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# Evaluation of Long-Term Quality of Life Using the Foot and Ankle Outcome Score (FAOS) Questionnaire in Patients Treated by Minimally Invasive Reduction and Percutaneous Stabilization of Intra-Articular Calcaneal Fractures

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Statistical Analysis C  
Data Interpretation D  
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**Background:** Treatment of displaced intra-articular calcaneal fractures is controversial. Choosing the optimal surgical technique is very important for patient quality of life and activity. In this study, we asked the question: "What is the long-term quality of life of patients after intra-articular calcaneal fractures treated by minimally invasive reduction and percutaneous stabilization (MIRPS)?"





**Material/Methods:** We included 51 patients – 45 males (88%) and 6 females (12%) – who underwent MIRPS of intra-articular calcaneal fractures. The males were ages 22–63 years, with a mean age of 46 years, while the females were aged 31–63, with a mean age of 47 years. The FAOS (Foot and Ankle Outcome Score) survey was used.

**Results:** Women's FAOS scores were 72–95%, with a mean of 82%, and varied according to type of fracture, surgery method used, and comorbid fractures. Men's FAOS scores were 50–95%, with a mean of 84%, and varied according to type of fracture, surgery method used, and comorbid fractures.

**Conclusions:** According to set criteria regarding the FAOS scale, mainly good and very good results were observed in patients treated surgically for intra-articular calcaneus fractures using MIRPS. Westhues' method scored a significantly higher foot rating than W-R (Westhues'-Rapała method). Patients with TTF (tongue-type fracture) scored higher in the FAOS than patients treated with JDTF (joint depression-type fracture). In other cases, no significant differences were observed.

**MeSH Keywords:** **Calcaneus • Quality of Life • Surgical Procedures, Minimally Invasive**

**Full-text PDF:** <https://www.medscimonit.com/abstract/index/idArt/921602>

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## Background

Intra-articular fractures of the calcaneus are one of the most serious injuries to the musculoskeletal system [1], although they are relatively rare [2]. The selection of an appropriate surgical technique is still a topic of wide discussion, involving many local and systemic complications, the occurrence of which significantly affects patient quality of life [3]. Morphology can be characterized by many classifications, but additional fractures are crucial in predicting the results of treatment of articular fractures of the calcaneus [4]. The assessment of the results of treatment with various methods, including minimally invasive percutaneous stabilization (MIRPS) [5,6], is based primarily on the reconstruction of the changed anatomical conditions of the talocalcaneonavicular joint, as well as the recovery of the functional efficiency of the foot, which is obviously associated with altered gait performance [7,8]. We performed the present study because the available literature lacks in-depth reports describing changes in the quality of life of patients undergoing surgery due to articular fractures of the calcaneus, assessing their morphology, the chosen treatment method, and comorbid injuries [9–12].

Our aim was to evaluate the quality of life of patients who underwent MIRPS of intra-articular calcaneus fractures, depending on morphology, surgery method, and frequency of comorbid injuries, to answer the following questions:

1. What is the quality of life of patients treated with MIRPS due to displaced intra-articular calcaneal fractures?
2. Do comorbid injuries significantly influence patient quality of life?
3. Do the surgical technique and a fracture type affect patient quality of life?

## Material and Methods

The study was carried out from 1998 to 2014 in the Department of Surgery of Trauma and Orthopedics, 5<sup>th</sup> Military Hospital, with Policlinic Independent Public Health Care Centre in Cracow (5 WSzK). Patients were divided by sex, age, and Essex-Lopresti classification according to X-ray examination in lateral and axial views.

We included 51 patients – 45 males (88%) and 6 females (12%) – who underwent MIRPS of intra-articular calcaneal fracture and agreed to take part in long-term follow-up. At the beginning, there were 66 patients after MIRPS in the hospital's database, but 4 refused to take part in the research and 11 could not be contacted due to wrong/out-of-date contact details. The included males were ages 22–63 years with a mean age of 46 years, and the females were 31–63 years old with a mean age of 47 years. According to Essex-Lopresti

classification, 35 joint depression-type fractures (JDTF) were diagnosed among men (77%); 1 man had an open (type I according to Gustilo classification) joint depression-type fracture (2%) and 9 men (20%) were diagnosed with tongue-type fracture (TTF). Five women were diagnosed with JDTF (83%) and 1 was diagnosed with TTF (17%).

