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## Ilizarov

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= Abstract =

### Treatment of Open Fractures of the Tibial Shaft by Sequential Compression technique in Ilizarov device

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External skeletal fixation is used widely in the management of open or closed tibial fractures, but delayed healing is common. There is concern that this might be due not only due to the severity of injury but also to the mechanical conditions imposed at the fracture site by the fixator. Since fractures treated by external skeletal fixation can rarely be reduced to perception nor held with absolute stability, union occurs by indirect healing, which is acutely sensitive to both the characteristics and timing of mechanical stimulation. So, the achievement of the optimum mechanical environment is particularly important where delay in bone healing is likely. Ilizarov external fixator is useful in treating open fractures of the tibial shaft because it permits axial micromotion which enhances bridging callus formation with stable fixation as well as its complications such as infected nonunion or limb length discrepancy. The impaired healing with external fixation is often caused by wrong surgical technique, such as distraction of fracture fragments by fixation device. Sequential compression at fracture site may overcome any fracture gap in external skeletal fixation and also enhance endosteal bone formation. We applied sequential compression forces at the fracture site in 18 open fractures of the tibial shaft, treated

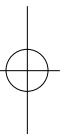
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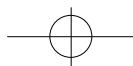
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by Ilizarov external fixator with or without autogenous bone grafting. Sequential compression technique is composed of initial compression with 1 mm/wk for 4 weeks and then compression 1 mm/10 days until adequate apposition of cortex and callus formation in radiograph. We acquired successful bony union in all cases except one which had additional bone grafting in open fractures of the tibial shaft by sequential compression technique using Ilizarov device.

**Key Words :** Open tibial shaft fracture, Ilizarov external fixator, Sequential compression technique

1994 3 1997 2  
가  
가 가 18

, 가

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,

1,2,4,12,16,18,25,26).

1994 3 1997 2  
18  
가  
11 35

3,11,21),

17

1)  
가  
18 가 13 , 가 5  
39.9 (21-75 ) .

4,9,16,20).

2)  
18  
가 8 (44%), 가 5 (28%)  
가 3 , 1 가 1

(Table 1).

가 ,

가

(bridging callus)

가

가 (endosteal

callus)

**Table 1. Mechanisms of Injury**

Pedestrian accident	8
Motorcycle accident	5
Motor-vehicle injury	3
Fall from a height	1
Violence	1
Total	18

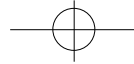
Table 2. Associated musculoskeletal injury

Upper extremity fracture	11
Knee ligament injury	8
Contralateral tibial fracture	5
Pelvic bone fracture	4
Femoral fracture	3
Spine fracture	3

3)  
 11 가  
 8 , 5  
 4 , 3  
 3 (Table 2).  
 4)  
 Gustilo Anderson Caudle Stern  
 8) 3B  
 3B1 1

