

# Tibiotalocalcaneal arthrodesis in osteoarthritis deformation of ankle and subtalar joint – evaluation of treatment results

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# Abstract

## Background

Tibiototalcaneal arthrodesis (TTCA) is an increasingly used method of stiffening the ankle and subtalar joints in advanced degenerative deformities.

## Material and methods

The study group consisted of 19 men who were subjected to intramedullary and intra-osseous arthrodesis using an intramedullary nail. The average age of patients was 46 years (19–68). The main indication for surgical treatment was post-traumatic arthrosis 11 (58%). In the studied group of patients, clinical condition was assessed using the AOFAS classification, quality of life using the SF-12 scale, and assessment of pain intensity using the VAS scale. The above parameters were evaluated before surgery in the early (under 2 years), intermediate (from 2–5 years) and late (over 5 years) postoperative period.

## Results

Analysis of the results showed that the assessed clinical condition on the AOFAS scale improved from an average of 20.6 points before TTCA to 63.5 points after the procedure. The result was statistically significant ( $p < 0.0001$ ). Analyzing the results obtained using the SF-12 quality of life scale, a statistically significant increase was found. In the physical sphere of quality of life PCS-12 increased from 26.5 points to 44.2 points ( $p = 0.0004$ ) and in the mental sphere of quality of life MCS-12 from 46.1 points to 52.6 points ( $p = 0.030$ ). The intensity of pain ailments, assessed in the VAS scale, decreased in all three periods of postoperative observation (in the early period  $p < 0.05$ , in the intermediate period  $p = 0.23$ , and in the late period  $p < 0.05$ ), with the strongest analgesic effect (reduction of pain intensity by 4.3 points on the VAS scale) was observed in the early post-operative follow-up period.

## Conclusions

Tibiototalcaneal arthrodesis using an intramedullary nail causes a significant improvement in the clinical condition according to the AOFAS classification, enabling most patients to move independently, a significant improvement in the physical and mental quality of life assessed in the SF-12 scale and a significant reduction in the intensity of pain ailments assessed in the VAS scale, especially in the early postoperative period.

## Introduction

Tibiototalcaneal arthrodesis – TTCA is an increasingly used method of stiffening the ankle and subtalar joints, which dates back to the 19th century [1, 2]. Correction of the deformation of the distal end

of the tibia due to repeated surgery, avascular necrosis of the talus, rheumatoid arthritis (RA) and ankle arthroplasty failure remain a major challenge for the surgeon [3]. According to literature data, this problem may affect up to 25% of patients after surgery, for whom retrograde intramedullary nailing is one of the most beneficial solutions [3, 4].

Pseudarthrosis resection at the distal end of the tibia using TTCA and the use of autogenous or allogenic spongy bone determines restoration of the limb support function. Obtaining bone union at the distal end of the tibia enables patients to move independently, thus allowing to dispense with the wheelchair. The most common complications of TTCA include: shortening of the operated limb, persistent infection of the surgical wound (SSI – surgical site infection), lack of bone union and further persistence of pain in the operated area [4, 5]. Apart from the surgeon's skills, the independent factors of success of the applied method of surgical treatment include: reduced bone density due to osteoporosis and additional accompanying diseases such as diabetes, rheumatoid arthritis – RA, atherosclerosis and atherosclerosis obliterans (AO), causing impaired limb blood supply [6].

Properly performed tibiototalcalcaneal arthrodesis with radiologically confirmed synostosis does not always correlate with the improvement of the patient's quality of life, because the accompanying mobility disorders combined with anxiety about the further course of the disease significantly affect the quality of life of these patients in many aspects. The disease, especially chronic and progressive, affects the functioning of the sick person not only in the area of the disease and the therapeutic process, but also in terms of functioning in the patient's near and distant social environment. Therefore, in the treatment process, apart from achieving medical goals, an important role is played by improving the patient's quality of life. This is especially important in degenerative-inflammatory diseases. For a sick or disabled person, it is very often important to maintain the possibility of an active, independent life. Chronic diseases, including degenerative ones, affect the deterioration of the patient's functioning not only in the biological, but also in social, emotional, professional and spiritual aspect [7, 8].