Eleven men had comorbid injuries, 10 with JDTF (22%) and 1 with TTF (2%). In the JDTF group, 1 patient (2%) had a distal radius fracture, 2 patients (4%) had undisplaced fracture of the lateral condyles of the tibia in the same limb, 2 patients (4%) had a proximal humerus fracture, 1 patient (2%) had a compression fracture of L1, 2 patients (4%) had a compression fracture of L3, and 2 patients (4%) had a fracture of S1. In the TTF group, 1 distal radius fracture was diagnosed (2%). Among men, the most common comorbid injury was L5 compression spine fracture (5 patients, 11%). No neurological complications were observed according to spine fracture. One patient was qualified for spine surgery before MIRPS of the calcaneus, and the rest of the comorbid fractures were treated conservatively without further complications.

Among females, 1 distal radius fracture was diagnosed in the TTF group, which also was treated conservatively. Comorbid fractures were diagnosed in 12 of 51 patients (24%). Surgical treatment of calcaneus fractures was by MIRPS.

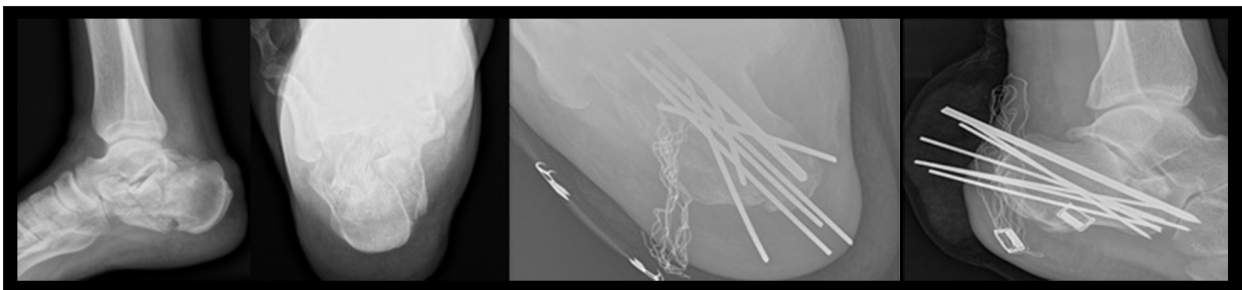
Twenty-seven (75%) men with JDTF were treated with modified by Rapała-Westhues' method (Steinmann's pins with additional Kirschner's wires stabilization, W-R), and 6 (17%) were treated by MIRPS only with K wires. Seven men with TTF (78%) were treated with Westhues' method and 2 (22%) were treated with W-R technique.

In females, 1 patient (100%) with TTF underwent treatment with Westhues' method. In the JDTF group, 3 (60%) women were treated with W-R method and 2 (40%) underwent MIRPS only with Kirschner's wires.

All included patients underwent surgery between the first and sixth day after the fracture occurred (delay mainly caused by local edema or blisters), and were immobilized with a lower leg cast until the operation. The surgery was performed by 2 different teams of surgeons (4 persons in various combinations, 2 surgeons per surgery) under subarachnoid or general anesthesia with antithrombotic prophylactics using low-molecular-weight heparins (LMWH) and antibacterial treatment using antibiotics (Cephalosporins-Cephazolin 1 g i.v.). Intraoperative X-rays were used (mainly lateral and axial view, sometimes Broden's view) to evaluate the subtalar joint surface during reposition and stabilization. The final decision about stabilization method was made during surgery, according to the surgeon's preferences and number of bone fragments, to obtain



**Figure 1.** TTF treated with Kirschner's wires bundle.



**Figure 2.** The JTDF treated W-R technique.

satisfactory and solid fixation. One patient who had an open fracture of the calcaneus received extended antibiotic therapy (7 days of Augmentin). Patients were discharged from the hospital 2–9 days after the surgery. All surgical patients were immobilized with a femoral cast for 4–5 weeks. After this time the radiological evaluation was taking place in lateral and axial view, then the Steinmann's pins and Kirschner's wires were removed, if bone union was satisfactory. After that, patients were given the lower leg cast for next 2–3 weeks. Patients received LMWH during the entire immobilization period.

During the observation period, 1 man (2%) had a JDTF local inflammatory reaction observed at the entry point of Kirschner's wires (1 week after wires removal), which subsided after empirical antibiotic therapy (Augmentin 2×1 g p.o. for 14 days). One patient after open fracture required admission to the hospital and additional debridement and antibiotic therapy for 14 days (Clindamycin 2×600mg p.o.) because of wound infection (11 days after surgery). After intervention, the infection subsided, full wound recovery was achieved by granulation within 3 weeks, and no deep infection or further complications were reported (Figures 1, 2).

