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Original article ■

External Fixation in the Management of Closed Segmental Tibial Fractures

Zoran Golubović¹, Predrag Stojiljković¹, Ivan Golubović¹, Zoran Radovanović², Aleksandar Višnjić², Branko Ristić³, Katarina Kutlešić Stojanović¹, Milan Trenkić², Stevo Najman², Miroslav Trajanović⁴

¹Orthopaedic and Traumatology Clinic, Clinical Center Niš, Serbia

²University of Niš, Faculty of Medicine, Serbia

³Orthopaedic and Traumatology Clinic, Clinical Center Kragujevac, Serbia

⁴University of Niš, Faculty of Mechanical Engineering in Niš, Serbia

SUMMARY

Segmental fractures represent the interruption of bone integrity at two or more levels. In these fractures, a wide zone of injury (damage of all structures of the lower leg) creates very unsuitable biological conditions for healing of the fracture. Because of the damage of both intramedullary and periostal vascularization, segmental fractures are predisposed to slow healing and development of pseudoarthrosis.

The aim of the paper was to present the results of treatment of patients with closed segmental tibial fractures treated by external fixation.

Within the period between January 1, 1998 and June 31, 2012 in the Clinical Center Niš, 26 patients with closed segmental fractures of the tibia were treated. The assessment of outcomes of treatment of closed segmental tibial fractures by external fixation was performed on a series of 24 patients. The mean age was 43.57 years. All the patients were treated by Mitković unilateral external fixator produced by "Trafix" firm.

Fracture healing occurred in 20 (83.33%) patients; four (16.67%) patients reported significant complications in the course of treatment that required further surgical treatment.

By applying the method of external fixation in the treatment of closed segmental tibial fractures, reposition of fragments is achieved through a small incision, with pins of external fixator placed outside the fracture zone to prevent further damage of intramedullary and periosteal bone vascularisation, which is very important for fracture healing.

Key words: closed segmental tibial fracture, external skeletal fixation, Mitković external fixator

Corresponding author:

Zoran Golubović •

phone: 063 109 43 44 •

e-mail: golubowic@gmail.com •

INTRODUCTION

Closed tibial fractures are the most common fractures encountered in orthopedic practice (1). Segmental tibial fractures represent a special category of closed tibial shaft fractures. They represent a discontinuity in the bone shaft integrity at two or more levels. Between two levels of fractures on tibia there is an intermediate fragment, the part of tibia which separates two fracture focuses and whose circumference is preserved. The length of the intermediate fragment can vary between 3 and 20 cm. Comminution can be present in both fracture focuses (2). According to the literature, the frequency of segmental tibial fractures ranges from 1-6% (3).

Besides severe open fractures, segmental fractures are among the most difficult groups of fractures. Usually, they occur in traffic accidents due to the effect of direct violent forces. It often occurs that a car, moving at high speeds, hits a pedestrian with a bumper into the lower leg. This injury is rarely isolated (4).

This kind of damage of all structures of the lower leg creates very unsuitable biological conditions for fracture healing. Because of the damage of both intramedullary and periosteal vascularization, segmental fractures are predisposed to slow healing and development of pseudoarthrosis (5).

The aim of the present paper was to present the results of treatment of closed segmental tibial shaft fractures in the patients who were treated with external fixation at the Clinic of Orthopedics and Traumatology, Clinical Center Niš. Also, one of the goals was to analyze the complications after using external fixation and show the way to resolve them.

PATIENTS AND METHODS

In the period from January 1, 1998 to June 31, 2012 at the Department of Orthopedics and Traumatology and the Department of Neurosurgery, Clinical Center Niš, 26 patients with closed segmental fractures were treated. One patient with closed segmental tibial fractures was treated non-operatively with plaster immobilization, and one multiply injured patient having lung injury, vertebre fracture and closed segmental tibial fractures died after surgical treatment in the course of further treatment.

The assessment of outcome of treatment of closed segmental tibial fractures by external fixation was performed on a series of 24 patients. All the patients were treated by Mitković external fixator, with convergent orientation of pins.