## Aim Of The Study

The aim of the study was pre- and postoperative clinical evaluation in men with advanced osteoarthritis deformities of the ankle and subtalar joints treated with tibiototalcalcaneal arthrodesis using an intramedullary nail.

## Material And Methods

In the years 2008–2018, 32 tibiototalcalcaneal arthrodesis procedures were performed in the Department of Trauma and Orthopedics of the District Hospital of Orthopaedics and Trauma Surgery in xxxx with the use of ChM retrograde intramedullary nail with allogenic spongy bone from the Tissue Bank. The study group consisted of 19 (60%) men undergoing this surgery, aged 19 to 68 (average 46). Initial treatment of the ankle injury in the examined group of patients consisted of conservative treatment by plaster immobilization in 8 patients (42%), AO stabilization in 4 patients (21%), intramedullary stabilization in 3

patients (16%), AO stabilization combined with intramedullary method in 2 patients (10%) or external fixator in 2 patients (11%). All patients, regardless of the primary trauma treatment, were qualified for TTCA due to post-traumatic deformities. Indications for tibiocalcaneal arthrodesis were: post-traumatic changes – 11, trauma to the ankle joint – 9, numerous multiple sprains – 1, damage to the tibiofibular fibrosis – 1; (fig. no 1, 2a and 2b); avascular ankle necrosis – 6 (fig. no. 3 and 4), RA – 1 and idiopathic lesions – 1 (fig. no. 5 and 6).

In the examined group TTCA procedures were performed on the right side in 11 patients and on the left side in 8 patients. ChM titanium reverse tibia nails 200, 220, 230, 240 and 260 mm long and 10–11 mm in diameter were used in all patients. Screws 30, 50, 65 and 70 mm long were used for locking the nails, placed in the proximal and distal section in the frontal and sagittal plane. In 5 (26%) patients, in addition to bones from the Tissue Bank, due to inflammation of the operated area, STIMULAN preparation containing antibiotics (vancomycin and gentamycin) was used.

Following coexisting medical conditions were diagnosed in the operated patients: hypertension (4 patients), previous myocardial infarction (1 patient), history of pulmonary tuberculosis (1 patient), diabetes (1 patient) and RA (1 patient).

The examination was conducted in accordance with the Declaration of Helsinki (1964) and its protocol was approved by the Local Bioethical Commission of the Medical University of Silesia in Katowice, Poland. All qualified patients signed a written consent for participation in this study.

## **Assessment Of The Clinical Condition Of Patients**

In all operated patients, the functional state of the ankle joint was assessed using the AOFAS (The American Orthopedic Foot and Ankle Score), quality of life was assessed using the SF-12 scale (including physical sphere - Physical Health Component Score-12 (PCS-12) and the mental sphere - Mental Health Component Score-12 (MCS-12) and pain intensity was assessed using VAS (visual-analog scale), before and after the procedure - in the early period (under 2 years) – 6 patients, in intermediate period (2–5 years) – 6 patients and in late period (over 5 years) – 7.

## **Statistical analysis**

Statistical analysis of the obtained results was carried out using the Statistica v10 PL program. Statistical significance of differences between values of parameters, assessed before surgery and in individual periods of observation after procedure, was assessed using the Student's T test for dependent variables, after checking the assumptions about the normality of distributions using the Kolmogorov-Smirnov test. Differences for  $p < 0.05$  were considered statistically significant.

## **Results**

The assessment of the functional state of the ankle joint, according to the AOFAS classification, was carried out before the procedure in all 19 patients, in the early postoperative observation period (under 2 years) in 6 (32%) patients, in the intermediate observation period (2–5 years) in 6 (32%) and in the late postoperative period (over 5 years) in 7 (36%). In the whole group of patients, the functional condition of the operated ankle joint according to the AOFAS classification improved statistically ( $p < 0.05$ ) from  $20.8 \pm 20.0$  points before surgery to  $63.5 \pm 17.2$  points after TTCA (Table 1). Improvement of the functional state of the operated joint in all observation periods showed statistical significance compared to the baseline values, with higher improvement values, according to the AOFAS classification, 43.5 points and 44.0 points observed in the early (under 2 years) and late (over 5 years) observation period. The improvement value in the intermediate observation period (from 2 to 5 years) was lower and amounted 17.2 points. (Table 1).

