

## **Treatment of Infected Bone loss with External Fixator in Long Bone Shaft Fracture**

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### **= Abstract =**

From July 1989 to February 1993, twelve patients were analysed for infected bone loss which treated with radically debriding all infected dead bone and closed suction-irrigation system with antibiotics and internal lengthening by using the external fixator.

The results are summarized as follows.

1. The average time for application of external fixation was 30.7 weeks in tibia, 27 weeks in femur and average time for bone union was 31.5 weeks in femur, 34.2 weeks in tibia.
2. Soft tissue defects were treated with split thickness skin graft in 6 cases, secondary closure in 4 cases, gastrocnemius rotational flap in 2 cases.
3. The length of bone defects after infected bone excision ranged from 2cm to 9.3cm, averaging 4.5cm. The bone defect was treated by internal lengthening after corticotomy with the Ilizarov apparatus in 4 cases, the Orthofix external fixator in 8 cases.
4. Four cases in this series were complicated; one pin tract infection, one angulation deformity, one checkrein deformity, one flexion contracture of knee joint.
5. Infection was managed with radical debriding infected dead bone and closed suction-irrigation system with antibiotics in all cases.
6. We recommend that the infected bone loss can be effectively managed with radically debriding dead bone and closed suction-irrigation system with antibiotics and lengthening with Ilizarov apparatus or Orthofix external fixator.

**Key Words :** Bone loss, Lengthening, Corticotomy, Ilizarov apparatus, Orthofix.

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## INTRODUCTION

Recently rapid industrial development has resulted in more serious open fractures from traumatic impact due to traffic and industrial accidents.

Despite an ever increasing availability of effective antibiotics, osteomyelitis remains a difficult clinical problems. The infected long bone is commonly riddled with sequestra, deprived of a healthy periosseous soft tissue envelope, and is chronically unstable. The purpose of this study is to evaluate the results and complications of lengthening with Ilizarov apparatus and Orthofix external fixator.

We analysed the twelve fractures of infected bone loss which treated with radically debriding all dead bone and closed suction-irrigation system with antibiotics and lengthening to regenerate the bone defect at Orthopaedic Surgery of Inha General Hospital from July 1989 to February 1993. The duration of follow-up ranged from 18 to 31 months(average, 22.4 months).

## MATERIALS AND METHODS

There were 9 males and 3 females. Their ages ranged from 25 to 54 years average 37.2 years old. The causes of fracture are traffic accident in 8 cases, fall from height in 2 cases, hit by heavy object in 2 cases. The level of fracture site are proximal one-third of tibia in 2 cases, middle one-third of tibia in 2 cases, distal one-third of tibia in 4 cases, proximal one-third of femur in 1 case, distal one-third of femur in 1 case. The soft tissue injuries were classified according to the system of Gustilo et al<sup>(6)</sup>. : 2 grade I, 2 grade II, and 8 grade III. All cases had had at least one previous surgical procedure to treat the original problem or the pseudoarthrosis. The mean number of previous surgical procedure were three with a range up to seven. Soft tissue defects were treated with split thickness skin graft in 6 cases, gastrocnemius rota-

tional flap graft in 2 cases, secondary closure in 4 cases.

For eradication of infection, radical resection of infected bone was performed to healthy margin of bleeding, until no dead infected bone remains. The wound was cultured for identifying the organism and its sensitivity. *Staphylococcus aureus* was the most common organism. All infection treated with antibiotics administered intravenously and debridement and continuous closed suction-irrigation system with antibiotics. All of the patients had bone loss, which was created by dead bone excision, greater than 2cm. The mean length of bone defect was 4.5cm ranging from 2 to 9.3cm. To restore bone defect after radical excision of dead bone, internal lengthening with corticotomy were carried out in all cases : bifocal lengthening was performed in 10 cases, trifocal lengthening was performed in 2 cases. Postoperatively the leg of patient was placed in a bulky dressing for 2 weeks and isometric quadriceps exercise was performed. Distraction began after a latency period of ten to fourteen days. The distraction rate was 1mm/day at a rhythm of 0.25mm q.i.d.

