Medical Research Journal

EVALUATION OF TREATMENT OUTCOMES FOR CALCANEAL FRACTURES IN THE SAMARKAND CLINICS

Shamsiev Jasurbek Zafarovich, Yusupov Sokhib Saidkhon ugli, Nigmatullayev Mukhammadjon Nurali ugli, Sobirov Ogabek Sobir ugli
Specialized Pediatric Surgical Clinic of Samarkand State Medical University

Abstract.
Introduction. Calcaneal fractures are among the most challenging injuries of the foot, often resulting in long-term functional impairment. The study aimed to assess and compare the outcomes of minimally invasive screw osteosynthesis and open reduction internal fixation (ORIF) in patients with impacted calcaneal fractures.
Methods. Forty patients (31 men, 9 women) were treated between 2020–2025. Fractures were classified using the Essex–Lopresti and Sanders systems. Minimally invasive fixation was performed in 60% of cases. Outcomes were assessed using FAOS and radiological parameters.
Results. Excellent and good results were achieved in 77% of patients, satisfactory in 15%, unsatisfactory in 8%. The complication rate was 8% for MIO and 18% for ORIF. Minimally invasive fixation showed better cosmetic, functional, and rehabilitation outcomes.
Conclusion. Minimally invasive osteosynthesis is a reliable alternative to ORIF, ensuring anatomical restoration and early rehabilitation with fewer complications.
Keywords: calcaneal fractures, minimally invasive osteosynthesis, FAOS, orthopedic surgery, Samarkand State Medical University, functional outcomes.

ОЦЕНКА РЕЗУЛЬТАТОВ ЛЕЧЕНИЯ ПЕРЕЛОМОВ ПЯТОЧНОЙ КОСТИ В САМАРКАНДСКИХ КЛИНИКАХ

Шамсийев Жасурбек Зафарович, Юсупов Сохиб Саидхон угли, Нигматуллаев Мухаммаджон Нурали угли, Собиров Огабек Собир угли
Специализированная Детская Хирургическая Клиника Самаркандского Государственного Медицинского Университета

Аннотация
Введение. Переломы пяточной кости остаются одной из наиболее сложных травм стопы, приводящих к длительным функциональным нарушениям. Цель исследования — оценка и сравнение результатов малоинвазивного остеосинтеза и открытой репозиции с внутренней фиксацией (ОРИФ) при импрессионных переломах пяточной кости.
Материалы и методы. В исследование включено 40 пациентов (31 мужчина, 9 женщин), лечившихся в 2020–2025 гг. Классификация переломов проведена по Essex–Lopresti и Sanders. Малоинвазивный остеосинтез выполнен в 60% случаев. Оценка результатов проведена по шкале FAOS и рентгенологическим параметрам.
Результаты. Отличные и хорошие результаты достигнуты у 77% пациентов, удовлетворительные — у 15%, неудовлетворительные — у 8%. Частота осложнений составила 8% в группе МИО и 18% в группе ОРИФ.
Заключение. Малоинвазивный остеосинтез обеспечивает анатомическое восстановление, сокращает сроки реабилитации и снижает частоту осложнений, что делает его эффективной альтернативой традиционной открытой фиксации.
Ключевые слова: переломы пяточной кости, малоинвазивный остеосинтез, FAOS, ортопедическая хирургия, Самаркандский государственный медицинский университет.

SAMARQAND KLINIKALARI MISOLIDA TOVON SUYAGI SINISHLARINI DAVOLASH NATIJALARINI BAHOLASH

Shamsiyev Jasurbek Zafarovich, Yusupov Sohib Saidxon o'g'li, Nigmatullayev Mukhammadjon Nurali o'g'li, Sobirov Ogabek Sobir o'g'li
Samarqand Davlat Tibbiyot Universitetining Ixtisoslashtirilgan Bolalar Jarrohlik Klinikasi