Quality of life evaluation using FAOS questionnaire took place 4–8 years (mean, 6.5 years) after the fracture was treated with MIRPS. The healing process in all patients was completed, including rehabilitation. The patients were asked to complete the survey, then the results were put into the website

**Table 1.** The interpretation of the FAOS score.

Score	FAOS [%]
Very good	80–100
Good	60–79
Satisfactory	40–59
Poor	0–39

program to generate a percentage score (<http://orthotoolkit.com/faos/>) (Table 1).

For statistical evaluation, regression analysis was used. The influences of fracture type, comorbid fracture, and surgery method on FAOS score were investigated. The Mann-Whitney U test and ANOVA Kruskal-Wallis test were performed because of non-normal distribution. The results were considered statistically significant at  $p < 0.05$ . STATISTICA software (version 13.1) was used to process all the results.

## Results (Tables 2–4)

Based on the test, a statistically significant difference was observed in the results of the FAOS questionnaire depending on the type of fracture. Patients with a TTF had significantly higher scores than patients with JDTF.

**Table 2.** Average FAOS score according to fracture type and treatment method among women.

Fracture type/Surgery technique/ Comorbid fracture	Average FAOS [%] score
TTF*/Westhues' method	90.00
TTF/W-R** method	83.50
JDTF***/MIRPS# using Kirschner's wires	72.00
TTF+distal radius fracture/MIRPS using Kirschner's wires	95.00

\* Tongue-type fracture; \*\* Westhues-Rapata; \*\*\* joint depression-type fracture; # minimally invasive reduction and percutaneous stabilization.

**Table 3.** Average FAOS score among men according to type of fracture, surgery technique, and comorbid fractures.

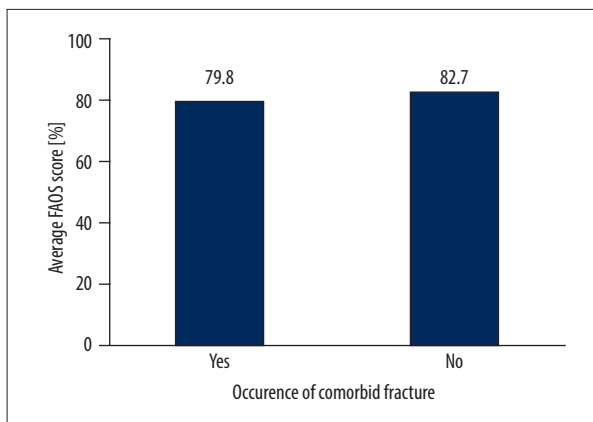
Type of fracture/Surgery technique/ Comorbid fracture	Average FAOS score [%]
TTF*/Westhues' method	86.60
TTF/W-R** method	75.00
JDTF***/Westhues' method	86.00
JDTF/W-R method	78.00
JDTF/MIRPS# using Kirschner's wires	79.60
JDTF+distal radius fracture/W-R method	86.00
JDTF+lateral condyles of tibia/W-R method	77.50
JDTF+proximal humerus fracture/W-R method	85.50
JDTF+compressive spine fracture L1/ W-R method	78.00
JDTF+compressive spine fracture L3/ W-R method	85.00
JDTF+compressive spine fracture S1/ W-R method	87.50

\* Tongue-type fracture; \*\* Westhues-Rapata; \*\*\* joint depression-type fracture; # minimally invasive reduction and percutaneous stabilization.

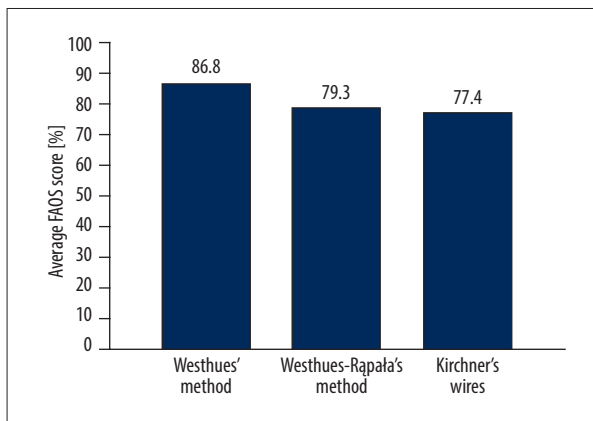
**Table 4.** Comparison of FAOS scores according to type of fracture.