## RESULT

The bony union time was defined as the time from the infected dead bone excision to the healing of the bridging site after lengthening, with healing characterized by the appearance of the bridging callus and trabeculae penetrated bridging site on two radiographs made with different projection. The bone union time with resolution of infection was 31.5 weeks in femur, 34.2 weeks in tibia(Table 3). *Staphylococcus aureus* was the most common organism. The types of isolated organism were listed(Table 1). The results were decided into bone results and functional results according to Paley and Catagni classification<sup>(8)</sup>. The bone results were excellent in 10 cases, 1 good and 1 fair. The functional results were excellent in

9 cases, 2 good, and 1 fair. Four cases in this series were complicated; one pin tract infection, one angulation deformity, one checkrein deformity, one flexion contracture of knee joint(Table 4).

**Table 1.** Isolated organism

	No. of pateints
Staphylococcus aureus	7
Group A -hemolytic streptococcus	2
Pseudomonas aeruginosa	2
Escherichia coli	1

**Table 2.** Average duration of external fixation

	Orthofix(wks)	Ilizarov(wks)
Tibia	31	30.2
Femur	26	28

**Table 3.** Average time reqiring bony union

	Orthofix(wks)	Ilizarov(wks)
Tibia	34.4	33.8
Femur	28	35

**Table 4.** Complications

	No. of case
Pin tract infection	1
Angulation deformity	1
Checkrein deformity	1
Flexion contracture of knee joint	1

## CASE PRESENTATION

### Case 1.

A fourty-six year old female sustained open fracture of the left proximal femur after colliding with a car(Fig. 1-A). The skin and soft tissue injuries on lateral aspect of thigh were grade III. The wound was debried and the skin was only partially sutured, leaving the greater part of the wound was closed with vastus lateralis muscle. The femoral fracture was fixed with Orthofix external fixator. After six weeks, The wound on thigh was almost covered with a split-thickness skin graft. But pus was drained from the proximal thigh through the pin site. And so radical excision of infected dead bone and closed suction-irrigation system with antibiotics were applied for infection control. The wound was cultured for identifying the organism and it's sensitivity so that proper antibiotics was given. Staphylococcus aureus was identified at the wound site. The infected dead bone was excised radically and then direct apposition of excised site with Orthofix external fixator was performed(Fig. 1-B). The length of bone shortening after radical excision of infected bone was 5.5cm. The lengthening with Ilizarov apparatus after corticotomy at the distal metaphysis was

**Fig. 1-A)** Preoperative radiograph showing the fracture of the proximal femur.

**Fig. 1-B)** The infected dead bone was excised radically and direct apposition of excised site with Orthofix external fixator was performed. The bone shortening after infected dead bone excision was 5.5cm.

**Fig. 1-C)** The lengthening with Ilizarov apparatus after corticotomy at the distal metaphysis.

begun to restore bone defect(Fig. 1-C). Through out the healing time the patient was able to do non-weight bearing active ROM exercise to preserve motion of the knee. The direct bone union without bone graft at the bridging site was achieved at 7 months(Fig. 1-D). The range of motion was zero to 100 degrees.

#### **Case 2.**

A fifty-one year old man collided with a truck while on a motor cycle and sustained a open comminuted fracture of the left tibia who had had open

reduction and internal fixation with dynamic compression plate and screws at the local clinic(Fig. 2-A). The skin at the anterior aspect of lower leg had indurated and drained purulent pus when the patient was visited in our hospital. We removed plate and screws and infected dead bone and soft tissue were radically excised. The fracture site was stabilized by Orthofix external fixator. And then antibiotics were administered intravenously until inflammation sign was subsided. The proximal end of distal fragment tend to displace medially causing skin tension. The distal wound was left

**Fig. 1-D)** After removal of Ilizarov apparatus, complete radiological union was obtained.

**Fig. 2-A)** Initial radiograph showing the nonunion of distal tibia after plate and screw fixation.

open after debridement and it was covered with a split thickness skin graft after four weeks. The length of bone defect after radical excision of infected dead bone was 2.3cm. The lengthening with Orthofix external fixator after corticotomy was begun to restore bone defect(Fig. 2-B). At three month after lengthening, curettage and sliding bone graft was applied at bridging site(Fig. 2-C). After 7 months, the fracture was united and the apparatus was removed. The leg was then protect-

ed for 2 months in a long leg cast and a patellar tendon bearing cast until good consolidation occurred. At ten months the fracture was solidly healed(Fig. 2-D). The range of knee motion was zero to 130 degrees and the ankle could dorsiflex to 15 degrees and plantar flex to 40 degrees.

### **Case 3.**

A twenty-nine year old male truck driver sustained a severe degloving injury and open fracture

**Fig. 2-B)** The lengthening with Orthofix external fixator after corticotomy at the proximal metaphysis. The bone defect was 2.3cm.

