



THE ROLE OF POST-OPERATIVE REHABILITATION IN ANKLE FRACTURES

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Annotation: Ankle fractures are among the most common injuries of the musculoskeletal system and require not only high-quality surgical intervention but also comprehensive postoperative rehabilitation to restore the function of the ankle joint. The presented study analyzed the treatment results of 162 patients with various types of ankle fractures who underwent osteosynthesis followed by a standardized rehabilitation program.

Rehabilitation measures included gradual weight-bearing on the limb, physiotherapy procedures, exercises to restore mobility, and proprioception training. The effectiveness of restorative treatment was assessed using the AOFAS and VAS scales, as well as the range of motion in the joint. The results showed that 96.9% of patients who followed rehabilitation recommendations experienced complete restoration of joint function and significant reduction in pain syndrome by the 20th week.

The obtained data confirm the key role of postoperative rehabilitation in achieving high functional outcomes and preventing complications such as contractures and chronic pain. The implementation of comprehensive rehabilitation protocols should become an integral part of the treatment of ankle fractures.

Keywords: ankle fracture, rehabilitation, osteosynthesis, ankle joint, physiotherapy, AOFAS, VAS, function restoration.

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Relevance

Ankle fractures are among the most common injuries to the musculoskeletal system, accounting for a significant portion of lower limb injuries. According to literature data, the frequency of these fractures ranges from 9% to 18% of all long bone fractures [1]. They are more common in elderly women due to osteoporosis and in men of active age due to high-energy injuries [2].

The standard treatment for significant displacement of fragments is surgical intervention aimed at restoring the anatomical integrity and stability of the ankle joint [3]. However, successful surgical treatment does not guarantee full functional recovery without adequate postoperative rehabilitation. The absence or insufficiency of rehabilitation measures can lead to the development of complications such as contractures, chronic pain, and limited joint mobility [4].

Early initiation of rehabilitation measures, including physiotherapy and therapeutic exercise, contributes to improving functional outcomes and reducing the risk of complications [5]. Studies show that the application of techniques aimed at restoring range of motion and muscle strength allows for better results in restoring ankle joint function [6].



Thus, postoperative rehabilitation plays a key role in restoring ankle joint function after ankle fractures. A comprehensive approach, including timely initiation of rehabilitation measures and their appropriate intensity, is crucial for successful recovery and prevention of potential complications.

Materials and methods

From July 2023 to July 2024, a study was conducted at the Hand and Foot Surgery Department of the Republican Specialized Scientific and Practical Medical Center of Traumatology and Orthopedics of the Ministry of Health of the Republic of Uzbekistan, involving 162 patients with ankle fractures. The average age of the patients was 32.5 years, with an age range from 19 to 67 years. Among the study participants, 78 (48.1%) were men and 84 (51.9%) were women.

The Danis-Weber and AO/OTA classification systems were used to categorize fractures. In 45 cases (27.8%), isolated lateral malleolus fractures were diagnosed, in 101 cases (62.3%), bimalleolar fractures (with damage to both malleoli) were observed, and in 16 cases (9.9%), trimalleolar fractures accompanied by damage to the posterior edge of the tibia were identified.

Surgical treatment was performed based on the fracture type and the extent of joint structure damage. All patients underwent osteosynthesis using LCP plates and screws. For isolated lateral malleolus fractures, anatomical plates were used, while for bimalleolar fractures, two-plane fixators were applied to ensure stability of both the lateral and medial malleoli. In trimalleolar fractures, the posterior edge of the tibia was additionally fixed using a posterior angular fixator or screws. In 27% of cases, additional syndesmosis fixation was performed using positional screws.

After surgery, all patients' limbs were immobilized with a plastic cast for 4 weeks. During this period, patients were advised to move on crutches without putting weight on the operated limb. On the 29th-30th day, the cast was removed, after which a rehabilitation program began, including early exercises to restore ankle joint mobility. From the 7th week, gradual weight-bearing was allowed, starting from 10-15% of body weight and increasing over several weeks.