Table 1

Comparison of the quantitative assessment of the functional state of the operated ankle joint (the number of points according to the AOFAS classification) in the studied group of patients before and after the pantalar arthrodesis using an intramedullary nail, in individual groups of patients with different postoperative observation periods.

Period of follow-up < 2 years no. = 6		Period of follow-up 2–5 years no. = 6		Period of follow-up > 5 years no. = 7		Total no. = 19
Before treatment mean $\pm$ SD	After treatment mean $\pm$ SD	Before treatment mean $\pm$ SD	After treatment mean $\pm$ SD	Before treatment mean $\pm$ SD	After treatment mean $\pm$ SD	Before treatment mean $\pm$ SD
24.5 $\pm$ 23.9	68.0 $\pm$ 13.5	18.8 $\pm$ 19.7	56.0 $\pm$ 3.0	19.3 $\pm$ 19.4	63.3 $\pm$ 14.9	20.8 $\pm$ 20.0
t = -5.50		t = -2.98		t = -8.63		t = 8.71
<b>p &lt; 0.05</b>		<b>p &lt; 0.05</b>		<b>p &lt; 0.05</b>		<b>p &lt; 0.05</b>

In the examined group of patients, 16 (84.2%) patients before the surgery used a wheelchair or two elbow crutches. This was due to the lack of limb supporting function (Table 2).

Table 2

Comparison of the qualitative assessment of the functional state of the operated ankle joint according to AOFAS classification in the examined group of patients before and after the pantalar arthrodesis procedure with intramedullary nail.

Function of joint	Before treatment	After treatment
	no. of patients (%)	no. of patients (%)
no restrictions on daily activities lack of support	3 (15.8)	15 (78.9)
limitation of daily activities (walking stick, crutches)	7 (36.8)	4 (21.1)
severe limitation of daily activities (wheelchair)	9 (47.4)	0 (0)
Foot positioning	Before treatment	After treatment
	no. of patients (%)	no. of patients (%)
well-positioned ankle-hindfoot	0 (0)	6 (31.6)
good positioning, slight deformations	3 (15.8)	12 (63.2)

In the whole group of examined patients, the quality of life, assessed on the SF-12 scale, improved statistically significantly, both in the sphere of physical quality of life, PCS-12 - from 25.8 points before surgery to 39.7 points after the TTCA procedure ( $p < 0.05$ ), as well as in the sphere of mental quality of life, MCS-12 - from 48.7 points before the procedure to 54.1 points after the TTCA procedure ( $p < 0.05$ ) (Tables 3 and 4).

The improvement in the quality of life in the physical sphere showed statistical significance compared to the baseline values in all periods of postoperative observation, with the highest value on the PCS-12 scale - 15.9 points observed at a late observation period (over 5 years) (Table 3). On the other hand, improvement in the quality of life in the psychological sphere in any of the analyzed observation periods did not show statistical significance compared to the baseline values (due to the insufficient number of individual patient subgroups), with the largest value on the MCS-12 scale - 10.6 points observed in the intermediate observation period (from 2 to 5 years) (Table 4).

Table 3

Comparison of the quality of life in the physical sphere (number of points on the PCS-12 scale) assessed using the SF-12 quality of life scale in the examined group of patients before and after the tibiototalcanal arthrodesis using an intramedullary nail, in individual groups of patients with different postoperative observation periods.

Period of follow-up		Period of follow-up		Period of follow-up		Total
< 2 years		2–5 years		> 5 years		no. = 19
no. = 6		no. = 6		no. = 7		
Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment
mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
25.0 ± 14.4	40.3 ± 12.6	27.0 ± 5.03	36.6 ± 11.0	25.5 ± 3.2	41.4 ± 12.3	25,8 ± 8.3
t = -2.98		t = -2.08		t = -4.05		t = -5.38
<b>p &lt; 0.05</b>		<b>p = 0.09</b>		<b>p &lt; 0.05</b>		<b>p &lt; 0.05</b>

Table 4

Comparison of the quality of life of the psychic sphere (number of points on the MCS-12 scale) assessed using the SF-12 quality of life scale in the examined group of patients before and after tibiototalcanal arthrodesis using an intramedullary nail.