**Fig. 2-C)** The sliding bone graft was performed at bridging site.

of the tibia(Fig. 3-A). Wound was massively contaminated and tibia was exposed. Staphylococcus aureus was identified at the wound site. The initial treatment consisted of radical debridement of all identifiably necrotic and infected soft tissue and the application of a Orthofix external fixator. Two additional procedure, consisting of further debridement and application of split thickness grafts were performed prior to transferring the gas-

trocnemius musculocutaneous rotational flap to the area of the skin defect. After all of the wounds had healed, radical excision of dead bone and closed suction-irrigation system with antibiotics were applied. The length of bone defect after radical excision of infected dead bone was 7.2cm. In order to restore bone defect, lengthening with Orthofix external fixator after corticotomy was begun to restore bone defect(Fig. 3-B).

**Fig. 2-D)** A final radiograph after removal of the Orthofix external fixator. Although union was achieved, there was about 20 degrees posterior angulation.

**Fig. 3-A)** Preoperative radiograph showing the comminuted fracture of the distal tibia and segmental fracture at the fibula.

At three months after lengthening, curettage and cancellous iliac bone graft was applied at bridging site. After 7 months from lengthening the external fixator was removed and cast applied to lower leg and patients was partially weight bearing. The complete radiologic bone union was obtained at 12 months(Fig. 3-C). The left ankle could dorsiflex to neutral and plantar flex to 20 degrees. There was no evidence of infection.

## DISCUSSION

The increasing frequency of severe compound long bone fracture with soft tissue injury due to high-speed traffic and industrial injury has stimulated interest in the use of external fixation.

Rosenthal and associates, in their series of 107 open tibial fractures, reported a nonunion rate of 27%, with half of these patients being infected<sup>16</sup>.

**Fig. 3-B)** The lengthening with Orthofix external fixator after corticotomy at the proximal metaphysis. The bone defect was 7.2cm.

**Fig. 3-C)** A final radiograph after removal of the Orthofix external fixator. Although tibio-fibular synostosis was complicated, the complete radiologic union was obtained.

Varma and Rao, in their 53 cases of open feactures treated without internal fixation, reported four of their 12 infected patients going on to nonunion<sup>18)</sup>. Clancey and Hansen also emphasized the negative effect of infection on the union rate of open fractures<sup>3)</sup>. Despite an ever increasing availability of effective antibiotics, osteomyelitis remains a difficult clinical problems.

The infected nonunuion of long bone is com-

monly riddled with sequestra, deprived of a healthy, bone-nutrient, periosseous, soft tissue envelope, and is chronically unstable. The goals of treatment are the elimination of infection and obtaining union. The antibiotics therapy alone often does not succeed due to failure to achieve adequate bactericidal levels at the foci of infection and to the development of resistant organisms.

For eradication of infection, radical excision of



all devitalized soft tissue and bone is essential. The principle of radical debridement are now well accepted and many different surgical techniques have been reported<sup>2,7,9,15,17,20</sup>. The difficulty lies in defining the border between dead and live tissue<sup>2,7,9,15,17,18</sup>. Intravital dye for determining of devitalized bone and soft tissue has been recommended<sup>8</sup>. This technique was not used in our cases. We decide that the most obvious sign of vascularized and live tissue is spot bleeding from cut surfaces. Treatment with closed suction-irrigation system with antibiotics has been described and recommended in the literature<sup>4,7,20</sup>. Jenny, Klemm et al prefer to use gentamycine-polymethylmethacrylate beads<sup>11,12</sup>. In our cases, radical debridement and closed suction-irrigation system with antibiotics were used in all cases. And the wound was cultured for identifying the organism and its sensitivity so that the proper antibiotics was given. All wound were proved to be infected with one or more organism. *Staphylococcus aureus* was found most frequently. Administration of antibiotics was begun, based on the findings of the gram stain, and changed as the sensitivity of organism. Antibiotics was administered intravenously until the systemic and local inflammatory reaction resolved, the pathogens could no longer be cultured from the wound. And then oral antibiotics were continued till fall of the erythrocyte sedimentation rates to within normal limit or negative conversion of C-reactive protein.

