

## TALOCRURAL ARTHRODESIS USING THE METHOD OF ILIZAROV

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(Original scientific paper)

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### **Abstract**

*Background: Talocrural arthrodesis using the method of Ilizarov is a reasonable procedure for patients with secondary ankle degenerative changes and comorbidities, making other surgical treatment impossible. The aim of this study is to evaluate the results of talocrural arthrodesis as union rate, deviations, functional restoration and complications. Patients and Methods: The study has included 26 patients with Ilizarov talocrural compressive arthrodesis at the Clinic for Orthopaedic Surgery in Skopje from 2015 to 2019, of which 3 were with simultaneous gradual distraction. The follow up was from 22 to 64 months. The age varied from 41 to 77 years. All patients were with comorbidities and poor bone and soft tissue condition. The monitoring was performed using native radiography and ultrasonography at the compression/distraction site. Results: A complete bone fusion was achieved in all patients. The median time of wearing the external fixator was 22 weeks. In three cases with simultaneous distraction, the average bone healing index was 47 days/cm. The final maximal length discrepancy was 11 mm. In 16 patients (61.53%) signs of pin tract infections were detected. The mean number of pin site infections was 2.3/patient. No pin infection has required a change of the pin. Once the construct was removed, patients used a cast for 4-6 weeks and a walker boot for next 6-8 weeks. Conclusion: A talocrural arthrodesis performed by the Ilizarov method offers a high union rate, few deviations and a good functional restoration, often with no additional surgical procedures. In cases with numerous comorbidities and a poor limb condition, it can be a method of choice instead of an arthrodesis using internal fixation in the treatment of end-stage ankle arthritis.*

**Key words:** Talocrural arthrodesis, Ilizarov method

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### **Introduction**

The compression-distraction method by Ilizarov is of great value in limb lengthening and deformity correction of segments and extremities. Bone fixation using a circular fixator and transfixing tensioned wires provides not only multiplanar stability during the process of segmental limb lengthening, but a possibility of flexible correction of various combined complex deformities on certain segments as well. (figure 1) While under traction in gradual limb lengthening, bones and soft tissues in many studies have presented a remarkable osteogenic capacity. (1,2) However, applied compressive forces on the segment with their piezoelectric effects favor osteogenesis too, according to some biologic principles such as the law of Wolff. (3,4) These postulates are in fact a basis for performing a compressive arthrodesis on various joints secondary damaged for a plenty of reasons. In that sense, ankle arthrodesis using the method of Ilizarov has been established as a reasonable salvage procedure for many patients with secondary ankle degenerative changes often associated with different medical conditions and comorbidities which make some other types of surgical treatment impossible.

### **Patients and Methods**

The study has included 26 patients who have underwent Ilizarov talocrural compressive arthrodesis at the Clinic for Orthopaedic Surgery in Skopje from 2015 to 2019. Since the analysis was based on the results of a prospective study, those patients who had inadequate follow up were excluded, as well as those with an additional surgical procedures on other neighboring joints such as talocalcaneal joint or any joints of the

foot. No patients were excluded between the time of ankle fusion surgery and the time of frame removal. The follow up period have ranged from 22 to 64 months (median 42.4). The age of the patients varied from 41 to 77 years (median 57.2). Almost all of the patients were with numerous comorbidities. Moreover, the frequent local and general osteopenia or osteoporosis or poor skin condition, have made major surgical approaches impossible, or internal bone fixation. The surgical procedures were performed using spinal anesthesia. No tournique was used. In 4 of the patients with complete joint destruction and mild or no axial deformity, but with poor skin or vascular conditions, no surgical incision or exploration was indicated, but compression and axial correction only. In the rest of the patients, lateral transfibular surgical approach was used to perform a fibular resection at the level of talocrural joint (3-4 cm). Cuts on the articular surfaces of distal tibia and proximal talus were usually sufficient to enable a good contact between bone ends and a proper position of the segment. Then the preconstructed frame was placed and tensioned. The frame was consisted of two tibial rings and a foot ring or a half-ring combined with two additional long plates. The stability of the forefoot fixation was achieved by two male posts placed in the distal holes of the plates connected with one horizontally positioned threaded rod fixed in the proximal holes of the posts. Each ring had at least two tensioned 1.8 or 2 mm wires fixed to the bones and tensioned with a wire tensioner. The foot ring was fastened to the distal tibial ring with 3-4 rods, then 2 wires were diagonally inserted through calcaneus and tensioned on the foot ring, whereas one or two wires were inserted and tensioned through metatarsal bones to stabilize the forefoot. (figure 1)