RESULTS

In the analyzed group there were 17 (70.83%) males and 7 (29.17%) females. The average age was

43.57 years. The youngest participant was 17 years old and the oldest was 77 (Table 1).

By analyzing the etiological factor of injury, we found that in 16 (66.67%) patients the cause of the closed segmental tibial fractures was a car accident, in 4 (16.67%) patients a fall from height, whereas 3 (12.5%) patients were injured while working in the field and one (4.17%) patient was injured by a piece of wood which hit the lower leg area.

Having analyzed the type of injury, we found that 11 (45.83%) patients had an isolated trauma of the below-knee segment, 9 (37.5%) patients had polytrauma and multiple fractures were reported in 4 (16.67%) patients.

In 20 (83.33%) patients, the healing of tibial fractures in both focuses of the fracture was reported, 4 (16.67%) patients suffered significant complications that required further surgical treatment (Figure 1).

In 2 (8.33%) patients with closed segmental fractures, we noticed slow healing of one fracture focus (Figure 2).

In one (4.17%) patient with closed segmental tibial fractures, after the application of external skeletal fixation, a dislocation occurred in one fracture focus. The cause of deformity was bending of external skeletal fixator pin. Correction of angular deformity was carried out on an outpatient basis after parenterally administered analgesic (Figure 3).

In 4 (16.67%) patients, the pin site infection was registered. In 3 patients the infection subsided after the antibiotic treatment and daily dressing changes. In one patient, the external fixator was removed and the treatment continued with functional braces by Sarmiento. Healing of closed segmental tibial fractures which were treated by the external skeletal fixation without major complication requiring the operative treatment were reported in 20 (83.33%) patients. In 4 (16.67%) patients who reported major complications during the treatment, surgical treatment was required.

In two patients who suffered aseptic pseudoarthrosis in one fracture focus, the management of pseudoarthrotic focus and spongioplasty was performed, after which compression-distraction apparatus was placed. In two patients who had aseptic pseudoarthrosis in one fracture focus, the treatment of pseudarthrosis focus was performed, as well as angioplasty, after which a compression-distraction apparatus was applied. After administered therapy, the bone healing at the site of pseudoarthrosis occurred. In 2 (8.33%) patients, aseptic nonunion of a fracture focus was reported. Spongioplasty was performed by taking the bone from the iliac crest and compression-distraction apparatus by Mitković was placed. After surgical treatment, the healing of fracture nonunion in both cases ensued. In one patient there was a 3 cm leg shortening, followed by angular deformity over 10°. Surgery was undertaken, when angular deformity was corrected and leg shortening was resolved.

In one (4.16%) patient, we registered a valgus angular deformity-more than 10 degrees and limb shortening over 2 cm, which required a new surgical intervention and correction of deformity. In one (4.16%) patient,

there was a loosening of external skeletal fixation pins causing the fixator to be removed, when treatment was continued with intramedullary fixation.

Table 1. Distribution of patients by age and sex

Age	10-19		20-29		30-39		40-49		50-59		60-69		70-79		Total	
Sex	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Male	1	4.17	3	12.50	1	4.17	6	25.00	3	12.50	2	8.33	1	4.17	17	70.83
Female	1	4.17	2	8.33	/		1	4.17	2	8.33	1	4.17	/		7	29.17
Total	2	8.33	5	20.83	1	4.17	7	29.17	5	20.83	3	12.50	1	4.17	24	100

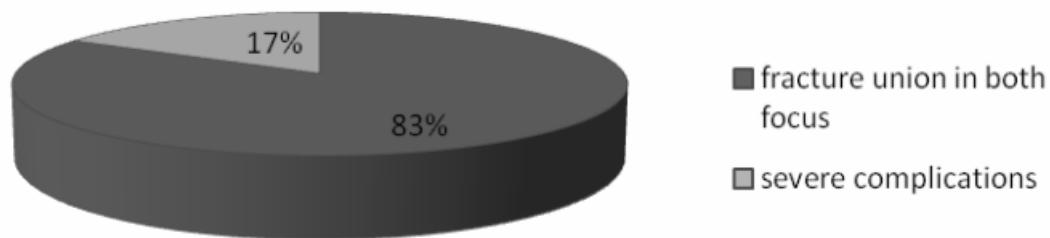


Figure 1. Results in treatment of closed segmental tibial fractures with Mitković external fixator



