sites, knees or feet and ankles.

We could conclude that the Ilizarov external fixator can be a stabilizer of choice for the open comminuted (Gustilo type III and more than AO type B) tibial shaft fractures of which fracture line extended over the proximal or distal metaphysis.

Key Words : Tibia, Open comminuted fracture, Ilizarov method.



1/3 가

1991 2 1996 12
Gustilo III
AO B

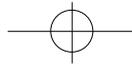
19) 91 Ilizarov
. 91
, 2 2 1
, 가가 42 (41)

2.8(1 7)
(unreamed interlocking IM nail)

1991 2 1.
1996 12 43(17 65) 가 35
Ilizarov (85.4%), 가 6 (14.6%) 가

1 가가 42





(21%)

2. 가37 (90.1%) 가
 가29 (70.1%), 가8 (20%)
 가2 (4.9%),
 1 (2.4%), 가1 (2.4%)

3. 가
 29 (70.7%)
 18 가
 7, 6, 3
 1, 5
 9, 13

4. Y
 (E1), (M1),
 (P), (C), (D),
 (M2)

(reference wire)
 Iizarov
 (half pin)
 가
 pulling system
 가 1
 Iizarov
 (33 cases) () , 2 (5 cases)
 가
 Iizarov
 () , 3 (4 cases)
 가
 2 ()
 가, 가
 가

5. Gustilo 9)
 Gustilo II 3 cases)
 Gustilo 9) Gustilo II 3 cases)
 (7.1%), IIIA 20 (47.6%), IIIB 19 (45.3%)
 Henley I 5 (12%), III 7 (17%), III 14 (33%), IV 12 (28%), V 4 (10%)
 , AO B1 4 (10%), B2 3 (7%), B3 13 (31%), C1 3 (7%), C2 10 (24%), C3 9

6. 가
 2 ()
 14 x 34
 , 14 X 17
 (CORA: center of rotation of angulation),
 (MAD: mechanical axis deviation),
 가

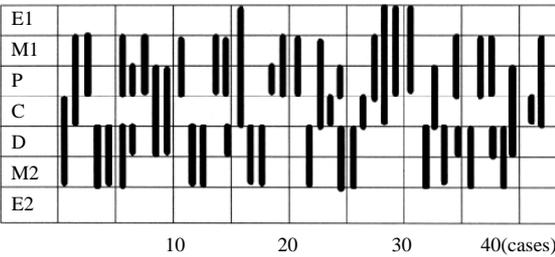
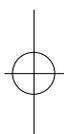
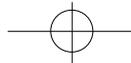


Fig 1. Length and location of fractures
 E1: prox. epiphysis M1: prox. metaphysis
 P : prox. diaphysis C: mid. diaphysis
 D: distal diaphysis M2: distal metaphysis
 E2: distal epiphysis





1.2
1)
48 2 1
48

가
6 , 14 ,
(late closure) 4 , Healing with 2nd intention 7
, 10 , 1

2)
Ilizarov
가 19
24 , 1 ,
4 , 4 , 3
, 2 , Ilizarov 2

2. 가
Ilizarov
가가 ,
13).
7.4 1 6.7 , 2
7.4 , 3 13.5 .
1)
1 (33 1)
(Fig 1)
(Diaphyseal
fracture: P-C-D, M1PC, CDM2) 8.2 ,
(Short diaphyseal
fracture including proximal metaphysis: M1P, E1M1P)
5 ,

Table 1. Bony union according to the Henley classification

Type	Months
1	7.5
2	5.9
3	7.4
4	6.5
5	13.5

Table 2. union according to the AO classification

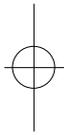
Type	Months
B1	3.1
B2	3.7
B3	5.9
C1	6.6
C2	8.0
C3	9.6

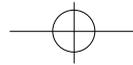
Table 3. Radiol. evaluation-deviation from neutral

Group	Frontal plane	Sagittal plane
1	7.8	4.0
2	5.4	2.8
3	8.3	9.8

(Short diaphyseal fracture including distal metaphysis: DM1, DM2E2) 5.4 .