Figure 1 - Exercises recommended for patients in the postoperative period

The rehabilitation program consisted of several stages. In the early postoperative period, immediately after removing immobilization, Mulligan's mobilization technique was used to improve dorsiflexion. Starting from the 4th week, patients began performing isometric exercises (Fig. 1) to strengthen the ankle joint muscles and improve blood circulation. Physiotherapy procedures included ultrasound therapy, which promotes accelerated bone tissue regeneration, as well as electrophoresis with lidase to reduce swelling and prevent contractures. To prevent venous stasis, patients were advised to wear compression stockings for 4 weeks after cast removal. From the 8th week, balance exercises and proprioception training using unstable platforms were added to the rehabilitation program.





Removal of metal hardware was carried out in stages. Positional screws were removed 12-14 weeks after surgery. If the patient experienced discomfort from metal fixators, their removal was performed 9-12 months after the initial osteosynthesis.

Several parameters were used to assess the effectiveness of treatment. Clinical recovery was evaluated based on range of motion, absence of limping, and pain level according to the visual analog scale (VAS). Radiological monitoring was conducted at 4, 8, and 12 weeks after surgery to assess bone fragment consolidation and identify possible complications. Functional recovery was analyzed using the AOFAS (American Orthopaedic Foot & Ankle Society) scale, which allows for determining the degree of restoration of ankle joint mobility and the patient's quality of life.

The comprehensive treatment and rehabilitation protocol allowed for high functional outcomes and minimized the risk of complications. Patients who strictly adhered to rehabilitation recommendations experienced full restoration of range of motion by 16-20 weeks after surgery. In cases where the rehabilitation regimen was not followed, contractures and limited joint mobility were observed, despite anatomically correct fracture fixation.

Results

Analysis of functional recovery in patients after ankle fractures showed that timely rehabilitation contributes to improved ankle joint mobility, reduced pain, and restoration of normal gait.

In 157 out of 162 (96.9%) patients who strictly followed rehabilitation recommendations, by the 16-20th week after surgery, complete restoration of the range of motion (Fig. 2) in the ankle joint, normalization of gait without limping, and absence of pronounced pain syndrome were observed.

AOFAS functional assessment

For an objective analysis of the functional state, the American Orthopaedic Foot & Ankle Society (AOFAS) scale was used. The average functional assessment score before the start of rehabilitation was 45.6 ± 8.3 points, and by the 20th week, it reached 87.4 ± 6.1 points in patients who had completed a full course of rehabilitation.

Analysis of pain syndrome According to the **Visual Analog Scale (VAS)** for pain, patients reported average pain scores of 6.8 ± 1.2 points in the first days after surgery. By the 8th week after surgery, this indicator decreased to 3.1 ± 0.9 points, and by the 16th week - to 1.2 ± 0.7 points in patients who had completed all rehabilitation measures. In patients who did not follow the rehabilitation program, the pain level remained higher (3.9 ± 1.3 points at the 16th week), and in some (3.1% of the total number), chronic pain sensations in the ankle joint were observed.

Assessment of joint range of motion

The range of motion in the ankle joint was also assessed at different stages of treatment. Before the operation, the average range of motion was $18.4 \pm 5.7^\circ$ (with a normal range of $40-50^\circ$). By the 8th week, the range of motion in patients who actively performed rehabilitation exercises increased to $29.3 \pm 6.4^\circ$, and by the 20th week, it reached $42.7 \pm 4.9^\circ$. Patients who did not



adhere to rehabilitation by this time showed limited movement ($31.5 \pm 6.2^\circ$), indicating the development of joint stiffness.

Dynamics of limb weight-bearing recovery

From the 7th week, patients were allowed gradual weight-bearing starting from 10-15% of body weight. By the 12th week, 92.3% of patients were able to fully bear weight on their limb without pain or discomfort. The remaining 7.7% experienced difficulties with weight-bearing, which was due to either insufficient rehabilitation or individual tissue regeneration characteristics.