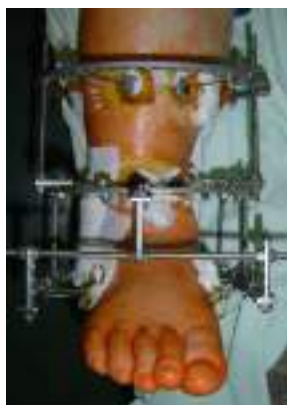


Figure 1: Ilizarov external frame used in transfibular talocrural arthrodesis after comminuted non-sanated fracture of distal tibia and fibula



In the majority of patients, the whole frame was fixed on the bones with tensioned wires only, except in those three in which a simultaneous lengthening of lower leg was mandatory because of shortening of the extremity of more than 2.5 cm. In those cases, all of them with sequelae of poliomyelitis, the half-pins were placed in the proximal tibial metaphysis and fixed to the additional proximal ring, combined with a tensioned wire transfixing the both bones at that level, in order to achieve a stability on the segment throughout the whole lengthening process once the corticotomy was accomplished. The corticotomy was performed on both bones either using an osteotome to crack the bone after a drilling procedure with multiple drilling holes, or using a Gigli saw in one patient. Intraoperatively, the wires were inserted using a power drill at a slow speed with a removal of the drill once the wire exited and a mallet was used to finish the contact between the wire and the ring on the opposite side. At the end of the operative procedure, gauzes with betadine in form of squares were placed on each pin site and an occlusive dressing was used around. 48-72 hours postoperatively, the whole region around the pin sites was left uncovered. An additional use of gauzes was necessary only in cases of exudates on the pin sites. The condition of each pin site was recorded daily, and a crust removal was performed if necessary. Pin site care was accomplished by local use of bacitracin-neomycine antibiotic spray which meant not merely a local prevention of pin site infection but also helped in maintaining dry pin sites. A single preoperative parenteral dose of Ceftriaxon, which was continued post-operatively for 72 hours, was usually sufficient in the general antibiotic treatment of the patients. The additional use of antibiotics was needed only in cases of osteomyelitis or pin site infections after the patients were discharged. Since no skin tension was detected on our clinical material, there was no need of release of skin or subcutaneous tissue. The infected sites were graded according to Saleh-Scott classification system:(5)

- Grade 0-No problems
- Grade 1-Responds to local treatment, increased cleaning and massage

- Grade 2-Responds to oral antibiotics
- Grade 3-Responds to intravenous antibiotics or pin releases
- Grade 4-Responds to removal of the pin
- Grade 5-Responds to local surgical curettage
- Grade 6-Chronic osteomyelitis

