

## ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

# Unilateral external fixation of the tibial shaft malunion

Saša S. Milenković<sup>1,2</sup>, Milan M. Mitković<sup>1,2</sup>, Milorad B. Mitković<sup>2</sup><sup>1</sup>Clinical Center of Niš, Clinic for Orthopaedics and Traumatology, Niš, Serbia;<sup>2</sup>University of Niš, Faculty of Medicine, Niš, Serbia**SUMMARY**

**Introduction/Objective** Fracture malunion is still a major problem in orthopaedic practice. The external fixation of tibial fracture malunion has become popular in recent years. The objective of this work was to evaluate clinical results in tibial shaft malunion treatment based on unilateral external fixation method.

**Methods** The patients with tibial shaft malunion have surgically been treated by unilateral Mitkovic external fixation system. Malunion deformities were corrected by "one stage" technique, using Mitkovic-CD type external fixator, or gradually, using Mitković-V type external fixator. This retrospective study included 15 patients with tibial shaft angular malunion. The main type of malunion was valgus deformity, in 10 patients, and varus deformity, in five patients.

**Results** The mean healing time was 89.66 days (range 50–125). There were no complications in the present study. The follow-up time after surgery was three years. Final functional results were excellent in 13 cases and good in two cases.

**Conclusion** This unilateral external fixator system was successfully used in the treatment of tibial shaft malunion, with good results and low complications rate.

**Keywords:** external fixation; tibial shaft; malunion

**INTRODUCTION**

Delayed union, nonunion and malunion are relatively frequent complications of tibial shaft fractures [1]. According to Nicoll, the important factors in prognosis are the amount of initial displacement, the degree of comminution, the presence or absence of infection and the severity of the soft tissue injury excluding infection [2]. What had to be taken into consideration were the clinical presence, age, level of activity and general health status of the patients. Rosemeyer and Pforringer [3] consider surgery indicated if valgus deformity exceeds 12°, varus deformity exceeds 6°, external rotational deformity exceeds 15° or internal rotational exceeds 10°. Commonly accepted indications for surgical management of tibial shaft malunion include 10° of varus, 15° of valgus or 20 mm of medial shift of the mechanical axis. Other indications include inability to place the foot in a plantigrade position and limb-length discrepancy greater than 20 mm [4]. Treatment of tibial shaft malunion is a challenge for the surgeon and requires extensive experience. Abnormal joint loading induced by the deformity may result in early osteoarthritis. Angulation may usually be corrected by corticotomy. Satisfactory alignment after corticotomy or hemi-corticotomy is difficult to maintain unless some type of internal fixation (compression plate, intramedullary nail, etc.) or external fixation is used [5–9]. External fixation techniques for the management of tibial malunion has become popular in recent years [10–16].

The objective of this study was to evaluate the clinical results for tibial shaft malunion treated with the unilateral external fixation method.

**METHODS**

The patients with tibial shaft angular malunion have primary been non-operatively treated, by plaster cast immobilisation, or surgically, by an open reduction and internal fixation or by an external fixation method. All these malunions have been secondary treated by tibial corticotomy or hemi-corticotomy followed by external fixation. Tibial corticotomy was performed in patients with angular deformity of 10°–15° and was followed by "one stage" correction technique using Mitković-CD type external fixator. Tibial hemi-corticotomy was performed in patients with angular deformity > 15° and was followed by gradual correction technique, using Mitković-V type external fixator. One patient with valgus/antecurvature deformity and with delayed union had been treated by gradual correction technique without previous tibial hemi-corticotomy. Malunion correction process was begun in the first postoperative day at the rate of 1 mm/day until good alignment was achieved. Fibular osteotomy was performed in 14 cases.

**RESULTS**

This retrospective study includes 15 patients with tibial shaft angular malunion (Figure 1