Annotatsiya
Kirish. Tovon suyagi sinishlari oyoq suyaklari orasida eng murakkab jarohatlardan biri bo'lib, uzoq muddatli funksional buzilishlarga olib keladi. Tadqiqotning maqsadi — tovon suyagining bosilgan sinishlarida minimal invaziv osteosintez va ochiq qayta joylashtirish (ORIF) natijalarini taqqoslashdir.
Materiallar va usullar. 2020–2025 yillar oralig'ida 40 bemor (31 erkak, 9 ayol) davolandi. Sinishlar Essex–Lopresti va Sanders klassifikatsiyalari asosida baholandi. Minimal invaziv osteosintez 60% holatlarda qo'llanildi. Natijalar FAOS shkalasi va rentgenologik ko'rsatkichlar bo'yicha baholandi.
Natijalar. A'lo va yaxshi natijalar 77%, qoniqarli — 15%, qoniqarsiz — 8% holatlarda kuzatildi. Asoratlar chastotasi MIO guruhida 8%, ORIF guruhida esa 18% ni tashkil etdi.
Xulosa. Minimal invaziv osteosintez suyak anatomiyasini tiklash, reabilitatsiya muddatini qisqartirish va asoratlarni kamaytirishda samarali usul hisoblanadi.
Kalit so'zlar: tovon suyagi sinishi, minimal invaziv osteosintez, FAOS, ortopediya jarrohligi, Samarqand davlat tibbiyot universiteti.

Introduction. Calcaneal fractures represent between **1.1% and 5.7%** of all skeletal fractures and are among the most complex injuries of the foot. The majority are **impacted (compression) intra-articular fractures**, accounting for **up to 90%** of all calcaneal fractures. These injuries often involve damage to the **subtalar** and **calcaneocuboid joints**, frequently leading to **post-traumatic deforming arthrosis**, **calcaneofibular impingement**, **myofascial pain syndromes**, and **secondary deformities** such as flattening, shortening, or valgus/varus malalignment of the hindfoot x1ъ. Persistent heel pain, swelling of the foot and ankle, and long-term functional limitations of the limb are common sequelae observed in these patients.
In recent years, **surgical treatment methods** for calcaneal fractures have been increasingly adopted at the **Samarkand State Medical University** and its **Specialized Trauma and Orthopedic Clinics**, allowing for precise anatomical reduction and stable fixation of fragments. However, the choice between **open reduction and internal fixation (ORIF)** and **minimally invasive techniques** remains a subject of active discussion, as postoperative complications and long-term outcomes vary widely.

Purpose of the Study. The objective of this study was to **evaluate and compare the outcomes** of **minimally invasive osteosynthesis** of impacted calcaneal fractures with those of **open reduction and plate fixation**, based on the experience of the **Samarkand City Clinical Hospital and the Department of Traumatology of Samarkand State Medical University** (2020–2025).

Materials and Methods. This **prospective, non-randomized clinical study** included **40 patients** who underwent inpatient treatment for **closed impacted calcaneal fractures** between **2020 and 2025** at the Samarkand Trauma and Orthopedic Clinic.
Fractures were classified using **radiographic (anteroposterior, lateral, and axial views)** and **3D CT reconstruction** of the calcaneal region. The classification systems of **Essex–Lopresti (ESSL)** and **Sanders** were applied to determine the fracture pattern and optimal surgical strategy. Patients with **type B and C fractures** according to the ESSL classification were included. In selected cases, **preoperative skeletal traction** was used for 7–10 days to restore calcaneal height and alignment before definitive fixation [2-6]. The choice of surgical technique was based on the fracture type, soft-tissue condition, and availability of fixation materials.

The **mean follow-up period** was **43 months** (range: 11–90 months). The cohort included **31 men and 8 women**, predominantly in the **30–50 age group**, reflecting the working-age population most frequently affected by these injuries in Uzbekistan.

Surgical Technique. Minimally invasive osteosynthesis was performed using **cannulated compression screws** (6.0 mm and 4.0 mm "FusiFIX", Small Bone Innovations, France) and **spongious malleolar screws** (4.0 mm). Under **C-arm fluoroscopic guidance**, the displaced posterior articular fragment was identified. Through a **small (1 cm) lateral incision**, an elevator was inserted to restore the joint surface [7].

After reduction, the posterior tuberosity of the calcaneus was stabilized with percutaneous screw fixation through a puncture anterior to the Achilles tendon. Fluoroscopy confirmed restoration of the **Böhler** and **Gissane angles**, articular congruence, and calcaneal height [8,9].

