

Total ankle arthroplasty versus ankle arthrodesis. Comparison of sports, recreational activities and functional outcome

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Abstract

Purpose Ankle arthrodesis (AAD) and total ankle replacement (TAR) are the major surgical treatment options for severe ankle arthritis. There is an ongoing discussion in the orthopaedic community whether ankle arthrodesis or ankle fusion should be the treatment of choice for end stage osteoarthritis. The purpose of this study was to compare the participation in sports and recreational activities in patients who underwent either AAD or TAR for end-stage osteoarthritis of the ankle.

Methods A total of 41 patients (21 ankle arthrodesis /20 TAR) were examined at 34.5 (SD18.0) months after surgery. At follow-up, pre- and postoperative participation in sports and recreational activities has been assessed. Activity levels were determined using the ankle activity score according to Halasi et al. and the University of California at Los Angeles (UCLA) activity scale. Clinical and functional outcome was

assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score. The percentage of patients participating in sports and recreational activities, UCLA score and AOFAS score were compared between both treatment groups.

Results In the AAD group 86% were active in sports preoperatively and in the TAR group this number was 76%. Postoperatively in both groups 76% were active in sports (AAD, $p=0.08$). The UCLA score was 7.0 (± 1.9) in the AAD group and 6.8 (± 1.8) in the TAR group ($p=0.78$). The AOFAS score reached 75.6 (± 14) in the AAD group and 75.6 (± 16) in the TAR group ($p=0.97$). The ankle activity score decrease was statistically significant for both groups ($p=0.047$).

Conclusions Our study revealed no significant difference between the groups concerning activity levels, participation in sports activities, UCLA and AOFAS score. After AAD the number of patients participating in sports decreased. However, this change was not statistically significant.

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Introduction

End-stage ankle osteoarthritis (OA) is a debilitating condition that results in functional limitations and a poor quality of life [1].

Ankle arthrodesis and total ankle replacement (TAR) are the major surgical treatment options for ankle arthritis [2–7]. There is an ongoing discussion in the orthopaedic community whether ankle arthrodesis or ankle fusion should be the treatment of choice for end stage osteoarthritis [8]. The relative benefits of total ankle arthroplasty and ankle fusion

continue to be one of the most debated topics in foot and ankle surgery. Proponents for each procedure advocate their point of view very strongly, but most of the information is anecdotal and based on personal experience [9]. There are pros and cons for both procedures.

Total ankle replacement is claimed to restore ankle kinematics whereas arthrodesis is thought to affect the kinematics of the tibiotalar joint and therefore restricts gait patterns [10–12]. After ankle arthrodesis the total mobility of the foot relative to the lower leg decreases by 70% in the sagittal plane [13]. Since *in vitro* studies have demonstrated that ankle arthrodesis has a higher impact on kinematics than total ankle replacement in terms of range of motion and movement transfer, it is deduced that ankle arthrodesis leads to functional limitations. In fact, range of motion in the frontal, sagittal and transversal plane is almost normal with total ankle replacement irrespective of two- or three component prosthetic design [10]. Controversially, there are recommendations that ankle arthrodesis should be performed in the young and active patient whereas TAR should be performed in patients with low functional demands [14, 15].

Patients suffering from post-traumatic ankle OA are often younger and report high levels of physical and sports activity earlier in their lives [16].

There are several studies that emphasise the effect of tibiotalar fusion on the adjacent joint degeneration. On the other hand, we have yet to read reliable data on the durability of ankle prostheses in young patients with high functional demands.

Despite these observations there is no study to date comparing activity levels and sports activities of patients who have undergone these procedures.

The ability to participate in sports activities leads to a higher satisfaction of sports medicine patients. Hence, the ability to perform sports activities can be considered a valid indicator of functional improvement.

Many researchers have investigated the return to sports and the level of sports activity after total joint replacement and joint preserving surgery for the treatment of osteoarthritis [16–25].