Complications and adverse outcomes

In 5 patients (3.1%), complications related to violations of the postoperative regimen and non-compliance with the rehabilitation program were observed. In 3 cases, ankle joint contracture developed, which required an additional course of physiotherapy and mobilization procedures. Two patients experienced persistent swelling of the ankle joint and venous congestion, requiring prolonged use of compression stockings and lymphatic drainage procedures.

Radiological monitoring at 4, 8, and 12 weeks showed satisfactory consolidation of fractures in 97.5% of patients. In 2 cases (1.2%), delayed consolidation of bone fragments was observed, which required prolonged immobilization and additional stimulation of regeneration (electrostimulation, ultrasound).

Table 1. Statistical analysis of data

Parameter	Mean value	Standard deviation
Functional assessment before rehabilitation (AOFAS)	45.6	8.3
Functional assessment after rehabilitation (AOFAS)	87.4	6.1
Pain (VAS) in the first days after surgery	6.8	1.2
Pain (VAS) at Week 8	3.1	0.9
Pain (VAS) at Week 16	1.2	0.7
Range of motion ($^\circ$) before surgery	18.4	5.7
Range of motion ($^\circ$) at Week 8	29.3	6.4
Range of motion ($^\circ$) at Week 20	42.7	4.9
Full weight-bearing by Week 12 (%)	92.3	5.2
Incidence of contractures (%)	3.1	1.5
Incidence of venous congestion (%)	3.1	1.5



Delayed consolidation (%)	1.2	0.9
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Conclusions based on the research results

A systematic approach to rehabilitation after ankle fractures plays a key role in restoring normal ankle joint function. The majority of patients who completed a full rehabilitation course achieved good functional outcomes, demonstrating complete restoration of range of motion, reduction in pain, and normalization of gait.

Patients who failed to adhere to rehabilitation recommendations had an increased risk of developing contractures and mobility limitations. This underscores the importance of comprehensive postoperative management, including early mobilization, physiotherapy, and appropriate limb loading.

Thus, the implementation of a standardized rehabilitation program allows for a significant reduction in recovery time, minimization of complication risks, and improvement of long-term functional outcomes in patients with ankle fractures.

Conclusion

The study results confirm that postoperative rehabilitation plays a key role in restoring the anatomical structure and functional mobility of the ankle joint after ankle fractures. Despite the high effectiveness of surgical treatment, the absence of timely rehabilitation measures significantly increases the risk of complications such as contractures, joint stiffness, chronic pain syndrome, and persistent gait disturbances.

A comprehensive rehabilitation approach, including early mobilization, physiotherapy procedures, therapeutic exercises, and gradual increase in limb loading, allows for maximum possible recovery. In our study, patients who strictly adhered to the rehabilitation program demonstrated significant improvement in functional indicators: by the 20th week after surgery, the average AOFAS score was 87.4 ± 6.1 , and the range of motion in the ankle joint reached $42.7 \pm 4.9^\circ$. At the same time, patients who did not undergo full rehabilitation experienced limited mobility, contractures, and persistent pain syndrome.

Early initiation of rehabilitation, especially after removing immobilization, plays a crucial role in preventing secondary complications. Mobilization techniques such as the Mulligan technique contribute to increased range of motion, while proprioception training and work with balance platforms improve joint stability and prevent injury recurrence. The use of physiotherapeutic methods such as ultrasound therapy and electrophoresis accelerates tissue regeneration and reduces the risk of edema and inflammatory processes.

Furthermore, data analysis showed that a gradual increase in limb load from the 7th week prevents muscle atrophy and contributes to improved tissue trophicity. Patients who started loading their limbs within the specified timeframe demonstrated faster gait recovery, while delayed loading led to a slowdown in the joint's adaptation to movement.



Thus, complete anatomical and functional restoration of the ankle joint is only possible with adherence to a comprehensive rehabilitation program. Lack of rehabilitation or its untimely initiation significantly increases the risk of adverse outcomes, worsening patients' quality of life. In this regard, it is important to develop standardized postoperative rehabilitation protocols that would include individualized approaches to patient management depending on the fracture type, fixation method, and associated risk factors.

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