A latency period before distraction, where necessary, was 10-14 days. The distraction rate was 1 mm daily divided in four equal intervals of 0.25 mm. Generally, at the first day after the surgical procedure, the gradual compression through the threaded connecting rods between the distal tibial ring and the foot ring was performed with a rate of 1-2 mm daily. At the end of the compression cycle, the amount of shortening had varied from 7 to 41 mm (median 21.3 mm). The additional distraction was 28 to 40 mm (median 32.8 mm) according to the measured limb length inequality only in the three cases with segmental shortening more than 25 mm. The average bone healing index (BHI) in this group was 47 days/cm. All the patients were encouraged of early weight bearing by means of crutches, and a full weight bearing as soon as possible, except the ones with neuropathic conditions. The monitoring of new bone formation was performed using A-P and lateral native radiography and ultrasonography with 7.5 MHz linear transducer both at the compression and at the distraction site in longitudinal and transversal plane at the same day. The examinations have started on the third day after the surgical procedure, and were conducted in monthly intervals, till the removal of the frame, followed by additional examination at the end of compression/distraction cycle. Afterwards, the monitoring was performed in an interval of three months till the end of the follow up period. The analysis of the results of radiographic and ultrasonographic examination was based on the presence of initial indicators of new bone formation, cystic formations and cortical margin at the compression/distraction site. (figure 2) We considered the consolidation and remodeling stage accomplished once a non-invaginated continuous cortical margin appeared on sonograms in longitudinal plane and a continuous hyper-reflecting solid line in transversal plane, with no cystic formations larger than 2 cm in diameter and presence of three of four cortical margins and a trabecular bone structure without a radiolucent zone or any cystic changes on the A-P and lateral radiographs. The external fixator was removed in the operating room under sedation. The median time of wearing the external fixator was 22 weeks (range, 12–58 weeks). Once the construct was removed, patients wore a cast for 4-6 weeks for partial weightbearing and afterwards a walker boot for a 6-8 weeks period.

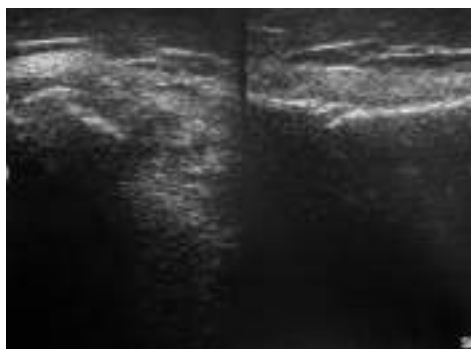


Figure 2: Ultrasonographic presentation of the distraction site of tibia: Non-completed hyper-reflecting solid line in transversal plane and invaginated cortical margin in longitudinal plane at the beginning of the consolidation stage

The external fixator was removed in the operating room under sedation. The median time wearing the external fixator was 22 weeks (range, 12–58 weeks). Once the construct was removed, patients wore a cast for 4-6 weeks for partial weightbearing and afterwards a walker boot for a 6-8 weeks period.

## Results

The study included 26 patients who underwent Ilizarov talocrural compressive arthrodesis at the Clinic for Orthopaedic Surgery in Skopje from 2015 to 2019. The patients were divided according to etiopathogenesis of the treated disorders. (Table 1)

Table 1: Etiopathogenetic classification of the clinical material

Disorders	Total number of patients	%
Fractures and delayed unions with ankle destructions	10	38,46
Septic arthritis	6	23,08
Sequealae of poliomyelitis with segmental shortening	3	11,54
Arthrosis with deformity due to rheumatoid arthritis	4	15,38
Charcot joint	2	7,69
Gout	1	3,85
Total number of patients	26	100

10 of the patients were surgically treated because of severe posttraumatic condition such as comminuted and non sanated fracture or delayed union of lower leg with consecutive ankle destruction, 6 were with chronic osteomyelitis and ankle arthritis preoperatively, 3 had sequelae of poliomyelitis with flaccid equinus and varus deformity with segmental shortening, 4 with ankle deformities and arthrosis due to reumathoid arthritis, 2 with Charcot joint with limb shortening, and one with complete ankle destruction due to gout.

In the total number of 26 patients a successful bone fusion was registered in the period not longer than 58 weeks, without a need for additional surgery after that period. (figure 3) In 4 of them (15.38%) initial radiographic and ultrasonographic clear signs of bone consolidation and remodelling have occurred after 4 weeks of wearing the frame, none of them in the group with additional distraction.