However, to the best of our knowledge this is the first study to focus on sports and activity levels in patients after ankle arthrodesis and to compare those results with patients undergoing TAR. Therefore, the purpose of our study was (1) to compare preoperative and postoperative participation in sports and recreational activities, (2) to assess levels of habitual physical activity, and (3) the functional outcome and satisfaction of patients who underwent either ankle arthrodesis or TAR for the treatment of end-stage osteoarthritis of the ankle joint.

We hypothesized that TAR may improve participation in sports more than ankle arthrodesis since some authors argue that arthroplasty restores the natural kinematics to a higher degree than ankle arthrodesis.

Material and methods

Study design

Between 1998 and 2006, 63 patients who suffered from end-stage osteoarthritis of the ankle joint, that failed conservative management (e.g. intraarticular corticoid injections, oral NSAIDs, orthotics), underwent surgical treatment. In 35 patients the joint was fused and in 28 patients total ankle replacement (TAR) was performed. Forty-one patients (21 ankle arthrodesis/20 TAR) were included in this retrospective analysis. Exclusion criteria were non-union (3) and additional procedures (1) in the arthrodesis group. In addition, seven patients did not wish to participate at follow-up. In the TAR group exclusion criteria were revision surgery (2) and secondary fusion (2). Again, three patients did not participate at follow-up. TAR was performed using the three-component uncemented Hintegra® prosthesis (Newdeal SA, Lyon, France). For ankle fusion three 7.3-mm cannulated self-cutting cancellous compression screws (Synthes GmbH, Salzburg, Austria) were inserted across the joint under fluoroscopic visualisation. Both the ankle arthrodesis and the total ankle replacements were performed by a single fellowship-trained foot and ankle surgeon (H.J.T.).

In the arthrodesis group there were eight male and 12 female patients with a mean age of 63.8 years±11.1. The mean body mass index (BMI) of the patients of this group was 28.0±4.0 and average follow-up was 30.0±22.0 months. The TAR group consisted of 11 male and ten female patients with a mean age of 56.2±10.5 years. Mean BMI for this group was 27.3±3.5 and the average follow-up was 39.0±17.0 months. There was no statistically significant difference in the demographic parameters between the groups (Table 1).

Outcome measures

The questionnaire inquired about the patient's overall satisfaction with surgery (1 = very satisfied, 2 = satisfied, 3 = fair, 4 = unsatisfied).

The sports and activity questionnaire ascertained patient's preoperative and postoperative engagement in 15 different sports and recreational activities (tennis, soccer, skiing, swimming, hiking, rowing, dancing, cycling, Nordic walking, cross country skiing, gymnastics, ice skating, horse riding, running, hand ball).

Table 1 Demographics of the patients and the results of AOFAS score, UCLA score and postoperative patient's satisfaction

Variable	Arthrodesis	Total ankle replacement	<i>p</i> -value
Age (mean; SD)	63.8 (11.1)	56.2 (10.5)	
Gender (male/female)	8/12	11/10	
UCLA score (mean; SD)	7.0 (1.9)	6.8 (1.8)	0.783
AOFAS score (mean; SD)	75.6 (14.0)	75.6 (16.0)	0.972
Satisfaction			
Very satisfied	80%	76%	
Satisfied	5%	10%	
Fair	10%	14%	
Poor	5%	0%	

UCLA University of California at Los Angeles, SD standard deviation, AOFAS American Orthopaedic Foot and Ankle Society

Patients could name other disciplines in a free text section. This data was recorded prospectively.

Preoperative sports participation was defined as participation in activities within the past year before surgery [19].

Pre- and postoperative sports participation was also assessed using the ankle activity score according to Halasi et al. [26]. This ankle-specific activity score is based on the Tegner score that was developed to evaluate activity levels in patients suffering from ligamentous injuries of the knee [27]. Halasi et al. modified the score described by Tegner and Lysholm by adding new kinds of sports and addressing differences between knee and ankle biomechanics. The score is tested for validity and sensitivity [28].