Period of follow-up		Period of follow-up		Period of follow-up		Total
< 2 years		2–5 years		> 5 years		no. = 19
no. = 6		no. = 6		no. = 7		
Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment
mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
52.7 ± 7.0	52.9 ± 5.7	41.4 ± 13.4	52.0 ± 11.6	51.5 ± 7.0	54.5 ± 6.8	48.7 ± 10.1
t = -0.85		t = -1.70		t = -2.30		t = - 2.35
<b>p = 0.43</b>		<b>p = 0.15</b>		<b>p = 0.06</b>		<b>p &lt; 0.05</b>

In the whole group of examined patients, the intensity of pain ailments on the VAS scale decreased statistically significantly from 6.7 points before surgery up to 3.6 points after TTCA ( $p < 0.05$ ). The largest, statistically significant, decrease in the intensity of felt pain compared to baseline was found in the early observation period (under 2 years) after the procedure - from 7.3 points before surgery up to 3.0 points after TTCA ( $p < 0.05$ ), reduction of pain intensity in the late observation period (over 5 years after surgery)

was also statistically significant and amounted to 2.5 points on the VAS scale, while in the intermediate observation period (2–5 years after the procedure) the decrease in pain intensity was 2.6 points, but it did not show statistical significance (Table 5).

Table 5

Comparison of pain intensity assessed on the VAS scale in the group of examined patients before and after pantalar arthrodesis using an intramedullary nail, in individual groups of patients in different periods of postoperative observation.

Period of follow-up		Period of follow-up		Period of follow-up		Total
< 2 years		2–5 years		< 5 years		no. = 19
no. = 6		no. = 6		no. = 7		
Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment
mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
7.3 ± 3.0	3.0 ± 2.3	6.1 ± 3.8	3.5 ± 2.3	6.7 ± 3.7	4.2 ± 3.2	6.7 ± 3.6
t = 3.53		t = 1.37		t = -8.63		t = 4.236
<b>p &lt; 0.05</b>		<b>p = 0.23</b>		<b>p &lt; 0.05</b>		<b>p &lt; 0.05</b>

Following postoperative complications occurred in the examined group of operated patients: limb shortening in 16 (84.2%) patients with an average of 1.95 mm, infection of the operated area in 5 (26.3%), prolonged post-operative wound healing persisting for more than 6 months in 4 (21.1%), no deformation correction in 3 (15.8%), lack of bone union in 3 (15.8%), nail fracture in 2 (10.5%) and chronic swelling of the foot persisting for more than 6 months in 2 (10.5%) patients. In 5 (26.3%) patients it was necessary to continue the administration of analgesics, and 1 (5.3%) operated patient did not feel any improvement in pain intensity after the procedure (Table 6).

Table 6

List of complications following after tibiocalcaneal arthrodesis using an intramedullary nail in the examined group of patients.

Complications	no. of patients	%
shortening of the limb	16	84.2
infection of the operated area	5	26.3
pains requiring continued use of analgesics	5	26.3
prolonging healing period of the postoperative wound (over 6 months)	4	21.1
no deformation correction (varus)	3	15.8
lack of normal bone union	3	15.8
nail fracture	2	10.5
chronic swelling of the foot (over 6 months)	2	10.5
no reduction in pain intensity	1	5.3

Full bone union after TTCA (confirmed by radiography and CT scan) was obtained in 16 (84.2%) patients, who after the surgery gained full independence in movement. Only 4 (21.1%) patients after surgery used one elbow crutch. On the other hand, 15 (78.9%) operated patients were able to walk independently more than 600 meters, while only 1 (5.3%) patient could walk such a distance before surgery (Table 7).

Table 7

Comparison of the distance that can be covered by the patients themselves, before and after tibiototalcaneal arthrodesis using an intramedullary nail.