Figure 3: Profile radiography on the fusion site of the talocrural joint: Clear radiographic signs of bone consolidation and remodeling in the tibiotalar joint

Generally, ultrasonographic detection of indicators of new bone formation preceded the radiographic signs for about 4-8 weeks, and were more reliable in terms of prediction of mechanical stability of the operated segment. The additional distraction was 28 to 40 mm (median 32.8 mm) according to the measured limb length inequality only in three cases with segmental shortening more than 25 mm. The corticotomy was performed using an osteotome with periosteal preservation, after a pre-drilling procedure. (figure 4) In all three cases the corticotomy was performed both on tibia and fibula. The average bone healing index (BHI) in this group was 47 days/cm. The final maximal limb length discrepancy have not exceeded 11 mm. The median time of wearing the external fixator in all patients was 22 weeks (range, 12–58 weeks).



Figure 4: Corticotomy using an osteotome to crack the bone after a drilling procedure with multiple drilling holes

In order to assess the pin infection rate, all 201 wires and three half pin entry sites were analyzed in this study. Since a transfixing wire has two pin sites, 405 pin sites were registered. Infection rate was assessed as a percentage of the number of pin sites as well as a percentage of the number of patients. Of the 26 patients analyzed in this study, in 16 of them (61.53%) signs of pin tract infections were detected. The number of pin site infections in each patient varied from zero to seven with a mean of 2.3 infections per patient. Sixty of 405 wire sites became infected, hence, the total pin site infection rate was 14.81%. All three half pin sites in the patients with gradual distraction due to segmental shortening, presented signs of infection. The majority of pin site infections occurred in the stage of bone consolidation (68.75%), and reached no further than grade 3 of the above mentioned Saleh-Scott classification system. A proper local and general antibiotic treatment resolved completely the changes at the pin sites, and regular pin site care was resumed thereafter and throughout the whole treatment. No pin infection has required a change of the stabilization method, neither removal or exchange of a pin due to a prolonged inflammation.

In all of the patients, a complete bone fusion at the site of the arthrodesis, as well as at the distraction site in those patients with an additional surgical gradual distraction, was achieved. (figure 5) Although tibial lengthening did not affect ankle fusion healing, a greater preoperative limb length discrepancy was associated with a higher risk of ankle nonunion, which was presented by an occurrence of initial indicators of new bone formation not earlier than 16 week after the surgical procedure at the arthrodesis site, and not earlier than 6 weeks at the distraction site. The latency period was from 7-10 days. Longer bone consolidation both at the distraction and at the fusion site was registered by changes in presentation of some ultrasonographic and radiographic parameters of new bone formation, too. In the period after removal of the frame, in all of the patients there was an obvious need of protective weight bearing of the limb, which was achieved by wearing a cast and a lower limb orthosis afterwards.



Figure 5 : Native radiography (A-P and lateral view) presents a completed bony fusion in patient with severe posttraumatic condition treated with talocrural arthrodesis using the Ilizarov method

In 19 of the whole number of patients local osteoporosis, pain, swelling, limited weight bearing and instability has followed during a rehabilitation period of average 10 months after the extraction of the apparatus, with complete withdrawal of the clinical symptoms in the next 3-6 months. In two cases treated by talocrural arthrodesis because of severe posttraumatic condition such as comminuted and non senated fracture of the distal tibia, a stress fracture of the third and the fourth metatarsal bone, respectively, occurred after 4 months, and in the other case after 11 months of frame removal. Both cases were treated by ankle and foot plaster for 8 weeks, and resulted with complete bone consolidation and remodeling and full weight bearing in 10 weeks after the fracture onset. At the end of the follow up period of 2 years, no case of complication in terms of axial deviation or distortion, nor refracture have been registered in the whole group of treated patients.