Figure 2. A female patient, 42 years old, sustained a severe segmental fracture of the left tibia and a hip fracture in a car accident. After the reposition, the fracture of tibia was stabilized by Mitković external fixator with convergent pin orientation, whereas a hip fracture was stabilized by Mitković internal fixator. Six month after the surgical treatment, the segmental tibial fractures healed in both focuses, and the external fixator was removed as excellent results had been achieved. In another surgical intervention, after healing of femoral neck fracture (14 month after injury), the internal dynamic fixator was removed. The patient returned to her daily activities and work.

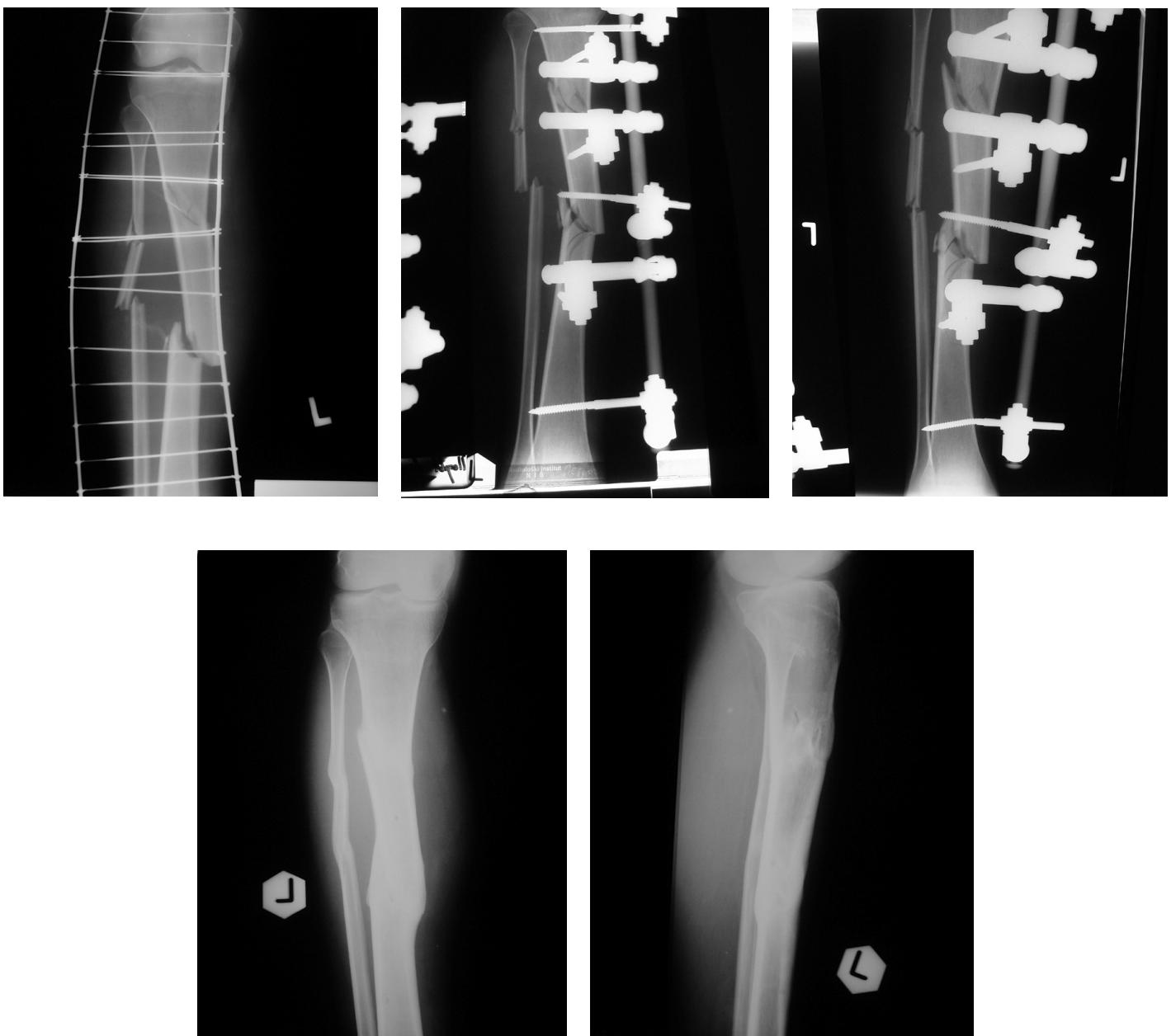


Figure 3. The patient, 24 years old, sustained a closed segmental fracture of the left tibia, a fracture of the left femoral shaft and a fracture of the left hand in a traffic accident when she was hit by a car. Osteosynthesis of the left femoral shaft fracture was done using the internal fixation, while segmental fracture of the left tibia was treated by external fixation. During rehabilitation, bending of the external fixator pin occurred, as well as the tibial deformity, which required angular correction. After 20 weeks, the segmental fracture of the left tibia healed, when external fixator was removed; however, 1 cm shortening of the left tibia remained. Twelve years later, on control examination, the patient denied the existence of any complaints.

DISCUSSION

In segmental tibial fractures that occur under the force of high intensity, all below knee segment structures suffer severe damage. Dermal layer of the lower leg is the most traumatized region. Seemingly less traumatized skin, after three to four days can show the real situation because there could be much more extensive necrosis than was assumed at the first examination. This

damage of all anatomical structures of the leg creates very unfavorable conditions for biological fracture healing. Because of damage to intramedullary and periosteal vascularization, segmental tibial fractures are predisposed to delayed healing and development of pseudoarthrosis, and in case of open fractures to the development of chronic osteitis (6, 7).

Because of extensive damage to all structures of the lower leg, treatment of segmental tibial fractures