**Received • Примљено:**

September 8, 2019

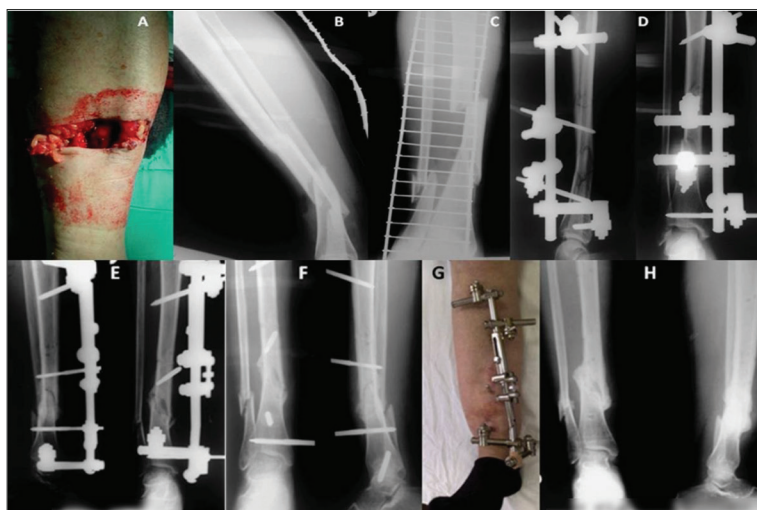
**Revised • Ревизија:**

November 16, 2019

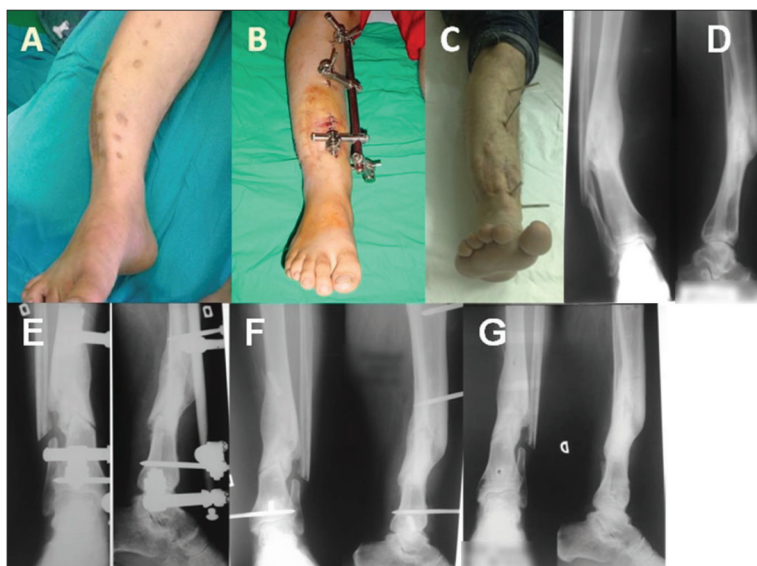
**Accepted • Прихваћено:**

November 17, 2019

**Online first:** November 19, 2019**Correspondence to:**Milan MITKOVIĆ  
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**Figure 1.** Open segmental tibial shaft fracture treated by external fixation method. A – Injured leg of the 27-year-old patient, injured in a traffic accident as a passenger on the motorcycle; B – X-ray after the injury (lateral view); C – X-ray after the injury (anteroposterior view); D – X-ray (lateral and anteroposterior view) after the external fixation; E – X-ray (lateral and anteroposterior view), four months after the injury; F – X-ray (anteroposterior and lateral view) varus and antecurvatum deformity was observed two weeks after the fixator frame removal; G – External fixator with V frame is installed for gradual angular deformity correction; H – X-ray (anteroposterior and lateral view) after deformity correction and after fixator removal, eight months after the injury [20]



**Figure 2.** A – Leg of the 29-year-old male patient with posttraumatic varus malunion, before correction; B – The same patient after correction using Mitkovic type external fixator; C – External fixator was removed 100 days after the correction surgery; D – X-rays (anteroposterior and lateral view) of varus (26°) and antecurvatum malunion, 20 months after injury; E – X-rays (anteroposterior and lateral view) one month after tibial and fibular corticotomy, correction of the deformity and application of the Mitkovic type external fixator; F – X-rays (lateral and anteroposterior view) three months after corticotomy and external fixation; G – X-rays (lateral and anteroposterior view) 100 days after correction of the malunion

and 2). The average age was 34.93 years (range 24–49). Ten were male and five were female. The mean healing time was 89.66 (50–125) days. There were two (13.33%) superficial pin tract infections, with good response to local pin care and oral antibiotics. There were no cases of deep infection or nonunion. There were no serious complications such as deep vein thrombosis, deep infection, iatrogenic neurovascular injuries and no instrumentation failure in the present

study. Ten patients suffered from malunion valgus deformity and five patients suffered from a varus deformity. Postoperatively, all patients were encouraged to walk using crutches with 50% weight bearing, gradually increasing until full weight bearing. Generally, full weight bearing was allowed 6–8 weeks after operation. In nine cases, tibial hemi-corticotomy was performed, followed by application of Mitković-V type external fixator, and gradual correction afterwards. In six cases, correction was realized intraoperatively, as “one stage” technique, followed by application of Mitković-CD type external fixator. The follow-up time after surgery was three years. Final functional results were excellent in 13 cases and good in two cases. Poor results were not perceived.