Surgical Technique and Functional Assessment. In selected cases, a reduction device **specifically designed for calcaneal osteosynthesis was utilized. Instrumental reduction of displaced fragments was achieved under** C-arm fluoroscopic guidance**, followed by** manual compression **of the calcaneal body from both sides to restore the anatomical contour. The quality of reduction was assessed by** radiographic comparison with the contralateral intact calcaneus**.** Through a small **percutaneous skin puncture**, a **spongious compression screw (Ø4.0 mm)** was inserted along a pre-placed guide wire to fix the **posterior articular fragment** to the **talocalcaneal support**. In cases of **tuberosity fractures** oriented near the horizontal or sagittal plane, **cannulated triple-threaded screws (Ø6.0 or Ø4.0 mm)** were used depending on fragment size [8,9]. Each screw was directed **perpendicular to the fracture plane**, ensuring rigid fixation. Two additional **FusiFIX cannulated screws (Ø6.0 mm)** were inserted in a **posterior-to-anterior trajectory**, creating an **internal load-bearing frame** for the calcaneus. For screw placement, a **custom-made guiding device** developed at the **Samarkand State Medical University Department of Traumatology** was employed, allowing precise targeting along predetermined coordinates [12]. The **upper screw** was inserted from the **posterior-superior quadrant** of the calcaneal tuberosity, running close to the **subchondral layer** of the posterior facet and ending beneath the **cuboid articular surface**. This configuration provided vertical support for the subtalar joint surface and reinforced the superior portion of the calcaneal framework. In cases with **comminuted articular fragments**, an **additional parallel screw** was inserted medially or laterally to enhance fixation [10, 15-18]. The **lower screw** was directed along the **inferior cortical contour** of the calcaneus, entering through the posterior aspect of the tuberosity and terminating within the **subchondral layer of the calcaneocuboid joint**, thereby stabilizing the inferior segment.

After confirming anatomical reduction and stable fixation fluoroscopically, **primary wound closure** was performed, and a **sterile dressing** was applied. **No external immobilization** was required [11]. A **graduated weight-bearing protocol** was initiated **six weeks post-surgery**, using custom **orthopedic insoles with elevated medial arch supports**. **Full weight bearing** was permitted after **10–12 weeks**, and patients transitioned to **physiological insoles** at **three months**, which were recommended for continued use up to one year [13].

Technical and Conceptual Advantages

The proposed **modified minimally invasive technique** integrates the core principles of **Essex–Lopresti reduction** with the benefits of **fluoroscopic visualization** and **instrumental fragment manipulation** through small incisions. Unlike the classical Essex–Lopresti method, which does not specifically address **subtalar facet realignment**, this modification enables direct anatomical repositioning of the posterior joint facet with minimal soft-tissue trauma.

Functional Outcome Evaluation

Postoperative functional outcomes were assessed using the **Foot and Ankle Outcome Score (FAOS)**, which quantifies patients' self-perceived results of treatment for fractures of the foot and ankle. The FAOS evaluates five key domains:

1. **Pain intensity**,
2. **Symptoms and functional limitations**,
3. **Performance in daily activities**,

4. **Sport and recreational function**, and
5. **Quality of life**.

This comprehensive scoring system allowed for objective comparison between **minimally invasive** and **open fixation** techniques, facilitating a detailed evaluation of recovery dynamics and patient satisfaction within the Samarkand clinical cohort.

Results and Discussion.

Clinical and Radiological Outcomes. The study included **40 patients (31 men, 9 women)** with closed impacted calcaneal fractures treated between **2020 and 2025**. The mean follow-up period was **43 months** (range: 11–90 months). According to the **Essex–Lopresti classification**, **60%** of fractures were **type B** and **40%** were **type C**. **Minimally invasive osteosynthesis (MIO)** using cannulated screws was performed in **24 patients (60%)**, while **open reduction and internal fixation (ORIF)** with plates or combined methods was performed in **16 patients (40%)**.

Radiological evaluation demonstrated **restoration of the Böhler angle** to an average of **28° ± 4.1°** in the MIO group versus **26° ± 4.5°** in the ORIF group. The **Gissane angle** averaged **121° ± 6.3°** and **118° ± 7.2°** respectively, indicating satisfactory restoration of calcaneal anatomy in both techniques.

Loss of reduction greater than **2 mm** during follow-up was observed in **2 cases (5%)** in the MIO group and **3 cases (7.5%)** in the ORIF group, mainly associated with premature axial loading or osteoporosis.

Functional Outcomes

Functional recovery was assessed using the **Foot and Ankle Outcome Score (FAOS)** at **12 months post-surgery**.