is a very complex problem. In general, the treatment of segmental tibial fractures can be non-operative and operative. Segmental fractures are rarely suitable for non-operative treatment, except for fracture with minimal dislocation. After repositioning, these fractures can be treated with thigh plaster boot. In order to achieve manual reposition, it is necessary to provide stability of both fracture focuses. By performing manual maneuvers, it can be accomplished in a single focal point of fracture, and while trying to perform the reposition of the second, a dislocation usually occurs in the previous one. Maneuvers are repeated several times, thus damaging more the soft tissues of the leg. And if a satisfactory repositioning of the fragment under X-rays is achieved and plaster immobilization is applied, a secondary dislocation of the fragments usually occurs as soon as edema at the fracture site subsides. For that reason, the majority of segmental tibial shaft fractures require early surgical treatment (8, 9).

Muller et al. in the treatment of segmental tibial shaft fractures recommended compression plating by a long plate that includes all three fragments. If the condition of the lower leg soft tissues is good, medially padded plate is recommended, while in case of compromised soft tissues of the lower leg and segmental tibial fractures, lateral plate placement is favored.

Muller et al. also indicate that the interlocking nail, possibly in combination with a narrow plate on the edge of the tibia, is a good solution in the treatment of segmental fractures. The authors do not suggest the reaming of the medullary canal as there is a danger that pieces of shaft fractures could be torn out of the soft tissues (10).

Mellise et al. present the series of 38 patients with segmental tibial fractures who were treated with interlocking nail. In the analyzed group there were 22 closed segmental tibial fractures and 16 open fractures. Reaming of the medullary cavity was performed and adequate fixation was ensured by the use of plaster cast. Weight-bearing was allowed after thirty days for closed fractures and sixty days for open fractures. All of the closed fractures healed without malunion or infection (11).

Unilateral external fixator with convergent pins orientation provides necessary stability of the segmental fracture and support, which is important for fracture healing. Two pins of the external fixator fix proximal and distal tibial fragment, and one or two pins of the external fixator fix the intermediate fragment, depending on its size (12).