## DISCUSSION

Deformities are described in terms of abnormalities of length, angulation, rotation, and translation. The malunion was defined by the location, range, and direction of the deformity. Proper evaluation allows the surgeon to determine an effective plan of deformity correction treatment. Surgical intervention is primarily indicated in symptomatic patients or those with relatively severe deformity. Abnormal joint loading, induced by the deformity, may result in early osteoarthritis. They are generally accepted by the surgical community as being predictive in preventing posttraumatic arthritis of the knee and ankle joints. Once the deformity has been corrected by a corticotomy, the bone requires stabilization to maintain the correction. Internal fixation with plates and screws provides compression across the osteotomy. Intramedullary fixation stabilizes osteotomies and allows early weight bearing. Intramedullary fixation can be technically difficult due to changes in the alignment of the intramedullary canal because of the osteotomy [5]. Gradual correction of a malunion can be performed using Ilizarov external fixator. This device uses distraction osteogenesis by slowly stretching the soft callus at the corticotomy site. The advantage of this technique is that multiple complex corrections can be performed at one time to include angular, translational, and rotational deformities and length discrepancy [17, 18]. Unilateral Mitkovic external fixators give the possibility of post-traumatic malunion deformities correction using the same biomechanical principle as the Ilizarov fixation method. Mitković-CD type external fixator is suitable for “one stage” correction of tibial shaft malunion. Preferred

location of the corticotomy in this technique is proximal tibial metaphysis. The pins are set proximally (two pins) and distally (two pins) to the corticotomy level before the corticotomy, procedure starts. After corticotomy procedure has been finished, the “one-stage” correction of the deformity is being performed. The final step is the attachment of Mitković-CD type external fixator frame for previously set pins. Mitković-CD type external fixator can also be used in correction of rotational deformities.

Other device, Mitković-V type external fixator, gives the possibility for gradual correction after hemi-corticotomy procedure. This treatment is based on gradual opening wedge technique, after hemi-corticotomy. Hemi-corticotomy can be performed on the same side as external fixation frame is or on opposite side [19]. If hemi-corticotomy is on the same side then opening wedge is performed by distraction of the telescoping unit in the external fixator frame. If hemi-corticotomy is on opposite side, then opening wedge is realized by compression of telescoping unit in the frame. Mitković-V type external fixator also allows corrections of antecurvatum or recurvatum combined with varus or valgus deformities [20]. The fixator-articulating unit has to be set as more as near to the hemi-corticotomy level. Thus, undesirable excess tension between external fixator components is being minimized during the compression or distraction maneuvers in the dynamic unit of the device. As hinge articulating unit is in the bar component of the device, plane of correction can be easily defined by proper rotation of the bar. This rotation can be completed intraoperatively or even postoperatively, within several first postoperative days, during temporary unlocking of the clamps. This procedure requires surgeon's extensive previous experience.

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Mitković external fixators are unilateral devices and its application is very simple. The most common complication of the present study was pin tract infection, but all of these cases had had good response to local pin care and to oral antibiotics therapy. If over-correction happened during the correction process, it would be easy to perform the correction, by the change of performance direction.

## CONCLUSION

Mitković unilateral external fixator system has been proved as successful method in the tibial shaft malunion correction, with good clinical results and with low complications rate. After pins insertion and corticotomy or hemi-corticotomy has been performed, the frame of the device is relatively easy to be set. These external fixation devices and techniques are suitable for minimally invasive surgery.

## ACKNOWLEDGEMENT

This work is a part of the project titled “Virtual human osteoarticular system and its application in preclinical and clinical practice” (Project No. III41017) funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

**Conflict of interest:** Saša Milenković and Milan Mitković declare no conflict of interest. Milorad Mitkovic has at this moment agreement with Ortokon, producer of the external fixator, on temporary assignment to the use of patent.

## Једнострана спољашња фиксација лоше сраслих прелома дијафизе тибије

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### САЖЕТАК

**Увод/Циљ** Лоше срасли преломи су још увек велики проблем у ортопедској пракси. Спољашња фиксација у лечењу лоше сраслих прелома тибије је последњих година све популарнија.

Циљ рада је евалуација клиничких резултата у третману лоше сраслих прелома дијафизе тибије методом једностране спољашње фиксације.

**Метод** У овом раду су анализирани болесници са лоше сраслим преломом дијафизе тибије, који су хируршки лечени методом једностране спољашње фиксације апаратом по Митковићу. Деформитети су кориговани у једној фази спољним фиксатором Митковић-CD или постепено спољним фиксатором Митковић-V. Ова ретроспективна студија

обухвата 15 болесника са лоше сраслим преломом дијафизе тибије. Код 10 болесника су преломи лоше срасли у положају валгус, а код пет болесника у положају варус.

**Резултати** Просечно време зарастања је било 89,66 дана (50–125 дана). У испитиваној серији није било компликација. Просечно време праћења је било три године. Крајњи функционални резултат је био одличан код 13 и добар код два болесника.

**Закључак** Метод једностране спољашње фиксације апаратом по Митковићу обезбеђује успешну корекцију лоше сраслих прелома дијафизе тибије, са dobrим резултатима и ниском стопом компликација.

**Кључне речи:** спољашња фиксација; дијафиза тибије; лоше срастање