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# Effect of Total Ankle Arthroplasty and Ankle Arthrodesis for Ankle Osteoarthritis: A Comparative Study

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**Background:** Surgical methods in treatment of joint osteoarthritis (OA) aim at meeting the increasing expectations of people with active lifestyles. Ankle joint arthroplasty has been performed increasingly more often as an alternative to arthrodesis. The aim of this study was to compare arthrodesis and arthroplasty in the treatment of ankle osteoarthritis.





**Material/Methods:** The study involved 56 patients (45 males and 11 females) aged 21–72 years (mean 51) presenting with end-stage ankle OA: 29 patients (52%) underwent arthroplasty (Group A) and 27 patients (48%) underwent arthrodesis (Group B). Patients underwent surgery between 2004 and 2016 at a single clinical center. The observation period ranged from 6 to 150 months (mean 55 months). To assess the results of surgical treatment, quality of life (Health Assessment Questionnaire-HAQ, 12-Item Short-Form Survey-SF-12) and functional (American Orthopedic Foot & Ankle-AOFAS, Kofoed, Takakura) scores were used. For pain assessment, Visual Analog Scale was used (VAS).

**Results:** After the surgery, group A and B had a statistically significant improvement in the joint function and pain relief according to AOFAS (A: 32.6 to 68.2; B: 27.4 to 61.3), Kofoed (A: 31.8 to 68; B: 25.9 to 60.3), Takakura (A: 30.6 to 62.9; B: 25.4 to 49.3), and VAS scores (A: 7.28 to 4.14; B: 7.33 to 3.78) compared with preoperative scores. After the surgery, quality of life scores improved in both groups, for HAQ (A: 0.91 to 0.53; B: 1.34 to 0.56) and for SF-12 (A: 26.6 to 36.8; B: 25.6 to 38.0).

**Conclusions:** The comparison of total ankle arthroplasty and ankle arthrodesis in treatment of end-stage ankle osteoarthritis did not reveal any significant differences.

**MeSH Keywords:** **Ankle Joint • Arthrodesis • Arthroplasty, Replacement, Ankle • Osteoarthritis**

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## Background

Osteoarthritis is the most common cause of motor dysfunction in older people. The prevalence is reported to be 49.6% in the population above 64 years of age [1,2]. It is estimated that 2% to 4.4% of all OA cases are located in the ankle joint [3,4]. According to epidemiological data, only 7.2% of cases have an idiopathic origin. Degenerative changes in the ankle are usually a consequence of past injury [5].

Active lifestyle and growing health consciousness of society with strong expectations have challenged physicians to develop methods of treatment that improve affected ankle joint functioning. Arthrodesis has been the criterion standard for the treatment of advanced osteoarthritis of the ankle joint. The introduction of arthroplasty aimed to obtain a painless joint while maintaining its motor function, improving gait, and preserving function in adjacent joints. The appropriate qualification of patients is a challenge in total ankle arthroplasty (TAA).

Due to the small number of reports in the literature and the complexity of the surgical procedure, there is controversy regarding the clinical usefulness of performing ankle arthroplasty. Both arthroplasty and arthrodesis allow a significant reduction of pain in patients with advanced degenerative changes in the ankle joint. In addition, arthroplasty retains joint mobility. The main advantage of ankle arthrodesis is its durability. However, this durable outcome comes at the expense of joint removal, which results in changing the biomechanics of the foot and increased compensatory load on other joints, leading to their accelerated arthrosis [6,7].

The multiplicity of methods and implants used for arthrodesis and for replacement of the joint, as well as the small number of standardized operations that would be carried out under the supervision of a single medical center, limits the formulation of treatment guidelines for end-stage ankle OA [3,8].

The aim of this study was to evaluate the utility of arthrodesis and arthroplasty in the treatment of end-stage ankle osteoarthritis.

## Material and Methods

A retrospective study was performed comparing 2 methods of surgical treatment of end-stage arthrosis in the ankle joint – arthroplasty (group A) and arthrodesis (group B) – from May 2004 to June 2016 in the District Hospital of Orthopedics and Traumatology in Piekary Śląskie, Poland. The study involved a total of 56 patients: 11 women (20%) and 45 men (80%). Group A included 29 (52%; 27 males, 2 females) patients age 21–72 years (mean age, 51 years) and group B included 27

(48%; 18 males, 9 females) patients age 20–64 years (mean age, 51 years). The observation period ranged from 6 to 150 months (mean, 55 months): for group A, from 6 to 117 months (mean, 44 months); and for group B, from 6 to 150 months (mean, 67 months).