Postoperative activity levels were determined using the University of California at Los Angeles (UCLA) activity scale [29]. The UCLA scale is a simple scale ranging from 1 to 10. The patient had to indicate her or his most appropriate activity level, with level 1 defined as “no physical activity, dependent on others” and level 10 defined as “regular participation in impact sports”.

Clinical and functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score [30]. This outcome measurement assesses pain, function, hindfoot motion, and alignment. The maximum score is 100 points.

The study was performed with the approval of the Research Ethics Board of our institution, and all participants signed an informed consent form prior to inclusion.

Statistics

Statistical analysis was performed using SPSS Version 16.0 for Mac (SPSS Inc, Chicago, Illinois). Data were compared using paired student's *t*-test and analysis of variance (ANOVA). Correlations were performed using Pearson's correlation coefficient (*r*).

Results

Sports activities

In the arthrodesis group 18 patients (90%) were active before operation and 15 patients (75%) were active after surgery. Three patients ceased activity after surgery. In the TAR group preoperatively 18 patients (86 %) were active in sports surgery and 16 patients (76%) were active after surgery (Table 1). There was no statistically significant intergroup difference with respect to the percentage of patients participating in sport either preoperatively or postoperatively. Nor was the decrease of patients participating in sports statistically significant for any group.

The most common sports and recreational disciplines in the arthrodesis group were cycling (61%), swimming (55%), hiking (45%), skiing (35%) and tennis (15%) preoperatively and cycling (45%), swimming (45%), hiking (25%), nordic walking (20%) and skiing (15%) after surgery. In the TAR group the most common activities before surgery were skiing (67%), cycling (48%), swimming (38%), hiking (38%) and gymnastics (24%). After surgery the most commonly performed activities were cycling (48%), hiking (43%), skiing and swimming (both 38%), and gymnastics (19%). The other activities remained the same. (Fig. 1)

No significant difference could be determined concerning type of activity between the groups or between the pre- and postoperative state.

In the arthrodesis group patients participated in 14 different disciplines preoperatively and in nine different disciplines after surgery. Patients of the TAR group performed 13 different sports disciplines before surgery and ten different disciplines after surgery.