Distance of independent walking	Before treatment	After treatment
	no. of patients (%)	no. of patients (%)
> 600 m	1 (5.3)	15 (78.9)
400–600 m	3 (15.8)	4 (21.1)
100–400 m	9 (47.4)	0 (0)
< 100 m	6 (31.6)	0 (0)

## Discussion

Extensive degenerative deformations in ankle and subtalar joints caused by: traumatic injuries, failures after ankle joint replacement and avascular necrosis require surgical treatment characterized by ease of implementation, minimal invasiveness, low number of complications and a chance to restore the supportive function of the limb. Intramedullary tibiototalcaneal arthrodesis meets all of the above-mentioned criteria [9–11].

The analysis of the functional state of the ankle joint in the group of examined patients was based on the AOFAS classification, before and after intramedullary nail arthrodesis. Follow-up observation of patients was divided into three periods: under 2 years, 2–5 years and over 5 years after surgery. The functional state of the operated joint in examined patients during the observation period under 2 years significantly improved, expressed in the increase in the average number of points on the AOFAS scale from 24.5 to 68.0 ( $p < 0.05$ ). During the observation period of 2 to 5 years after surgery, the functional condition of the operated joint deteriorated slightly, and the average number of obtained points was 56.0. However, in the late observation period over 5 years after surgery, the functional condition of the operated joint was comparable to the early observation period, and the average number of points on the AOFAS scale in this period was 63.3. Only 4 (21.1%) of the operated patients after the TTCA procedure walked with one crutch. However, almost 80% of operated patients moved without the orthopedic equipment and were able to cover a distance of over 600 meters on their own.

Lee et al., in a group of 20 patients after performing tibiototalcalcaneal arthrodesis, obtained an improvement in the functional state of the ankle joint according to the AOFAS classification from an average of 54 to 76 points in the observation period of 28 months [10]. Whereas Ozer et al. using tibiototalcalcaneal arthrodesis with the AO method (proximal humerus) in a group of 8 patients obtained the functional state of this joint at an average level of 60 points in the AOFAS classification over an average follow-up of 2.5 years [5]. The authors of this work suggest that performing arthrodesis with a proximal brachial plate may be an alternative to intramedullary arthrodesis.

Muckley et al. evaluated, according to the AOFAS classification, a group of 55 patients who had 59 tibiototalcalcaneal arthrodesis using an intramedullary nail, obtaining 66.4 points during the follow-up period of 66 months [12]. The results of the assessment of the functional state of the ankle joint obtained in our study are comparable to this report.

In turn, Brodsky et al. in the material of 30 detachable stiffeners using an intramedullary nail obtained, in the average observation period over 2 years, a statistically significant increase according to the AOFAS classification with an average of 29.7 points up to 74.3 points. Such significant clinical improvement in the examined group of patients may result from proper correction of joint deformation conducted parallel to arthrodesis [11].

TTCA in combination with arthroscopic resection of damaged articular surfaces of the ankle and subtalar joints carries a lower number of septic complications [13]. In the available literature we can find examples of papers confirming the occurrence of a lower SSI frequency when TTCA is performed under arthroscopic control [9, 13]. On the other hand, arthrodesis performed under arthroscopic control is associated with a greater likelihood of lack of bone union.

Baumbach et al., comparing the results of arthroscopic arthrodesis performed by the open method in high-risk patients (patients with diabetes, limb ischemia and RA), showed that the frequency of achieving normal bone union of 75% and 67%, respectively, did not differ statistically significantly in both groups of patients. The incidence of complications in the group of patients treated with the open method was 63%,

mainly infections of the operated area (80%), while in patients treated by the arthroscopic method, the incidence of complications was almost half lower (33%) and in all cases it was the lack of bone union [13]. Hence, the choice of arthroscopic arthrodesis should be considered in cases of slight deformation, where it is enough to perform a resection of the damaged surface of articular cartilage without the need for extensive correction.