Table 3. Details of 18 patients

Case	Age,Sex (yrs)	Location	Severity	Soft tissue Management	Additional Procedures	Time in B/G(Wks)	Time, Numbers of Compression(Wks)	Time to Union(Wks)	Complications
1	31, M	Mid-1/3	IIIB2	Delayed local flap. STSG	B/G	17	20, 6	32	Pin tr. infection Delayed union
2	27, M	Mid-1/3	IIIB1	Delayed primary closure. STSG	none	-	16, 5	26	Neuropraxia
3	45, F	Mid.-1/3	I	Early primary closure	BM injection	12	14, 4	24	-
4	51, M	Mid-1/3	IIIB1	STSG	none	-	16, 4	28	Joint contracture
5	75, M	Mid-1/3	IIIB1	STSG	none	-	15, 5	27	Pin tr. infection
6	33, M	Prox.-1/3	IIIB2	Delayed gastroc. flap. STSG	B/G	16	19, 5	27	Pin tr. infection Valgus def.
7	24, M	Mid-1/3	IIIB2	Delayed LD flap STSG	B/G	18	21, 6	33	Delayed union Joint contracture
8	26, M	Mid-1/3	IIIC	Delayed LD flap STSG	none	-	21, 5	31	Peroneal N. palsy, Delayed U.
9	21, F	Mid-1/3	IIIB1	Early primary closure	none	-	19, 4	30	Delayed union
10	42, M	Dist.-1/3	IIIB1	Delayed primary closure	BM injection	16	18, 6	29	Valgus def Pin tr.infection
11	58, M	Prox.-1/3	II	STSG	B/G	16	19, 5	27	Wire breakage
12	38, M	Mid-1/3	IIIB2	Delayed local flap. STSG	B/G	15	18, 7	49	Nonunion Osteomyelitis
13	45, F	Dist.-1/3	I	Early primary closure	none	-	14, 5	22	Pin tr. infection
14	27, M	Prox.-1/3	IIIB2	STSG	BM injection	13	15, 4	24	Pin tr. infection
15	31, M	Mid-1/3	IIIA	Delayed primary closure	none	-	15, 4	26	Wire loosening
16	56, F	Distal-1/3	I	Early primary closure	none	-	15, 5	24	Pin tr. infection
17	45, F	Mid-1/3	II	Dealyed primary closure. STSG	none	-	16, 5	25	Joint contracture Pin tr. infection
18	41, M	Mid-1/3	IIIA	Dealyed primary closure	none	-	21, 5	30	Osteomyelitis Delayed union



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3B2 1 가

1 3 , 2 2

3A 2 3B1 5 , 3B2 5

3C 1 3

(72%) (Table 3).

5)

18

1 Cefa Aminoglycoside 26.0 , 3A 27.5 , 3B1 23.3 , 2

2 가 33.2 3C 1 31 28.0 , 3B2 28.6

가 (p<0.03).

10 16.9

6 가 (p<0.05). 30

4 (22%) 3B1 1 , 3B2 2

3C 1 3

8 9

5 , 3 1 (6%) 가

가 3B2

2 (11%) 10

3B1 3B2 1

5 가

3B2 4 2

1 , 3 5 ,

1 , 3B1 3B2 2 7 (39%)

1 2 , 1

1 mm / 1 step

4 ,

가 10 1 mm / 1 step

가

50% 가 1

3 , 2 75 가

17.4 , 3B1 (Fig 1A).

4.7 ,

19.6 5.8 (Fig 1B), 2

14

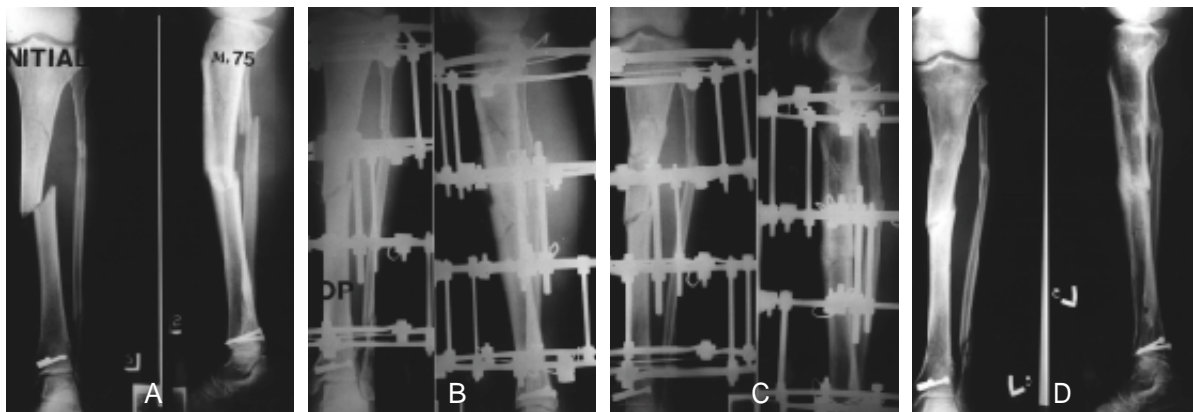


Fig 1-A. 75-year-old man injured open IIIB1, semental fracture of the tibial shaft.  
 B. Plain radiographs at postop. 14 weeks show distracted fracture site and delayed union evidence.  
 C. After applying sequential compression, endosteal bone formation was enhanced.  
 D. Final X-Ray after removal of Ilizarov apparatus