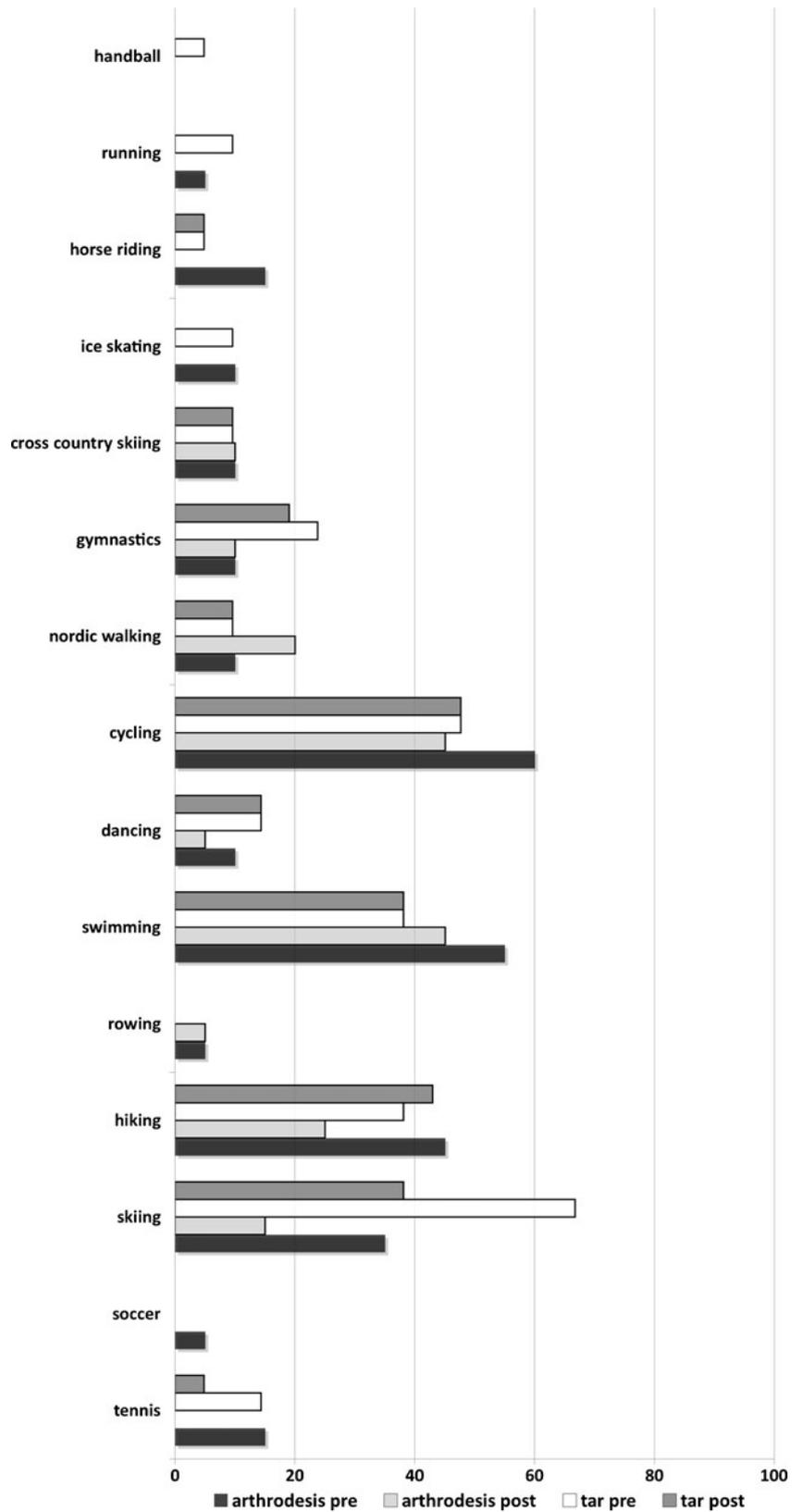
The percentages of patients participating in different sports and recreational disciplines are presented in Fig. 1.

Activity levels

According to the UCLA scale, there was no statistically significant difference in the activity level between the arthrodesis group (7, SD 1.9) and the TAR group (6.8, SD 1.8) at follow-up. There was no correlation between the UCLA scale and the AOFAS score for either the arthrodesis or the TAR group ($r < 0.7$) (Table 1).

The ankle activity score according to Halasi et al. was 4.5 (SD 2.8) for the arthrodesis group preoperatively and decreased to 3.1 (SD 1.7) at follow-up. In the TAR group the score decreased from 4.7 (SD 2.3) to 3.3 (SD 2.7). Analysis of variance revealed statistically significant difference for the changes ($p = 0.047$) (Fig. 2). Preoperatively, six patients (30%) of the arthrodesis group participated in sports activities ranked in categories in the upper half of the ankle

