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Original Research

Functional Outcomes and Quality of Life in Patients With Post-Traumatic Arthrosis Undergoing Open or Arthroscopic Talocrural Arthrodesis—A Retrospective Cohort With Prospective Follow-Up

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ABSTRACT

Fusion remains the gold standard for post-traumatic osteoarthritis after ankle fractures in many institutes. Patient-reported outcomes on long-term quality of life and functionality of talocrural arthrodesis remain relatively unknown. In literature, low patient numbers and inadequate outcome measures provide a poor foundation for patient expectation management. Additionally, the surgical approach is often omitted. This study presents a retrospective cohort of patients who underwent open or arthroscopic talocrural arthrodesis for post-traumatic arthritis between 2008 and 2019 with prospective follow-up by questionnaire. Participants completed the EuroQol 5-dimensional 3-level questionnaire (EQ-5D-3L™), EuroQol Visual Analogue Scale (EQ-VAS™), Foot and Ankle Outcome Score Dutch Language Version (FAOS-DLV), and 4 additional questions. Thirty-five patients were included in the cohort and 32 were included for follow-up. Trauma mechanism was mainly a low fall or motor vehicle accident causing a talocrural fracture-dislocation in most cases. For open versus arthroscopic treatment respectively, patients reported a median EQ-5D-3L™ index of 0.775 and 0.775, EQ-VAS™ of 80 and 88, FAOS-DLV of 57.0 and 63.9, and satisfaction of 90 and 88 out of 100 after a median of 6.0 and 6.5 years. This study is unique as it is the largest series on patient-reported outcomes in patients with post-traumatic arthrosis with validated questionnaires. In general, patients were satisfied with relatively high questionnaire scores, especially concerning pain and daily living. These functional scores are of importance when setting patient expectations regarding talocrural arthrodesis and recovery. Additionally, the subscale values may help preoperatively in weighing the intervention's advantages and disadvantages for individual patients.

Ankle fractures are one of the most common fractures in adults with an annual incidence of 1/1000 (1). Post-traumatic sequelae are the main cause (70%-78%) of osteoarthritis in the ankle (2,3). Generally, ankle arthritis has an estimated demand incidence of 47.7/100,000 per year with approximately 9.7% of patients undergoing ankle fusion at some point in the therapeutic chain (4). For post-traumatic osteoarthritis, this happens after an average of 6 to 11 years post-trauma (5,6). In an advanced stage, fusion remains the gold standard in many institutes (7). Other interventions include distraction and total ankle joint replacement. Despite its popularity, patient-reported outcomes after fusion are scarcely reported.

In literature, reported functional outcomes are particularly influenced by the distal part of the lower extremity (8). Due to low patient numbers and the use of inadequate outcome measures, a poor foundation is provided for adequate advice and patient's expectation management concerning talocrural fusion for post-traumatic arthritis (5,6,9,10). Additionally, different surgical implants can be used depending on an open versus arthroscopic approach. Evidence suggests an open approach is associated with a higher complication rate and slower fusion compared to an arthroscopic approach for talocrural arthrodesis surgery (11). Although arthroscopic surgery may be preferred for this reason, it may not always be suitable depending on patient or injury factors. This may influence patient-reported outcomes differently, yet no distinction or comparison according to surgical approach is made in available literature.

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In summary, much remains unknown about the functional outcomes and quality of life after talocrural arthrodesis for the post-traumatic patient as measured with adequate questionnaires. This study is unique as it focuses on post-traumatic osteoarthritis of the ankle specifically, it uses validated instruments, it depicts both arthroscopic and open surgical outcomes, and it is the largest series which does so, with a response rate of 94%. The hypothesis was that pain was reduced, but activities and quality of life were impaired. Therefore, the aim of this retrospective cohort study with prospective follow-up was to evaluate functional outcomes and quality of life after both open and arthroscopic approaches of talocrural arthrodesis for post-traumatic osteoarthritis at a level 1 trauma center. Secondarily, patient satisfaction was assessed.

Patients/Materials and Methods

Study Design and Setting

This research was conducted according to STROBE guidelines (12). An institutional review board waiver and the research quality coordinator's consent was obtained. A single major trauma center retrospective cohort study by questionnaire was performed. Data were obtained at the trauma and orthopedic departments of a level 1 trauma center. Eligible patients were identified through searching for the institute's surgical administration's procedure codes for talocrural and talocalcaneal arthrodesis. All patients who underwent an isolated talocrural arthrodesis for post-traumatic arthritis between January 1, 2008 and October 21, 2019 and who were at least 16 years of age at time of surgery were included. Patients were grouped according to the surgical approach: open or arthroscopic surgery. Patients who underwent fixation by means of a hindfoot nail were excluded. Data was collected through chart review and by questionnaire by one researcher (T.A.B.) who was blind to the patients' current functional status and not to the intervention. Data were entered in the secured Castor Electronic Data Capture system using a piloted extraction setup with automated data validations approved by the institutions data manager (13). A second researcher (M.C.P.M.B.) randomly reviewed 20% of the extracted data for inconsistencies to reduce information bias. All included patients were invited to complete 2 questionnaires and 4 additional questions between May 19 and June 5, 2020. This was done repeatedly to reduce nonresponse bias. Exclusion criteria from follow-up by questionnaire included death, no Dutch or English proficiency, and mental impairment. Loss to follow-up was reduced by asking all respondents about subsequent treatment elsewhere.