Trauma was the most common cause of arthrosis in the ankle joint. The distribution of comorbidities in both groups was statistically insignificant (Table 1). Patient body weight during surgery was 87 kg on average for group A and 86 kg on average in group B. Patients were qualified to the study according to established inclusion and exclusion criteria.

### Inclusion criteria:

- operations performed in a single medical center,
- diagnosed primary or secondary end-stage ankle arthrosis.

### Exclusion criteria:

- patients with cancer,
- patients with learning difficulties,
- patients withdrawing their consent or being non-compliant,
- smokers,
- active inflammatory process,
- patients with a history of infected wounds in the past 6 months,
- necrosis of the talus,
- patients who died within than 6 months after surgery,
- ankle valgus or varus deformity exceeding more than 10 degrees.

The treatment method was chosen and performed by foot and ankle surgeons experienced in both procedures. All patients underwent surgery under regional anesthesia in supine position and regional ischemia. The TAA surgery was done by anterior approach to the ankle joint. Salto Talaris® Total Ankle Prosthesis was implanted from 2012 to 2016 (n=11, 38%), AES Total Ankle endoprosthesis was used between 2006 and 2012 (n=11, 38%), and J&J Mobility Total Ankle Replacement was used between 2009 and 2012 (n=7, 24%). In ankle arthrodesis, open surgery was performed using Campbell (n=13, 48%) or Adams (n=14, 52%) technique, and the treatment was selected by the performing surgeon. The average time of surgery was 128,6 (min 80, max 180) min for group A, and 93 (min 60, max 150) min for group B. Number of days the patient was hospitalized from admission to discharge was on average 4,9 (min 4, max 9) days for group A, and 3,9 (min 3, max 9) days for group B. Patients were immobilized after the surgery in a below-the-knee cast (2 to 3 weeks for group A and 6 to 7 weeks for group B).

All patients filled out the evaluation questionnaires before surgery and during follow-up visits performed routinely at the orthopedic outpatient clinic. The quality of life scales

**Table 1.** Characteristics of the studied groups (frequency of occurrence).

	Type of treatment			
	Arthroplasty n=29		Arthrodesis n=27	
	Average	n	Average	n
<b>Gender (Men in%)</b>	93%	27	67%	18
<b>Indication for surgery</b>				
Idiopathic arthrosis	3%	1	26%	7
Post-traumatic arthrosis	86%	25	74%	20
<b>Rheumatoid arthritis</b>				
Comorbidities	10%	3	0%	0
Rheumatic diseases	14%	4	15%	4
Cardiovascular diseases	17%	5	33%	9
Respiratory system diseases	7%	2	4%	1
Metabolic diseases	28%	8	15%	4
Infectious diseases	0%	0	7%	2
Mental disorders	3%	1	4%	1

n – group size.

**Table 2.** Scales of functional evaluation of the foot.

Scale	Type of treatment				p
	Arthroplasty		Arthrodesis		
	Average	SD	Average	SD	
	n	29	n	27	
AOFAS before (max 100 points)	32.6	17.1	27.4	19.7	0.294
AOFAS after	68.2	17.2	61.3	18.7	0.160
Comparison before and after surgery	p<0.001		p<0.001		
AOFAS difference	35.6	19.9	34.0	24.8	0.787
Kofoed before (max 100 points)	31.8	19.0	25.9	14.7	0.196
Kofoed after	68.0	17.8	60.3	16.5	0.085
Comparison before and after surgery	p<0.001		p<0.001		
Kofoed	36.2	22.2	34.4	23.8	0.775
Takakura before (max 100 points)	30.6	15.4	25.4	18.9	0.263
Takakura after	62.9	15.4	49.3	15.2	0.002
Comparison before and after surgery	p<0.001		p<0.001		
Takakura difference	32.4	19.3	23.9	22.4	0.136

SD – standard deviation; p – significance level; n – group size.