## Discussion

The distraction/compression method using the external frame of Ilizarov is of great value in limb lengthening and deformity correction of extremities. Bone fixation using a circular apparatus and tensioned

wires transfixing bones, offers a possibility of postoperative gradual lengthening, compression and correction of various segmental deformities. The scientific principles of "the law of strain of tension and/or compression" are basis for a gradual and permanent traction/compression of supportive tissues, which means a metabolic activation of tissues and stimulating effect on the proliferative and other biologic processes in the treated segment. These processes are closely related to the segmental blood supply, to the functional capacity of the tissues and to the local potential for a biologic response of the exposed segment, e.g. extremity.(6,7) The stability of the frame is of particular importance in maintenance of normal bone axes not only after the so-called corticotomy has been commenced, but throughout the whole process of surgical lengthening till the moment of removal of the apparatus. (7) Ilizarov defined corticotomy as a low-energy osteotomy of the cortex, with preservation of the local blood supply to the periosteum and the medullary canal. The greatest threats in new bone formation at the distraction/compression site still remain, either because of the poor bone consolidation and remodelling of the newly generated bone or its premature healing. This can lead to fractures, distortion of the axis, or lack of osseous consolidation around the newly formed bone. Therefore, a permanent monitoring of the entire process is necessary, from the beginning of treatment, until the distraction apparatus is removed. (8,9)

A compressive ankle arthrodesis using the compression/distraction method of Ilizarov means a kind of surgical solution in patients with numerous comorbidities. A group of authors present results in terms of early weight bearing and post-operative adjustment of alignment of arthrodesis, and recommend the method especially in revision cases and in the cases with infections of the ankle joint and around it. (10) On the other hand, some clinicians report about complications throughout the whole treatment course using Ilizarov method for compressive ankle arthrodesis. According to their studies, this arthrodesis type can be accompanied with complications in terms of pin tract infections, tibial stress fractures, wire breakage, talar necrosis, loosening, residual deformities, delayed and non-unions, etc. (11-13) Nevertheless, the majority of authors present a high fusion rate (to 100%) at the compression site at the end of the treatment (14), whereas some clinical experiences indicate that ankle arthrodesis with Ilizarov stabilization is associated with lower prevalence of pain after surgery than after internal screws stabilization and generally, the outcomes are slightly better than after internal fixation. (15) These results suggest that Ilizarov external fixation may be an effective substitute to plate internal fixation in the treatment of end-stage ankle arthritis. (16) Moreover, the frequent local and general osteopenia or osteoporosis or poor skin condition often make impossible major surgical approaches or internal bone fixation. In that sense, an ankle arthrodesis performed by a transfibular approach and fixation performed by the Ilizarov method offers a high union rate, rare residual axial deviations and a good functional restoration of the patient without a necessity of an additional surgical procedure, especially in complex cases with numerous comorbidities and a poor bone and soft tissue condition. (17)

In all of the treated patients in our study, a successful talocrural bone fusion was registered in the period not longer than 58 weeks, without a need for additional surgery. The results of our study reveal a complete bone fusion both at the site of the arthrodesis, and at the distraction site in those patients with a surgical gradual distraction. Lower leg lengthening have not affected the talocrural fusion healing, although the initial indicators of new bone formation have occurred much later after the surgical procedure, both at the arthrodesis and at the distraction site. Longer bone consolidation at both sites was registered by changes in presentation of some ultrasonographic and radiographic parameters of new bone formation, too. Native radiography and diagnostic ultrasonography were used throughout the whole treatment in order to assess the newly formed bone. The majority of pin site infections in the stage of bone consolidation, have reached no further than grade 3 of the used Saleh-Scott classification system, and have caused no complication at the end of the treatment. In the period after removal of the frame, in all of the patients, there was an obvious need of protective weight bearing of the limb, which was achieved by wearing a cast and a lower limb orthosis afterwards.

## Conclusion

A talocrural arthrodesis performed by a transfibular minimal incision approach and fixation performed by the Ilizarov method offers a high union rate, rare residual axial deviations and a good functional restoration of the patient with early mobilisation and weight bearing, often without a need of an additional surgical procedures. In complex cases with numerous comorbidities and a poor bone and soft tissue condition, it can be a method of choice as an effective substitution to an arthrodesis using internal fixation in the treatment of end-stage ankle arthritis.

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