Fracture	Average FAOS score	SD*	N**	Z***	p#
TTF##	83.6	12.6	10	2.0113	0.0443
JDTF###	79.7	9.4	41		

\* Standard deviation; \*\* number of patients; \*\*\* Mann-Whitney U test; # probability value; ## tongue-type fracture; ### joint depression-type fracture.



**Figure 3.** Average FAOS score according to occurrence of comorbid fracture in general. P value=0.0583.



**Figure 4.** Comparison of average FAOS score according to surgery technique. P value=0.0402.

Statistically significant differences were not observed in the results of the FAOS questionnaire depending on the comorbid fracture. An additional fracture tended to result in a slightly higher score on the foot/ankle assessment questionnaire, but the difference was not significant, probably due to the small sample size. A statistically significant difference was observed in the results of the FAOS questionnaire depending on the surgery technique, with Westhues' method scoring significantly higher than W-R method. In other cases, no significant differences were observed (Figures 3, 4).

According to the hospital's database, 2 men out of 66 patients after MIRPS underwent the subtalar arthrodesis, but we were unable to contact with them, which is why they were not included.

## Discussion

Men treated with W-R method with compression spine fracture of L1, L3, and S1 had slightly better FAOS scores, probably because the injury force was partly distributed to the vertebral body, causing less damage to joint cartilage of the calcaneus.

Unfortunately, the Essex-Lopresti classification does not divide the JDTF into specific sub-types, which may have affected our results. CT assessment of damaged structures gives better insight into the size of injuries and allows more precise classification of fractures [13,14]; for example, according to Sanders, fractures type III and IV have worse prognosis [15–17]. Without the abovementioned imaging examination, the Essex-Lopresti classification seems to be insufficient, which results in difficulties in characterizing patients who are at risk of worse functional or radiological results, which affects their quality of life, as confirmed by Swords et al. [18]. The worse results on the FAOS questionnaire in men treated with the W-R method who had additional fracture of the lateral condyle of the tibia can be explained by the axially acting force on the articular surfaces of the calcaneus, where only a small part of the energy is accumulated outside the heel and leads to non-dislocated lateral condyle fracture of the tibia. Good results were achieved by men diagnosed with JDTF of the calcaneus, treated with the W-R method, who additionally had upper-limb injuries such as distal radius fracture and proximal humerus fracture. This is caused by the accompanying fall on the upper limb, most often in a defensive position (elbow in extension, shoulder in flexion), which absorbs some energy and changes the distribution of forces acting on the articular surface of the calcaneus, which leads to less damage.

The choice of treatment of articular calcaneal fractures (percutaneous stabilization by Westhues method, W-R, or only with Kirschner's wire bundle) depends on the comminuted nature of the fracture. A high degree of fragmentation of the joint surface can also predict healing, local and systemic complications, and changes in quality of life. It is interesting that none of the patients scored 100% on the FAOS questionnaire, which shows the magnitude of problems that patients face after intra-articular calcaneus fractures.

Arand et al. [19] found that the long-term consequences of calcaneus fractures, which manifest in degeneration of the subtalar joints, also negatively affect physical activity and quality of life. Romeo et al. [20] reported reduced sports activities in patients after articular calcaneal fracture, which is reflected by the significantly worse results on FAOS questionnaire sections focused on heavy housework, sports, and recreation. Paradoxically, the occurrence of additional injuries in patients who had an articular calcaneal fracture seem to be a good prognostic factor, especially when they affect the spine and upper limbs. Open fractures have the worst prognosis because the energy of the injury gets outside, most often through the medial heel surface, thus resembling an "explosive fracture" [21].

The good and very good results on the FAOS questionnaire can also be explained by the structure of the survey itself, which focuses only on problems and issues related to the foot/ankle, without taking into account other anatomical areas. Although this "favors" patients with upper-limb and spine injuries, it confirms our theory of the distribution of energy acting on the musculoskeletal system.

Patients were asked about problems with other body systems, in particular when they had comorbid injuries, and none reported complaints except regarding the ankle/foot. Treatment of articular calcaneus fractures using the presented MIRPS techniques is useful and relatively cheap, especially for high-risk patients [22].

## Conclusions

1. According to set criteria regarding the FAOS scale, mainly good and very good results were observed in patients treated surgically for articular calcaneus fractures with MIRPS.
2. There was no statistically significant evidence that additional injuries affected patient quality of life.
3. Patients with TTF had significantly higher scores than patients with JDTF. Westhues' method scored a significantly higher foot rating than the W-R method. In other cases, no significant differences were observed.

## Conflict of interest

None.



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