(HAQ and SF-12), functional scales (AOFAS, Kofoed, Takakura) and the visual analog scale (VAS) for pain, were used for obtaining data. Functional scales included subjective and objective information about pain, function, and alignment. Scores ranged from 0 to 100, with healthy ankles receiving a maximum

of 100 points. The Visual Analog Scale (VAS) is a 10-cm line where the left end is determined by the lack of pain and on the right end by extreme pain. The 12-item Short-Form Survey is a general health questionnaire in which 2 summary scores are reported: a mental component score (MCS) and a physical

**Table 3.** Assessment of quality of life – HAQ scale.

Scale	Type of treatment				p
	Arthroplasty		Arthrodesis		
	Average	SD	Average	SD	
	n	29	n	27	
HAQ before	0.91	0.47	1.34	0.46	0.001
HAQ after	0.53	0.49	0.56	0.42	0.827
Comparison before and after surgery	p<0.001		p<0.001		
HAQ difference	0.38	0.37	0.78	0.46	<0.001

SD – standard deviation; p – significance level; n – group size; HAQ – Health Assessment Questionnaire.

**Table 4.** Assessment of quality of life – SF-12 scale.

Scale	Type of treatment				p
	Arthroplasty		Arthrodesis		
	Average	SD	Average	SD	
	n	29	n	27	
SF-12 before (PCS)	26.6	7.29	25.6	6.76	0.591
SF-12 after (PCS)	36.8	9.41	38.0	9.54	0.631
Comparison before and after surgery	p<0.001		p<0.001		
SF-12 difference (PCS)	10.2	9.95	12.4	10.3	0.411
SF-12 before (MCS)	43.3	9.74	35.7	13.4	0.014
SF-12 after (MCS)	47.4	9.25	42.9	12.0	0.119
Comparison before and after surgery	p=0.012		p<0.001		
SF-12 difference (MCS)	4.08	7.68	7.21	8.86	0.163

SD – standard deviation; p – significance level; n – group size; SF-12 – 12-Item Short-Form Survey; PCS – Physical Health Summary Scales; MCS – Mental Health Summary Scales.

component score (PCS). The average PCS-12 and MCS-12 scores in the United States population are both 50 points. The Health Assessment Questionnaire was developed to assess difficulty in performing activities of daily living and is widely used in all fields of medicine. The scores range between 0 and 3.0, and increasing scores indicate worse functioning. Data were collected and stored in Excel (Microsoft) spreadsheets. Subsequently, it was analyzed to assess differences in the results of treatment of patients with end-stage ankle osteoarthritis. Ethics approval for this study was obtained from our Local Ethics Committee.

**Statistical analysis**

Statistical analysis was performed using Statistica 10.0 PL software. Descriptive statistics included average and standard deviation. Normality of distribution and homogeneity of variance were tested with Shapiro-Wilk and Levene test, respectively. For comparison between groups, the t test for independent samples or the t test with independent estimation of variance

was used. The Mann-Whitney U test was used for non-parametric data. The Wilcoxon test and t test for dependent sample were used for analysis in time. Spearman test was used to assess correlation. The confidence level was set at 95%.

**Results**

The study compared the results of 2 different operative treatments by means of evaluation questionnaires before and after surgery. The commonly used scales assessing the functionality of the foot were used, namely AOFAS, Kofoed, and Takakura. All showed a significant improvement after the surgery with the exception of Takakura’s questionnaire, where the results in group B were significantly poorer compared to group A (Table 2).

To assess the quality of life of treated patients, the HAQ and SF-12 evaluation forms were used. Assessments were divided

**Table 5.** Visual analog scale for pain assessment (VAS).

Scale	Type of treatment				p
	Arthroplasty		Arthrodesis		
	Average	SD	Average	SD	
	n	29	n	27	
VAS before surgery	7.28	1.58	7.33	1.44	0.888
VAS after rehabilitation	4.14	2.21	3.78	2.33	0.553
Comparison before and after surgery	p<0.001		p<0.001		
VAS difference	-3.28	2.76	-3.56	2.59	0.698
VAS before surgery	7.28	1.58	7.33	1.44	0.888
VAS during last follow-up visit	3.55	1.88	2.81	2.40	0.205
Comparison before and after surgery	p<0.001		p<0.001		
VAS difference	-3.72	2.56	-4.52	2.71	0.264

SD – standard deviation; p – significance level; n – group size.