In the group of examined patients, who had tibiocalcaneal arthrodesis using an intramedullary nail, complete bone union was found in 16 (84%) patients. 18 (94.7%) procedures were performed using the open method, while using arthroscope 1 (5.3%). Shah et.al., in the mean follow-up period of 9 months, achieved full bone union in more than 80% of operated patients who had tibiototalcaneal arthrodesis using an intramedullary nail with additional fibular transplantation [6]. In turn, Ozer et al., performing the TTCA procedure using the AO method with the proximal humeral locking plate achieved bone union in 7 (87.5%) operated patients, 87% of the examined group were women [5]. Peterson et al., using the anatomical locking plate technique from the posterior access to obtain tibiototalcaneal arthrodesis, diagnosed lack of bone union in 22% of operated patients in the short term of observation [9]. However, Nikhil et al., in surgical treatment of severe stiff club foot with the use of an intramedullary nail, obtained bone union in all operated patients [14].

Wukich et al. compared the incidence of bone union in 117 patients operated with a retrograde intramedullary nail and divided them into 2 groups: patients with diagnosed diabetes and without diabetes. In the group of patients with diabetes, the authors diagnosed lack of bone union in 10 (16.39%) operated patients, while in the control group without diabetes, lack of bone union occurred in 14 (25%) operated patients [15]. Based on the results obtained in the authors' assessment, properly managed diabetes (with HbA1c levels up to 6%) does not increase the incidence of bone union in patients operated on using the TTCA method.

Pellegrini et al. showed in their work significant advantages of posterior access in the form of better visualization of the ankle and subtalar joints, high incidence of bone union (80.4%) and the presence of potentially better conditions for healing the postoperative wound due to no interference in vascularization [16].

It is currently believed that the choice of posterior access to the ankle joint may have an impact on obtaining better results in surgical treatment, taking into account the extensive scars occurring after repeated treatment with lateral and medial access [3, 9]. In the present study, performing open surgery for resection of damaged joint surfaces: anterolateral in 13 (68%) patients, antero-medial in 4 (21%) patients and posterior in 1 (5%) patient, we did not show any advantage. During the checkup of the examined group of patients, 16 (84%) operated patients had a shortened length of the operated limb, on average 1.95 mm.

Quality of life was another analyzed parameter in the examined group of patients. Health Related Quality of Life (HRQoL) research is widely used in medical practice and clinical research. Living with a chronic disease is often associated with redefining patient's physical abilities. A significant problem of patients

suffering from degenerative diseases are also emotional problems and depression, which affect both the physical and mental quality of life [8, 17, 18]. Comparing the quality of life before and after the TTCA, we observed a significant improvement in the quality of life in the operated patients, both in the physical sphere PCS-12 - with an average of 25.8 points up to 39.5 points and mental sphere MCS-12 - with an average of 48.7 points up to 54.1 points. The greatest improvement in the quality of life in operated patients in the physical sphere was noted in the late observation period (over 5 years), on the PCS-12 scale - 15.9 points, while in the psychological sphere in the intermediate observation period (from 2 to 5 years), on the MCS-12 scale - 10.6 points.

Brodsky et al. in the larger group of patients (30 patients) after the surgery, using SF-36 scale to assess the quality of life, observed its improvement with an average of 85.6 points up to 98.9 points [11]. Also Lee et al., using the SF-36 scale, found a significant improvement in the individual components of this classification [10].

Escudero et al. evaluated 10 patients during a follow-up period of at least one year after retrograde intramedullary nail fixation using allogeneic grafts at the site of extensive bone defects in the ankle and subtalar joints resulting from failures after ankle arthroplasty, using the SF-12 classification to assess quality of life, and obtained higher results compared to ours, both in terms of the PCS-12 component and the MCS-12 component [19].

Comparing the intensity of pain ailments in the examined group of patients before and after the TTCA, using the VAS scale, the greatest relief was observed in the early observation period (under 2 years) - with 7.3 points up to 3.0 points. In both later observation periods, the reduction in pain intensity had lower VAS scores. It seems that the reduction in the severity of pain may have been due to a change in biomechanics of the foot.