Giotakis N. et al. present their treatment of 20 patients with segmental tibial fractures, who were treated between 2000 and in 2006 with circular external fixator. In the analyzed group of patients there were 15 males and 5 females. In 17 patients the injury was sustained in a traffic accident, while in three patients the causes of injuries were the falls. In the analyzed group, there were 13 closed segmental tibial fractures and 7

open ones. The mean age was 47, 2 years. In 18 patients there was fracture healing, whereas in 2 patients the nonunion and pseudoarthrosis formation were reported in the distal fracture focus. In one patient, the treatment was continued with circular external fixator, and in other one with open and autologous bone grafting. In one patient, osteomyelitis developed around the wire, so that the replacement and debridement were performed. In three patients, fracture healed with angular deformity (13).

CONCLUSION

Segmental tibial fractures, besides severe open tibial fractures, are among the most difficult types of fractures. Usually, they occur in traffic accidents due to the effect of direct violent forces. Segmental tibial fractures are rarely isolated injuries and are frequently encountered in polytraumatized patients. In segmental tibial fractures, the damage of all anatomical structures creates very unfavorable conditions for biological fracture healing.

Unilateral placement of Mitković external fixator with convergent pin orientation provides necessary stability of the fracture and support. With careful application of the external fixator, after the reposition of fragments (closed or open reposition achieved through a small incision), there is a minimum additional damage of both periosteal and intramedullary vascularization of tibial diaphysis, which is very important for fracture healing.

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SPOLJNA SKELETNA FIKSACIJA U LEČENJU ZATVORENIH SEGMENTNIH PRELOMA TIBIJE

Zoran Golubović¹, Predrag Stojiljković¹, Ivan Golubović¹, Zoran Radovanović², Aleksandar Višnjić², Branko Ristić³, Katarina Kutlašić-Stojanović¹, Milan Trenkić², Stevo Najman², Miroslav Trajanović⁴

¹Ortopedsko-traumatološka klinika, Klinički centar Niš, Srbija

²Univerzitet u Nišu, Medicinski fakultet, Srbija

³Ortopedsko-traumatološka klinika, Klinički centar Kragujevac, Srbija

⁴Univerzitet u Nišu, Mašinski fakultet, Srbija

Sažetak

Segmentni prelomi tibije predstavljaju prekid kontinuiteta koštanog tkiva dijafize tibije na dva ili više nivoa. Kod segmentnih preloma potkoljenice dolazi do oštećenja svih anatomskih struktura, što stvara veoma nepovoljne biološke uslove za zarastanje preloma. Zbog oštećenja kako intramedularne tako i perioskalne vaskularizacije, segmentni prelomi potkoljenice predisponirani su za usporeno zarastanje i razvoj pseudoartroza.

Cilj rada bio je da se prikažu rezultati lečenja zatvorenih segmentnih preloma potkoljenice metodom spoljne skeletne fiksacije.

U periodu od 01.01.1998. do 31.06.2012. godine u Kliničkom centru u Nišu lečeno je 26 bolesnika sa zatvorenim segmentnim prelomom potkolenice. Procena krajnjih rezultata lečenja izvršena je na seriji od 24 bolesnika. Prosečna starost ispitanika iznosi 43,57 godina. Svi bolesnici lečeni su spoljnim skeletnim fiksatorom Mitković.

Zarastanje preloma bez težih komplikacija registrovali smo kod 20 (83,33%) ispitanika. Kod četiri (16,67%) ispitanika javile su se značajnije komplikacije u toku lečenja, koje su zahtevale dodatne hirurške intervencije.

Prilikom primene metode spoljne skeletne fiksacije u lečenju zatvorenih segmentnih preloma potkolenice, repozicija fragmenta ostvaruje se kroz male rezove, a klinovi spoljnog skeletnog fiksatora plasiraju se van žarišta preloma, tako da se dodatno ne ošteće ni intramedularna ni periostalna vaskularizacija kosti u zoni preloma, što je veoma važno za proces zarastanja preloma.

Ključne reči: zatvoreni segmentni prelom tibije, spoljna skeletna fiksacija, spoljni fiksator Mitković