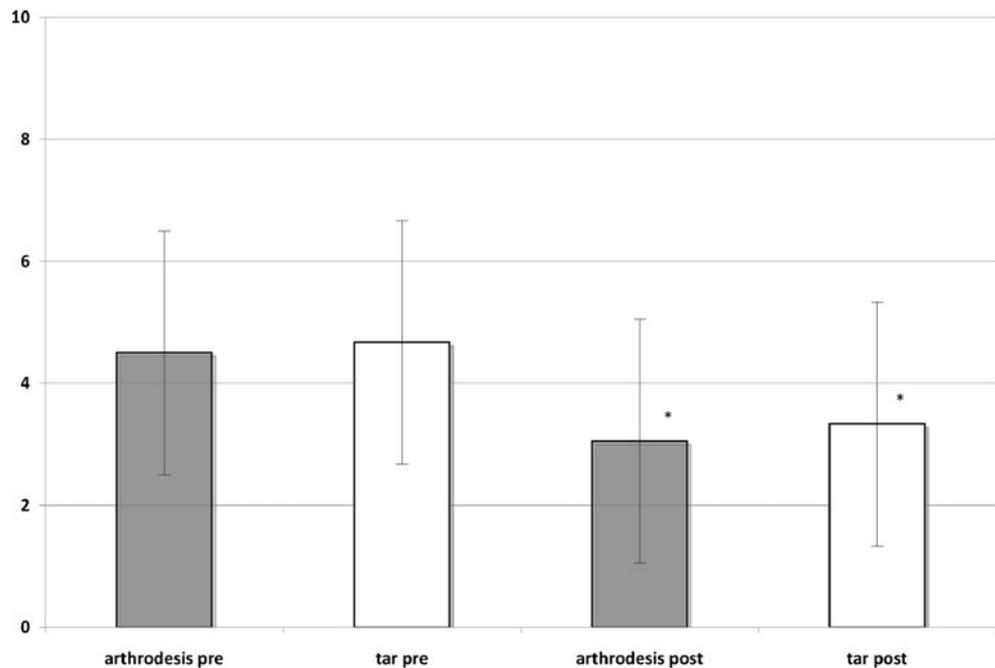
Fig. 1 Percentage of patients participating in different sports activities before and after reconstructive surgery for end stage osteoarthritis of the ankle



activity score. In the TAR group nine patients (42.9%) participated in those activities. After surgery, the percentage of patients participating in activities of the upper half of the

ankle activity score decreased for both groups. In fact, there were three patients (15%) in the arthrodesis group and six patients (28.6%) in the TAR group who took part in

Fig. 2 Results of the ankle activity score according to Halasi et al. The error bars indicate the standard deviation (SD) and the star (*) indicates statistically significant difference



activities of the upper half of the score. Statistical analysis did not reveal significance for this trend ($p=0.211$).

Clinical outcome

In the arthrodesis group 16 patients (80%) were very satisfied with the operation, one patient (5%) was satisfied with the operation, for two patients the result was fair (10%), and one patient (5%) was unsatisfied with the operation. The unsatisfied patient participated in sports before as well as after surgery. Sixteen patients of the TAR group were very satisfied with the operation (76%), two patients (10%) were satisfied, for three patients the result was fair (14%), and none of the patients was unsatisfied with the operation (Table 1). There was no statistically significant difference in the satisfaction of the operation between the groups. Also, no significant correlation could be found between the UCLA rating scale and patients' satisfaction.

The mean AOFAS score of the arthrodesis group was 75.6 (SD 14) for the arthrodesis group and 75.6 (SD 16) for the TAR group (Table 1). There was no statistically significant difference between the groups ($p=0.972$).

The subscores of the AOFAS regarding pain, function and alignment did not reveal statistically significant differences. The mean subscore for pain was 35.8 (SD 6.9) for the AAD group and 31.8 (SD 8.5) for the TAR patients. The mean functional subscore was 30.3 (SD 7.1) for the AAD group and 33.1 (SD 8.3) for the TAR group. The average alignment score reached 9.6 (SD 0.8) for both groups.

Discussion

The results of our study show that there is no major difference in sports and recreational activities in patients who underwent either ankle arthroplasty or ankle fusion for the treatment of end-stage osteoarthritis of the ankle at a mid-term follow-up.

Actually, there is a substantial debate regarding the role of ankle replacement in the treatment of ankle arthritis. Ankle fusion has been shown to have successful results, but there is ongoing concern about the long-term consequences in terms of functional limitations [9, 13, 31]. Biomechanical studies revealed that ankle fusion affects ankle kinematics more than TAR; however, there is little information if this causes a difference in functional scores or activities of daily living respectively [10, 11, 32, 33].

Our patients continued to participate in sporting activities after surgery, indicating the ability to maintain an active sporting lifestyle after ankle arthrodesis or after total ankle replacement.