Lee et al., in a comparable group of patients who had tibiototalcalcaneal arthrodesis using an intramedullary nail during the observation period of 13–49 months, found a significant reduction in pain intensity on the VAS scale with an average of  $7.41 \pm 2.12$  points up to  $1.77 \pm 2.77$  [10].

In turn, Cabrera Mendez et al., in a group of 28 men with post-traumatic degenerative changes caused by gunshot injuries of the lower leg operated on with the use of a proximal shoulder plate for tibiototalcalcaneal arthrodesis, found a significant decrease in the intensity of pain, on average from 8.0 to 2.35 points on the VAS scale, over a minimum of 6 months follow-up [20].

By contrast, Brodsky et. al., in patients operated using pantalar arthrodesis using an intramedullary nail, observed a significant reduction of pain in the VAS scale before surgery from 6.5 to 1.3 in a follow-up period of over 2 years (26 months). Significant reduction in the intensity of pain in these patients was accompanied by recovery of the operated area.

Tibiototalcalcaneal arthrodesis often restores the supporting function of the limb, however, its implementation is associated with a relatively large number of complications. In the pre-operative

assessment regarding qualification for this procedure, in addition to the degree of deformation, the following should be taken into account: the state of arterial and venous vascularization of the limb, the presence of additional diseases and the degree of their control (diabetes, rheumatoid, neurological and psychiatric diseases), previous infections of the operated area, and it is important to know the patient's expectations and combine them with the skills and experience of an orthopaedic surgeon.

## Conclusions

1. Tibiotalocalcaneal arthrodesis surgical procedure causes significant improvement in the functional state of the operated ankle joint assessed by the AOFAS classification, allowing most patients to move independently.
2. Implementation of this treatment also induces significant improvement in physical and mental quality of life assessed using SF-12 scale and a significant decrease in the intensity of perceived pain assessed using VAS scale, particularly in the early post-operative period.

## Abbreviations

TTCA – tibiotalocalcaneal arthrodesis

SSI – surgical site infection

RA – rheumatoid arthritis

PCS – 12 – Physical Health Component Score

MCS – 12 – Mental Health Component Score

## Declarations

### Ethics approval and consent to participate

The examination was conducted in accordance with the Declaration of Helsinki (1964) and its protocol was approved by the Local Bioethical Commission of the Medical University of Silesia in Katowice, Poland (permission no.: KNW/100/08). All qualified patients signed a written consent for participation in this study.

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## Competing interests

The author's declare that there is no conflict of interests regarding the publication of this paper.

## Funding

Not applicable.

## Authors' contributions

TS – study design, data collection, data interpretation, manuscript preparation

BD – study design, data collection, data interpretation, manuscript preparation

JP – study design, data collection, data interpretation, manuscript preparation, literature search

KSz – data collection, data interpretation, manuscript preparation, statistical analysis

MP – data collection, manuscript preparation, literature search

DS – data collection, literature search

MB – data interpretation, manuscript preparation

PCz – data interpretation, manuscript preparation

BP – data interpretation, manuscript preparation

KW – data collection, literature search

GC – study design, data interpretation, manuscript preparation

RL – study design, data collection, manuscript preparation

LP – study design, data collection, manuscript preparation

BK – study design, data interpretation

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Not applicable.

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## Figures



**Figure 1**

43-Year-Old Patient K. Sz. with diagnosis of posttraumatic changes of ankle and subtalar joint.



A



B

**Figure 2**

A and B. 43-Year-Old Patient K. Sz. with diagnosis of posttraumatic changes of ankle and subtalar joint (after surgical treatment with intramedullary nail).



**Figure 3**

46-Year-Old Patient Cz. R. with diagnosis of avascular necrosis of ankle and subtalar joint.



**Figure 4**

46-Year-Old Patient Cz. R. with diagnosis of avascular necrosis of ankle and subtalar joint (after surgical treatment with intramedullary nail).



**Figure 5**

71-Year-Old Patient K.A. with diagnosis of idiopathic osteoarthritis changes of ankle and subtalar joint.



**Figure 6**

71-Year-Old Patient K.A. with diagnosis of idiopathic osteoarthritis changes of ankle and subtalar joint (after surgical treatment with intramedullary nail).