2)
Henley
(Table 1) , I
7.5 , II 5.9 , III 7.4 , IV
6.5 , V 13.5 .
3) AO
AO
(Table 2) , B1 3.1 , B2
3.7 , B3 5.9 , C1 6.6 ,
C2 8 , C3 9.6 ,





3) 1 , 3 129
 3. 가 3 , 4
 Holbrook ¹⁰⁾ 5 , 10 가 , 5 , 77 , 4
 1cm , 20 5 .
 10 10 4) 가 20 ,
 가 , 1cm 가 21 ,
 가 ¹⁴⁾ , 가 12 ,
 가 1 0.9 (12 -15) , 2 5) 14 , (6) 1 ,
 2.8 (11 -2) , 3 7.2 (20 -2) 2 , 8 ,
 2.3 (15 -6) , 2 0.6 (11 - 3 , 2 , (100
 3) , 3 4.8 (12 -10)) 6 , (10) 5 ,
 . 1 6.9mm(6 - (15) 8 ,
 28), 2 8.8mm(-2 -17), 3 (10) 4 , (10)
 15.8mm(-5 -24) , (MAD) 1 4 , (10mm) 5 가 .
 4.1mm(30 -22), 2 6.8mm(3 -
 15), 3 18mm(20 -21) (Table 3).
 가
 , 1
 7.8 , 2 5.4 , 3 1
 8.3 , 1 4 , 54
 2 2.8 , 3 9.8 .
 , (MIPC)
 , AO C1, Gustilo III-B
 (Fig 2-a).
 4. 가
 1) (Gait) , 20 (2 Ilizarov
 1 17 , 2 1 , 3 2) , (Fig 2-b),
 가 21 (1 15 , 2 4 2 8
 , 3 2) , 가 12
 가 1 1 . 가 (Fig 2-c), 6
 Ilizarov
 2) , 7
 , 16mm, 5
 (Fig 2-d).
 .19 (1 15 , 2 2
 1 , 3 3) , 6 (1 2
 4 , 2 1 , 3 1) . 36 ,



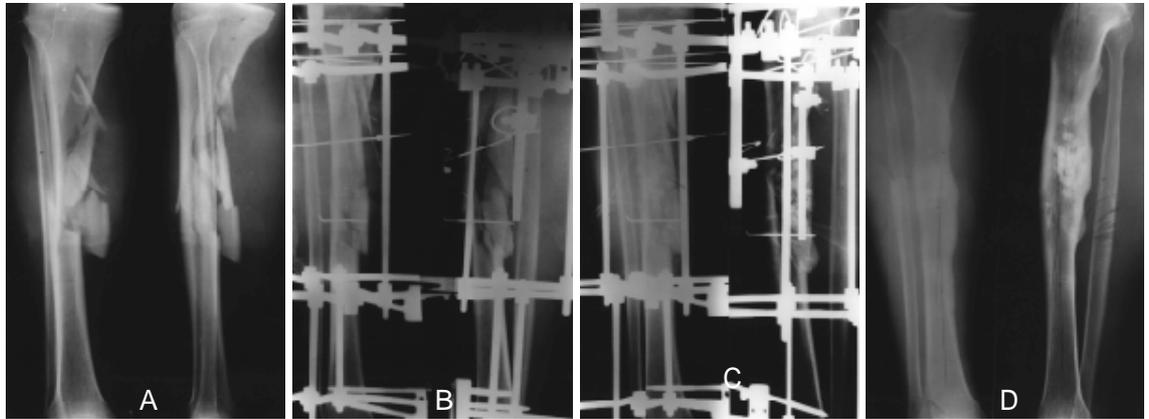
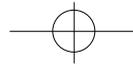


Fig 2. Gustilo grade IIIB open comminuted tibial shaft fracture of 54-year-old male
A. Preoperative anteroposterior and lateral radiographs of the right tibia.
B. Postoperative radiograph showing the reduced fracture with Ilizarov external fixator
C. Postoperative 12 weeks radiographs showing callus formation
D. Final follow up anteroposterior and lateral radiographs showing 50 of CORA, 16mm of MAD and 70 of anterior angulation formation