The main limitation of the study is its retrospective nature. We did not evaluate preoperative AOFAS score or UCLA score. Therefore, we are not able to state if the functional and activity scores did improve after surgery. Also, the patient groups are relatively small. However, all operations were performed by a single surgeon. Also, all patients were offered both surgical options for the treatment of end-stage osteoarthritis of the ankle, namely, tibiotalar arthrodesis and ankle arthroplasty. Most data was recorded retrospectively. However, the evaluation of participation in sport activities and the ankle activity score according to

Halasi et al. was carried out in a prospective manner. Additionally, we do not believe that a retrospective evaluation represents a major bias factor for the validity of data regarding sports activities. The ability to participate in sports and recreational activities could be considered a type of benchmark. Therefore, patients will clearly remember their activity profile before the onset of symptoms of a functional impairment. This takes effect when data is recorded in a retrospective manner and is reflected in the recent literature dealing with activity profiles after joint preserving surgery or total joint replacement respectively [16–25].

One of the major findings of the study is that the percentage of patients participating in sports and recreational activities was not different before or after surgery between the groups. There was a decrease of number of patients participating in sports activities whether they underwent total ankle arthroplasty or tibiotalar arthrodesis. This indicates that neither procedure is superior in terms of improvement in overall activity profile.

The UCLA score at follow-up was 7 for the arthrodesis group and 6.8 for the ankle replacement group. There was no statistically significant difference between the groups.

Recent attention has focussed on patient's activity levels before and after total ankle arthroplasty. In a prospective study on 101 patients who underwent three component mobile bearing total ankle replacements, Naal et al. found a significant improvement of UCLA score from 3.7 presurgically to 6.2 at 3.7 years after surgery. At follow-up the mean UCLA score was slightly smaller than in the patients of our series with both ankle arthrodesis or total ankle replacement. The AOFAS score also improved from 45.5 to 84.4. This represents a higher value than in the patients of our study, regardless of the option of treatment. In the study of Naal et al. 62.4% of the focus group were active before surgery and 66.3% participated in sports after surgery, which indicates an improvement of their activity level. However, this increase was not statistically significant. In our study, the overall number of patients participating in sports and recreational activities was higher before and after surgery but we detected a decrease of percentage of patients participating in sports. Patient's demographics and criteria of definition of sports participation of patients of our series are similar to the criteria of the study of Naal et al. In contrast to their study, we excluded patients with major complications. This might explain the difference of activity levels even though there is no statement concerning revision rates in the study of Naal et al. Preoperatively, the most frequent sports (in descending order) were swimming, cycling, fitness/weight training, hiking and downhill skiing. After total ankle arthroplasty the order of the three most frequent sports stayed the same. However, downhill skiing and hiking changed their order. In our series skiing, cycling,

swimming, and hiking represented the four most frequent sports preoperatively. Postoperatively, the percentage of each procedure changed but in general the most favoured activities remained the same regardless of the option of treatment. Therefore, our results are comparable with others after total ankle replacement.

Another study of Valderrabano et al. investigated 147 patients before and after total ankle replacement concerning their activity levels and preferred sports. They found a statistically significant increase of patients who were active in sports. In fact, the percentage increased from 36% preoperatively to 56% after a mean follow-up period of 2.8 years. Contrary to our results, these authors found a correlation between activity levels and postoperative AOFAS hindfoot score. The score improved from 36 points preoperatively to 84 points postoperatively. The overall satisfaction rate of this study was comparable to our results of both treatment options. Good to excellent results were reported by 84% of the patients, 11% presented moderate results and 6% presented poor results. In addition, the most frequent sports activities preoperatively and postoperatively were similar to our results. Before total ankle replacement the most favoured sports (in descending order) were biking, swimming, and hiking. At follow-up the most frequent sports (in descending order) were hiking, biking, and swimming.

This is comparable to our results even though the percentage of patients participating in downhill skiing was higher in our series since this sport is extremely popular in Austria.

Both studies may be biased because of a conflict of interest of individual authors who are contributing to the design of the prosthesis.