**Table 6.** Complications after surgery in the examined groups of patients.

Scale	Type of treatment				p
	Arthroplasty		Arthrodesis		
	Average	SD	Average	SD	
	n	29	n	27	
Periodic pain during the observation period	48%	14	59%	16	0.420
Patient subjective feeling of a reduced ROM	17%	5	4%	1	0.108
Edema during the observation period	14%	4	26%	7	0.263
Instability during the observation period	17%	5	0%	0	0.024
Prolonged healing of the postoperative wound	3%	1	0%	0	0.353

n – group size; p – significance level.

into 2 aspects: physical and mental. There was a clearly lower preoperative assessment score in the HAQ questionnaire in group B compared to patients in group A (p=0.001) and a comparable assessment after surgery in both groups. In the SF-12 questionnaire, the result of physical assessment was comparable and improvement after surgery in both groups was noticeable. In mental assessment, a significantly lower quality of life was noted in the group of patients before arthrodesis of the ankle joint, but after the procedure the results were higher and comparable (Tables 3, 4).

Pain intensity assessment was evaluated. The obtained results were quite comparable. Pain intensity decreased after surgery and this decrease was greater in group B both after rehabilitation (4 to 6 months after surgery) and at the last control visit, but the differences were statistically non-significant (Table 5).

We found no statistically significant differences between implanted type of total ankle endoprosthesis and final outcome

in the abovementioned scales (HAQ, SF-12, AOFAS, Kofoed, Takakura, and VAS) (p<0.5). Also, comparing both types of arthrodesis surgical techniques did not reveal differences among them (p<0.5).

During the last follow-up visit in the clinic, the patients were asked whether they would have decided again to have that surgery. In group B, 24 people (89%) said they would definitely decide to undergo the procedure again, and 3 patients (11%) were not sure. In group A, 22 patients (76%) would decide to undergo the procedure again, 4 persons (14%) would not agree, and 3 patients (10%) were unsure.

Complications were mainly related to periodic pain (n=30; 53.5%) and edema of the operated joint and foot (n=11; 19.6%). Instability of the ankle (n=5; 8.92%), limitation of the range of motion (n=6; 10.71%), and prolonged healing of the surgical wound (n=1; 1.78%) were also reported (Table 6).



In our study, 14% of TAA patients required revision after arthrodesis (56 months after surgery on average) and 10% required replacement of the polyethylene insert (21 months after surgery on average). After arthrodesis, 11% of patients required revision due to nonunion.

## Discussion

Although ankle arthroplasty has been performed for almost 50 years, due to inconsistent results, it is not deemed superior to arthrodesis. The first TAA outcomes, published in 1972, were unsatisfactory due to imperfect implants [9]. Over the following years many improvements were made, including new generations of implants, novel medical technologies and biomaterials, and a better understanding of ankle biomechanics [10,11].

Results of this study show that there is no significant advantage of one operational method over the other in surgical treatment of end-stage ankle osteoarthritis. Many publications arrive at similar conclusions. Latham and Lau compared data from numerous medical centers in Canada, and concluded that mid-term outcomes did not differ between arthroplasty and arthrodesis, while the former carried a greater risk of complications and revisions [12]. Similar conclusions were drawn by Kim et al. [13].

Clinical evaluation of the ankle is based on measurements quantified by standardized scales assessing joint function (AOFAS, Kofoed, Takakura), pain intensity (VAS), and quality of life (HAQ, SF-36, SF-12) [14]. Their low number greatly facilitates their comparison when outcomes are recorded by many centers performing the abovementioned operations. The AOFAS scale is the most commonly used scale to assess the function of the foot and ankle. According to the AOFAS and Kofoed score, our study did not identify an advantageous method in terms of final functional results. The comparison of functional improvement between the 2 methods was statistically insignificant for both scales ( $p=0.787$  on the AOFAS scale and  $p=0.775$  on the Kofoed scale). Braitto et al., Schuch et al., and Haddad et al. reached similar conclusions in their works assessing medium- and long-term results after arthrodesis and arthroplasty of ankle joint using the AOFAS scale [15–17]. In turn, Jastifer et al. described a significant difference in the mobility of the foot 12 months after TAA, which resulted in a higher AOFAS score compared to arthrodesis outcome [18]. Significant long-term improvement in Kofoed scores after ankle joint replacement was reported by Frigg et al. [19]. Anderson et al. noted a satisfactory Kofoed score in patients after arthrodesis of the ankle joint [20]. When assessing patients with the Takakura questionnaire, we found a significantly lower functional estimation after arthrodesis compared to endoprosthesis ( $p=0.002$ ). Unfortunately, lack of available references for this score in the

literature regarding ankle arthrodesis, as well as insufficient number of TAA assessments, constrains the interpretation of our results. However, it may be assumed that the observed difference is related to a greater emphasis on mobility and function in the Takakura questionnaire in contrast to painful ailments as in the Kofoed scale, or to foot pain congruence, as in the AOFAS scale.