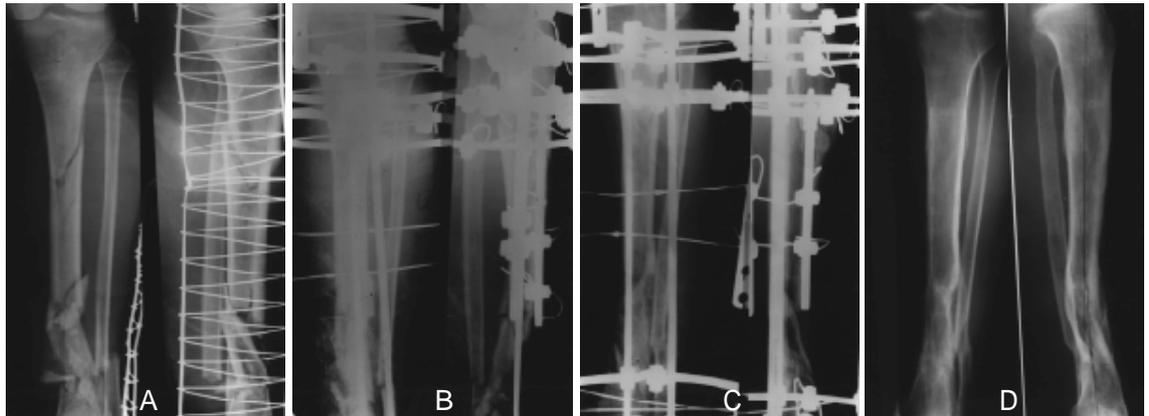
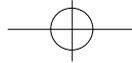


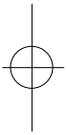
Fig 3. Gustilo grade IIIA open comminuted tibial shaft fracture of 36-year-old male.
A. Preoperative anteroposterior and lateral radiographs of the right tibia.
B. Postoperative radiographs showing large bone defect at distal metaphyseal area.
C. Postoperative 15 weeks anteroposterior and lateral radiographs showing callus formation
D. Final follow up anteroposterior and lateral radiographs showing 60 of CORA, 3mm of MAD and 50 of posterior angulation formation.

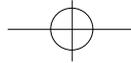
(P, DM2) , AO C2, Gustilo 2 Ilizarov (Fig
III A Winquist 4 (Fig 3-b), 9
3-a) . .3 .





8 가 20 66
 . 15 가 35.4 .
 (Fig 3-c), 6.2 Whittle
 . 6 19) 50 28 (13 64) 96%
 Ilizarov , 1) 23 (16-29), Tometta
 3mm, 6 5 , 17) 23 (12 30)
 (Fig 3-d), Ilizarov
 . 1 6.7
 . 1
 , (P-C-
 D, MIPC, CDM²) 8.2 ,
 ,
 가 , Henley
 ,
 . Ilizarov 가
 Tucker 18) 5.6.8) Ilizarov AO ,
 ,
 가 ,
 ,
 (Poor appearance),
 ,
 ,
 5,9,11,13,15,19) ,
 Holbrook 10)
 36%, 21% , Tucker 18)
 Ilizarov 19%, Whittle 19)
 0%, Tometta 17) 13%,
 0% . 4
 - , 4 - , 5
 가
 7,12,16,19) Whittle 19)
 59 ,
 7 , 1 7.8 , 2
 , , 5.4 , 1 4 , 2
 . 2.8 . 2 가
 ,
 (physis) ()
 ,
 가
 2,3,4,10,17,18,19),
 Ilizarov 가 , 2) 가





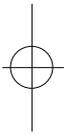
7.4
 20
 가
 . Holbrook ¹⁰⁾ 35%, ⁴⁾ 50%
 . McGraw Lim ¹³⁾ Ilizarov
 44% Ilizarov

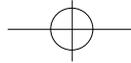
Ilizarov 2 ,
 8 , 3
 . Tornetta ¹⁷⁾ Gustilo IIIB
 29
 가 . Tucker ¹⁸⁾ 26
 Ilizarov
 가 75% , Holbrook ¹⁰⁾
 63
 Ender
 (alignment), , ,
 11%
 5
 8
 가

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1991 2 1996 12
 Ilizarov
 1 가가
 42
 . Ilizarov
 Gustilo III
 AO B ,
 , , ,





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