For bone defects, Shannon et al. used immediate skin grafting and secondary bone grafting as a reconstructive procedure, and in the method of Papineau, primary cancellous bone grafting and secondary skin grafting were performed<sup>15,17</sup>. Lortat-Jacob et al. reviewed a series of 82 nonunions treated by the Papineau method<sup>13</sup>. Ilizarov and workers from Kurgan, USSR, since 1950 have employed new biological techniques and a different system of external fixation to achieve union, correct deformity, eradicate infection, reestablish limb

length, and eliminate bone defect<sup>10</sup>.

The great advantages of Ilizarov method is the ability of the patient to be ambulatory and bear weight and joint motion is easily started immediately after operation. The disadvantage is pin site infection after percutaneous pinning, especially bulky muscular portion; in thigh, proximal calf.

Ilizarov used the terms monofocal treatment for compression and distraction with lengthening all at one level; bifocal treatment for distraction at a second level(corticotomy) and compression at a second level; and trifocal treatment for distraction at two corticotomy sites and compression at the level.

Vidal, Adrey, and Dwyer stated that percutaneous fixation combined with compression can make a fracture sufficiently stable to permit weight-bearing<sup>1,5,19</sup>. However we did not allow patients to bear on the fractured leg until relatively late, after the soft tissues had healed and a certain degree of union had been established. Movements of the soft tissue against the pins associated with weight-bearing cannot be prevented even when there is complete fracture stability and may result in the development of granulation tissue and superficial infection. In our cases, bone defects were treated by an internal lengthening. Bone defects were closed by the Ilizarov bone transport technique of sliding a bone fragment internally, producing distraction osteogenesis behind it until the defect is bridged. When the bone defect is nearly bridged, cancellous iliac bone graft was applied for bone union in 8 cases and direct union without bone graft at bridging site was in 4 cases. We found the Ilizarov technique successful to restore bone defect.

## SUMMARY

A clinical study was performed on the 12 patients of infected bone loss treated by radically excision infected dead bone and closed suction-

irrigation system with antibiotics and internal lengthening by Ilizarov apparatus in 4 cases, Orthofix external fixator in 8 cases.

1. The average time for application of external fixation was 27 weeks in femur, 30.7 weeks in tibia and average time for bone union was 31.5 weeks in femur, 34.2 weeks in tibia (Table 2,3).

2. The length of bone defects after infected dead bone excision ranged from 2cm to 9.3cm, averaging 4.5cm. The bone defects were treated by internal lengthening after corticotomy with Ilizarov apparatus in 4 cases, Orthofix external fixator in 8 cases.

3. Four cases in this series were complicated; pin tract infection in one case, angulation deformity in one case, checkrein deformity in one case, flexion contracture of knee joint in one case.

4. Infection was managed with radical debriding infected dead bone and closed suction-irrigation system with antibiotics in all cases.

5. We recommend that infected bone loss can be effectively managed with radically debriding dead bone and closed suction-irrigation system with antibiotics and lengthening with Ilizarov apparatus or Orthofix external fixator.

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= 국문 초록 =

## 외고정장치를 이용한 장관골 골절의 감염의 골결손의 치료

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장관골 골절의 염증성 골결손은 감염의 치료와 골유합을 얻어야 하는 어려운 점이 있다. 저자들은 1989년 7월부터 1993년 2월까지 감염성 피사골의 근치적 절제술과 항생제를 사용한 지속적 흡인 세척술로 감염을 치료하고 골결손은 골연장술을 시행하여 골유합을 얻었던 환자중 12개월이상 추시가능 하였던 12환자 12례를 대상으로 분석하여 다음과 같은 결과를 얻었다.

1. 외고정 장치의 평균고정기간은 대퇴골의 경우 27주이었고 경골의 경우 30.7주이었으며 평균 골유합기간은 대퇴골의 경우 31.5주이었고 경골의 경우 34.2주이었다.

2. 연부조직결손의 피복방법으로는 유리피판술이 6례, 2차봉합술로 치료한 경우 4례, 비복근 회전피부근육판이식술이 2례이었다.

3. 감염성 피사골의 절제후 골결손은 최소 2cm에서 최대 9.3cm으로 평균 4.5cm이었고 골결손은 Ilizarov기구나 Orthofix외고정기구를 이용하여 내부연장술을 시행하였다.

4. 합병증으로 핀주위감염 1례, 각변형 1례, Checkrein 변형 1례, 슬관절 굴곡구축 1례이었다.

5. 감염의 치료는 감염성 피사골의 근치적 절제후 항생제를 사용한 지속적 흡인세척술로 치료하였다.