One of the most important goals of arthroplasty and arthrodesis of the ankle joint is to reduce pain in patients with degenerative changes. Currently, the most commonly used scale for pain intensity evaluation is the VAS scale. Braitto et al. showed a significant reduction in pain after TAA (from 8.4 to 3.3 points) and after arthrodesis (from 8.1 to 2.6 points) [15]. Similar results were obtained by Jastifer et al. ( $p<0.05$  for both groups before and after treatments) [18]. Results of our study regarding the VAS scale are comparable. We recorded a significant decrease in pain in both groups of patients, while the difference in pain relief between the groups was statistically insignificant.

There is very scant literature on the quality of life of patients after arthroplasty and arthrodesis of the ankle joint. According to our study, both scales showed a significant improvement in the studied groups, which agrees with Kwon et al., who used the QWB (Quality of well-being index) questionnaire to assess quality of life [21]. On the HAQ scale, the quality of life in patients before arthrodesis was significantly lower than in patients before TAA (1.34 to 0.91 points). However, after the surgery, the results were significantly improved and were comparable. In the SF-12 PCS questionnaire, the improvement after surgery was comparable for both groups. In the SF-12 MCS scale, the patients' scores before endoprosthesis surgery were significantly higher than that before arthrodesis (43.3 to 35.7), but after the surgery, the results were comparable ( $p=0.119$ ). Usulli et al. showed that SF-12 PCS increased from 34.3 to 45.4 points 12 months after ankle endoprosthesis, while MCS scores increased from 39.8 to 51.4 [22]. Those results are similar to ours. Saltzman et al., using the SF-36 scale, obtained results that are comparable with previous results [23].

An important factor determining the result of the performed procedure is the subjective evaluation of satisfaction by the patient. In a study by Schuha et al., 85% of patients after arthrodesis of the ankle joint and 86% after arthroplasty were satisfied or very satisfied with the procedure [16]. Kamrad et al. found that 71% of patients were satisfied after TAA [10]. We obtained comparable results with only 4 (15%) patients out of 27 who would not have decided to undergo the TAA procedure again given their experience. In the arthrodesis group, none of the patients denied the purposefulness of the procedure.

According to SooHoo et al., the number of revision procedures 5 years after surgery is 23% for TAA and 11% for arthrodesis [24].

Criswell et al. recorded a much higher rate of revisions after arthroplasty; in a group of 41 patients, 16 (39%) underwent revision surgery after an average of 4 years. The authors have associated this increased number of complications after TAA with a quite flat learning curve [25]. The low revision rate for total ankle replacement in our study (14%) may be due to the fact that surgical procedures were performed by experienced surgeons. In contrast, Lawton et al. found a relatively high rate of complications in patients after arthrodesis (26.9%) compared to arthroplasty (19.7%). However, the revision rate after arthroplasty was higher (7.9%) than after arthrodesis (5.4%) [26].

Currently, arthrodesis is still the most common method of surgical treatment in advanced degenerative changes of the ankle joint, and scientific publications do not prove the superiority of arthroplasty over arthrodesis. The complexity of arthroplasty, its cost, the time required, hospitalization time, and the flat learning curve do not favor this treatment in public hospitals [27–29]. There is still no clear indication in the literature about which treatment method is best. A full and reliable

comparative assessment of the 2 methods of surgical treatment of advanced degenerative changes in the ankle joint will be possible only after a minimum 10-year observation period. There are many scores and questionnaires used in the literature for comparing both groups that are unmatched by the small number of patients undergoing surgery. The major challenge to performing a reliable comparison is gathering sufficient data.

## Conclusions

Analysis of treatment outcomes did not reveal significant differences between total ankle arthroplasty and ankle arthrodesis. The lack of superiority of the far more complex arthroplasty may favor arthrodesis. The most common complication after ankle joint arthroplasty and arthrodesis is intermittent pain.

## Conflicts of interest

None.

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