Bonnin et al. investigated return to sports activities in 170 patients 53.8 months after total ankle arthroplasty. One outcome measurement tool was a visual analog scale in which patients had to state the percentage of their activity level during daily living as well as sports participation in relation to their pre-pathology level. The mean rating was 70.2 for activities of daily living and 53.7 for sports activities respectively at follow-up. The percentage of patients who were able to return to the initial level of sports activities was significantly higher in the patient group that suffered osteoarthritis than in the group with rheumatoid arthritis. Unfortunately, these authors only investigated the osteoarthritis group. The five preferred activities at follow-up were swimming (58%), hiking (43%), cycling (38%), dancing (27%) and downhill-skiing (17%). Once again, these results are comparable with others and the results of our study. In addition, they found that the return to impact sport was rarely possible.

In order to assess participation in sports and recreational activities and quantify activity levels with regard to mechanical load of the ankle joint the ankle activity score according

to Halasi et al. was used in our study [26]. This score was originally introduced as an outcome measure for patients with ligamentous injuries of the ankle. It is based on the activity score of Tegner and Lynsholm and represents a ten-point scoring system. The different sports activities are summarised in ten categories according to the biomechanical load of the ankle joint during the activities. Three different levels of activity can be chosen for each activity ranging from recreational level (exceeding one hour per week) to top level (international elite, professional). This score allows one to precisely assess and quantify the amount of sports and recreational activities in patients with ankle-related disorders. Preoperatively, the score reached 4.5 points for the patients of the arthrodesis group and 4.7 points for the patients of the TAR group. For both groups the decrease was statistically significant to 3.1 points and 3.3 points, respectively, after surgery. Also, the percentage of patients participating in activities of the upper half of the activity score and therefore representing activities providing high load of the ankle joint decreased postoperatively. However, this change was not statistically significant. However, the decrease of the ankle activity score indicates that both patient groups changed their activity profile. They selected less demanding sports activities with regard to the ankle joint after surgery. Both before and after surgery the percentage of patients participating in activities of the upper half of the activity score was higher for the patients of the TAR group. This shows that patients of the TAR group were more likely to participate in highly demand activities of the ankle joint than patients of the arthrodesis group.

The patient's satisfaction revealed good results in the study regardless of the option of treatment. In fact, there were 85% and 86% of patients, respectively, satisfied or very satisfied with the results of the operation [34].

In common with the aforementioned studies the preferred activities after total ankle arthroplasty in the patients of our study were low impact sports such as swimming, cycling, and gymnastics. However, we found no major difference postoperatively between the preferred types of activities between the two treatment options.

In our study, the mean AOFAS hindfoot score was 75.6 (SD 14) for the arthrodesis group and 75.6 (SD 16) for the TAR group. This corresponds to recently published studies investigating the clinical outcome of these treatment methods at a mid-term follow-up [9, 16, 35–38]. There was no statistically significant difference in the AOFAS hindfoot score between the treatment groups. The subscore for pain was better in the AAD group at 35.8 compared to 31.8 in the TAR group. In contrast to the results for pain subscore the functional subscore was higher in the TAR group (33.1) compared to the AAD patients (30.4). However, the difference was not statistically significant.

The primary indications for reconstructive surgery in patients with end-stage osteoarthritis of the ankle remain pain and loss of function. Both methods should relieve pain and restore function. Patient expectations regarding those procedures have increased, with many expecting to continue athletic activity postoperatively. The physical and mental health benefits of exercise are well known, and patients with arthritic joints frequently complain about their loss of aerobic and athletic activity [39]. In the study both methods led to a decrease of the percentage of patients participating in sports and recreational activities compared to the level before onset of symptoms.

In summary, we demonstrated that there is no significant difference in sports and recreational activities or functional outcome in patients who underwent either ankle arthrodesis or total ankle arthroplasty for the treatment of end stage osteoarthritis of the ankle. In both groups there was a tendency towards engaging in low impact sports after surgery in comparison to the activity levels before the onset of symptoms.

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