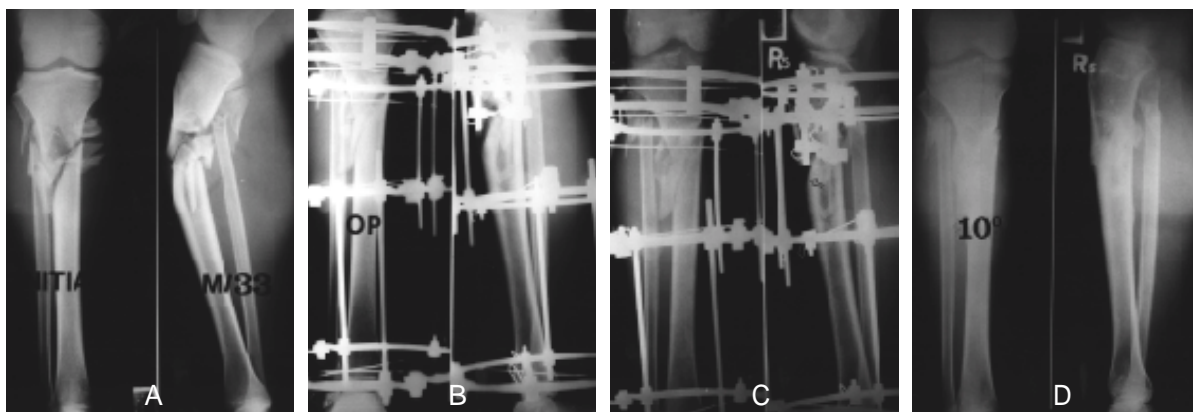
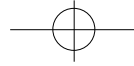


Fig 2-A. 33-year-old man injured open IIIB2 fracture of the tibial shaft with bone loss.  
 B. Radiograph at postop. 16 weeks show persistent cortical defect at anterior cortex due to initial bone loss.  
 C. After applying sequential compression with bone grafting, the fracture healing was enhanced.  
 D. Final X-Ray after removal of Ilizarov apparatus show 10 degrees of valgus angulation.

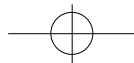
15 1 1 mm , 4 4 mm 2  
 10 가 1 mm 33 가  
 (Fig 1C). 18  
 25  
 (Fig 1D), (Fig 2A), 3B2



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(Fig 2B). 12

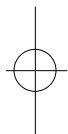
16 가  
(Fig 2C). 3 1 1 mm  
, 4 1 mm/10 , 2 6 mm 가 ,  
, 27 가 5,15,17,19) 가  
, 10 3,9,13,24)  
(Fig 2D). 6,13,14,24)  
, 5,7,13,17) . Fischer 14)  
가  
, 가 , Blick 6)  
1,4,8,11,12,16,18,22)  
가 2 ,  
, 6 3.4  
1 6,8,12,23)  
가 . Blenman 5)  
(vascularity) 가  
6,8,10,14,22) 가 ,  
가 가  
(intermittent hydrostatic stress) ,  
가 가 가  
4,12,16,18,25,26) 가 가  
가 가 , (gap)  
,  
,  
7  
30  
, 가  
4,9,16,26) 3B 3C 1) 3  
34.4 , Holbrook

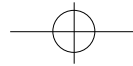


6) 21% 6.6 2) 32.8 28.6 9 6 . 1 (6%)가 49 Holbrook 6) 11%, 1) 27%, Rosenthal<sup>22)</sup> 27%, 2) 17% 1,2,12,16) 2 가 (11%) 가 (39%) 5 , 10 , 1cm , 5 10 1cm 2 (11%) 16.9(14-21) , 가 가 . docking site 가 가 가 .

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