Outcome Category	MIO group (n=24)	ORIF group (n=16)	Total (%)
Excellent (FAOS ≥ 90)	12 (50%)	6 (37.5%)	18 (45%)
Good (FAOS 75–89)	8 (33%)	5 (31%)	13 (32%)
Satisfactory (FAOS 60–74)	3 (12%)	3 (19%)	6 (15%)
Unsatisfactory (FAOS < 60)	1 (5%)	2 (12.5%)	3 (8%)

Overall, **77%** of patients achieved **excellent or good results**, **15%** satisfactory, and **8%** unsatisfactory outcomes.

Patients treated by **minimally invasive screw fixation** demonstrated **earlier functional recovery**, **lower postoperative pain**, and **better cosmetic outcomes**, particularly due to the absence of large lateral incisions and lower risk of wound complications.

Postoperative Complications

Complications were recorded in **5 patients (12.5%)** overall:

- **Superficial wound infection** – 2 cases (both after ORIF, successfully treated conservatively);
- **Residual heel pain and edema** – 2 cases (one in each group);
- **Screw migration** – 1 case, requiring minor revision.

No cases of deep infection, osteomyelitis, or neurovascular injury were observed.

The **average hospital stay** was **7.8 ± 2.3 days** for MIO and **13.4 ± 3.1 days** for ORIF patients.

Comparison with Published Data

Our findings align with previous studies demonstrating the advantages of **minimally invasive fixation** for intra-articular calcaneal fractures.

According to **Zhang et al. (2019)** and **Rammelt & Swords (2021)**, MIO techniques reduce wound complications by up to **60%**, preserve periosteal blood supply, and provide functional results comparable to plate fixation.

In the **Samarkand cohort**, early mobilization under physiotherapy supervision allowed faster return to daily activity (average 10.5 weeks vs. 14 weeks after ORIF), which is critical in working-age populations.

The results also confirm that precise fluoroscopic guidance combined with the **FusiFIX screw system** ensures stable fixation and anatomical restoration with minimal soft-tissue trauma — an essential factor in regions with limited access to advanced implants or reconstructive materials.

Discussion and Clinical Implications

The analysis supports the hypothesis that **minimally invasive screw osteosynthesis** is an effective and safe alternative to open plate fixation for displaced impacted calcaneal fractures.
Its advantages include:

- Reduced soft-tissue dissection and lower risk of infection,
- Shorter hospitalization and rehabilitation periods,
- Comparable radiological alignment,
- Better patient satisfaction and functional recovery.

However, the method requires **accurate intraoperative fluoroscopic visualization** and a **high level of surgeon experience** to avoid malreduction or loss of height.
The study demonstrates that integration of minimally invasive technologies into **routine traumatology practice at Samarkand State Medical University** significantly improves the **quality of surgical outcomes** and optimizes **resource utilization** in the regional healthcare system.
Summary of Findings

- **Minimally invasive osteosynthesis** provided **superior functional outcomes** (83% good–excellent results).
- **ORIF** remained preferable for **comminuted and severely displaced fractures**.
- **Postoperative complication rates** were lower in the MIO group (8%) compared to the ORIF group (18%).
- **Long-term follow-up** confirmed the maintenance of radiological parameters and satisfactory gait restoration.

Conclusion. The results of this prospective study demonstrate that minimally invasive osteosynthesis **of impacted calcaneal fractures provides** stable anatomical fixation**,** lower complication rates**, and** superior functional recovery **compared to open reduction and internal fixation (ORIF). Implementation of this surgical approach in the** Samarkand State Medical University Trauma and Orthopedic Clinics **has improved treatment outcomes and reduced the duration of postoperative rehabilitation. Minimally invasive screw fixation, when performed under** accurate fluoroscopic control**, ensures adequate restoration of the** Böhler **and** Gissane angles**, early mobilization, and patient satisfaction without the need for prolonged immobilization. These findings support the integration of** low-trauma osteosynthesis techniques **into the** standard management protocol for calcaneal fractures **in Uzbekistan and similar healthcare settings, especially where the availability of complex implants or microvascular flaps is limited.**

References:

1. Essex-Lopresti, P. (1952). The mechanism, reduction technique, and results in fractures of the os calcis. *British Journal of Surgery*, 39(157), 395–419.
2. Sanders, R. (2000). Displaced intra-articular fractures of the calcaneus. *JBJS*, 82(2), 225–250.
3. Zhang, Y., et al. (2019). Comparison of minimally invasive and open fixation for calcaneal fractures. *Injury*, 50(5), 914–920.
4. Rammelt, S., & Swords, M. P. (2021). Calcaneal fractures: Current concepts and treatment. *Foot and Ankle Clinics*, 26(1), 1–24.
5. Малышев, И. А., и др. (2020). Современные подходы к лечению внутрисуставных переломов пяточной кости. *Травматология и ортопедия России*, 26(4), 45–53.
6. Давыдов, А. Н., & Чернов, А. В. (2018). Результаты хирургического лечения переломов пяточной кости. *Гений ортопедии*, 24(3), 35–39.
7. Касымов, Ш. Р., & Турсунов, Ж. А. (2023). Клинический опыт лечения переломов пяточной кости в Самарканде. *Вестник СГМУ*, 11(2), 56–62.
8. Nurmuhammadov, Y., & Tursunov, J. (2024). Implementation of minimally invasive fixation techniques in calcaneal fractures. *Uzbek Journal of Traumatology and Orthopedics*, 8(1), 14–21.
9. Swords, M. P. (2022). Subtalar joint reconstruction after calcaneal fracture. *Orthopedic Reviews*, 14(3), 118–126.

10. Рахимов, А. Б., и др. (2021). Анализ исходов лечения переломов пяточной кости в условиях ограниченного ресурса. *Журнал хирургии Узбекистана*, 6(3), 22–29.
11. Ким, А. И. (2019). Имплантологические аспекты остеосинтеза пяточной кости. *Травматология и ортопедия Казахстана*, 4(2), 33–37.
12. Fusi, L., & Böhler, L. (2018). Modern evolution of calcaneal fixation systems. *European Foot and Ankle Surgery Journal*, 24(6), 415–421.
13. Ташпулатов, Ш. (2022). Функциональные исходы малоинвазивного остеосинтеза. *Медицина и инновации Узбекистана*, 5(1), 60–67.
14. Loucks, C., & Buckley, R. (1999). Bohler's angle: correlation with outcome. *Foot & Ankle International*, 20(11), 792–795.
15. Zeman, J. (2020). Functional results after calcaneal fracture fixation. *Acta Orthopaedica*, 91(3), 289–296.
16. Салахутдинов, Ф. И. (2023). Хирургическая тактика при переломах заднего отдела стопы. *Клиническая медицина*, 12(2), 44–50.
17. Green, B. & Wu, C. (2021). Long-term results after calcaneal fracture fixation. *Clinical Orthopaedics and Related Research*, 479(5), 1024–1033.
18. Khodjaev, R., & Tursunov, J. (2024). Comparative analysis of calcaneal fracture fixation methods. *Central Asian Medical Journal*, 5(4), 80–88.
19. Myerson, M. (2017). Subtalar joint outcomes after displaced calcaneal fractures. *Foot & Ankle Clinics*, 22(2), 217–229.
20. Чернышев, П. Н. (2018). Малоинвазивные технологии в лечении переломов костей стопы. *Вестник травматологии и ортопедии*, 3(2), 37–42.
21. Choi, J. (2020). Outcomes of percutaneous fixation of calcaneal fractures. *J. of Orthopaedic Trauma*, 34(4), 198–204.
22. Бобоев, Ш. Т., & Нурмухаммадов, Й. Н. (2024). Сравнение методов фиксации переломов пяточной кости. *Вестник СамГМУ*, 14(1), 49–55.
23. Taha, A., et al. (2022). Percutaneous fixation of calcaneal fractures using screw systems. *Asian Journal of Orthopaedics*, 9(3), 153–160.
24. Khurshidov, A. (2023). Experience in management of intra-articular fractures of calcaneus. *Tashkent Medical Journal*, 18(2), 25–30.
25. Руцкий, Д. С. (2022). Малоинвазивные методы остеосинтеза при травмах заднего отдела стопы. *Хирургия Урала*, 9(2), 70–74.
26. Böhler, L. (1931). Diagnosis, pathology and treatment of calcaneal fractures. *JBJS*, 13(1), 75–89.
27. Ahmad, M., & Hamid, R. (2020). Radiographic and functional evaluation after minimally invasive fixation. *Trauma Care International*, 7(2), 112–119.
28. Икрамов, Б. А. (2024). Применение остеосинтеза при сложных переломах пяточной кости. *Журнал практической медицины*, 5(3), 61–68.
29. Buckley, R., et al. (2014). Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures. *J Bone Joint Surg Am*, 96(18), 1524–1532.
30. Халилов, Д. Х. (2025). Ранняя функциональная реабилитация после остеосинтеза пяточной кости. *Вестник современной медицины Узбекистана*, 12(1), 15–22.