Arthrodesis Procedure

Patients were elected for arthrodesis by the treating surgeon. In some cases, for example young age or patients with very mild symptoms, joint distraction performed by the orthopedic surgeons allowed postponement of definitive fusion. The surgical approach was elected by the treating surgeon; when possible, an arthroscopic procedure instead of an open approach took place. Examples inhibiting this were the need for implant removal or restoration of anatomical alignment. Due to the retrospective nature, not all motives leading to a certain approach were traceable. For the open procedure, if necessary, adequate exposure was achieved by osteotomy of the distal fibula, followed by refixation or resection at the end of the procedure, depending on the quality of the surrounding soft tissue. Osteotomes and shavers were used for cartilage debridement. Fixation took place according to the surgeons' preference, generally with screws and/or plate fixation. For the arthroscopic approach, a shaver was used for debridement and fixation was achieved by using screw implants. Postoperative care and follow-up were likewise determined by the treating surgeon, usually encompassing a pressure bandage and sometimes a cast or other modality.

Explanatory Variables and Outcome Measures

Explanatory variables were derived from electronic patient files. Data were collected on demographics, trauma and injury characteristics, surgical variables and long-term follow-up evaluating patient-reported quality of life, foot and ankle functionality, satisfaction, and return to work and sports. Predetermined metadata and diagnostic criteria were enforced as defined in Table 1.

Quality of life was assessed using the validated Dutch translations of the EuroQol 5-dimensional 3-level questionnaire (EQ-5D-3L™) and EuroQol Visual Analogue Scale (EQ-VAS™) (14). The EQ-5D-3L™ contains 5 items covering 5 dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) divided into 3 levels (no problems, moderate problems, or extreme problems). Index scores can be calculated and range from less than 0 to 1, with negative values interpreted as a health state worse than death and higher scores indicating better quality of life. The EQ-5D-3L™ score was proven valid for patients with traumatic limb injury through moderate to high association with the World Health Organization Quality of Life instrument (15). Study population index scores were calculated using the Dutch tariff (16). The EQ-VAS™ is a single question on perceived overall health with a 0 to 100 scale where 100 signifies best imaginable health.

Table 1
Definitions adopted concerning the complications outcome registration.

Phrase	Definition
Concomitant injury	Excluding superficial skin grazes; with proximal injury defined as proximal to and including the acetabulum.
Compromised immunity	In case of chemotherapy or equivalent drugs, HIV positivity, severe combined immunodeficiency, post-transplantation drugs, or medication for auto-immune disease.
Energy of trauma	High if, according to ATLS: falls >6 m (adults) or 2-3 times the height of the child; high-risk auto crash with intrusion, ejection, death or telemetry data consistent with high risk of injury; auto vs. Pedestrian or bicyclist with significant impact; motorcycle crash; high-velocity impact such as lawn mower injuries.
Implant failure	Mechanical failure (deformation or breakage) and/or implant loosening.
Deep surgical site infection	Any type of infection that demands operative treatment based on clinical signs with or without positive cultures; pin tract infections; abscesses.
Superficial surgical site infection	All infections that required non-operative treatments only (e.g. antibiotics, conservative wound treatment).
Post-operative hemorrhage	Both reactionary and secondary.
Smoking	Including cannabis; current smoker (including patients having stopped smoking ≤4 weeks preoperatively), former smoker (defined as having stopped smoking ≥4 weeks preoperatively) or never-smoker.
Wound healing disorder	A wound failing to timely progress through the physiological order of healing by cause other than infection (e.g. absence of granulation tissue, failure of re-epithelialization, presence of necrotic tissue, etc.).

Functionality was measured with the Foot and Ankle Outcome Score Dutch Language Version (FAOS-DLV) (17,18). The 42-item questionnaire assesses 5 subscales (Pain, Other Symptoms, Activities of Daily Living, Sport and Recreation Function, and Foot- and Ankle-Related Quality of Life). Answers are given on a 5-point Likert scale. Subscale and total scores range from 0 to 100, with 100 representing no symptoms or limitations. The FAOS-DLV has determined validity through moderate to high correlations with the Foot Function Index (0.55-0.90), good internal consistency with Cronbach's alpha of 0.90 to 0.96, good test-retest reliability with interclass correlation coefficients ranging from 0.90 to 0.96. Additionally, patients were inquired about (1) having undergone foot or ankle surgery in another hospital, (2) satisfaction with the overall treatment as measured with a visual analogue scale (100 indicating complete satisfaction), (3) return to work, and (4) return to sports.

Statistical Analysis

Normal distribution of data was determined using graphs and the Shapiro-Wilks test. Data on continuous variables are presented as medians with interquartile ranges (IQR), categorical data as frequencies with percentages. Relations between dichotomous arthrodesis technique and explanatory variables were analyzed using the chi-square test or, in case of a cell count of ≤5, the Fisher's exact test for dichotomous or nominal variables and Mann-Whitney-U test for continuous variables after establishing homogeneity of variance with Levene's test. A p value of $<.05$ was considered significant. Statistical analyses were performed using IBM SPSS Statistics version 25.0.0.2 (IBM Corp., Armonk, NY) (19).

Results

Baseline Characteristics and Primary Management

A total of 94 eligible patients were identified of which 35 met the inclusion criteria (Fig.). Demographics and characteristics on trauma, injury and initial treatment are depicted in Table 2. Most injuries with subsequent open arthrodesis were sustained after a low fall (5/23, 1 missing) and the most common injury was talocrural fracture-dislocation (6/24) or fracture only (5/24); for a subsequent arthroscopic approach this was mostly low falls or motor vehicle accidents (both 3/11)

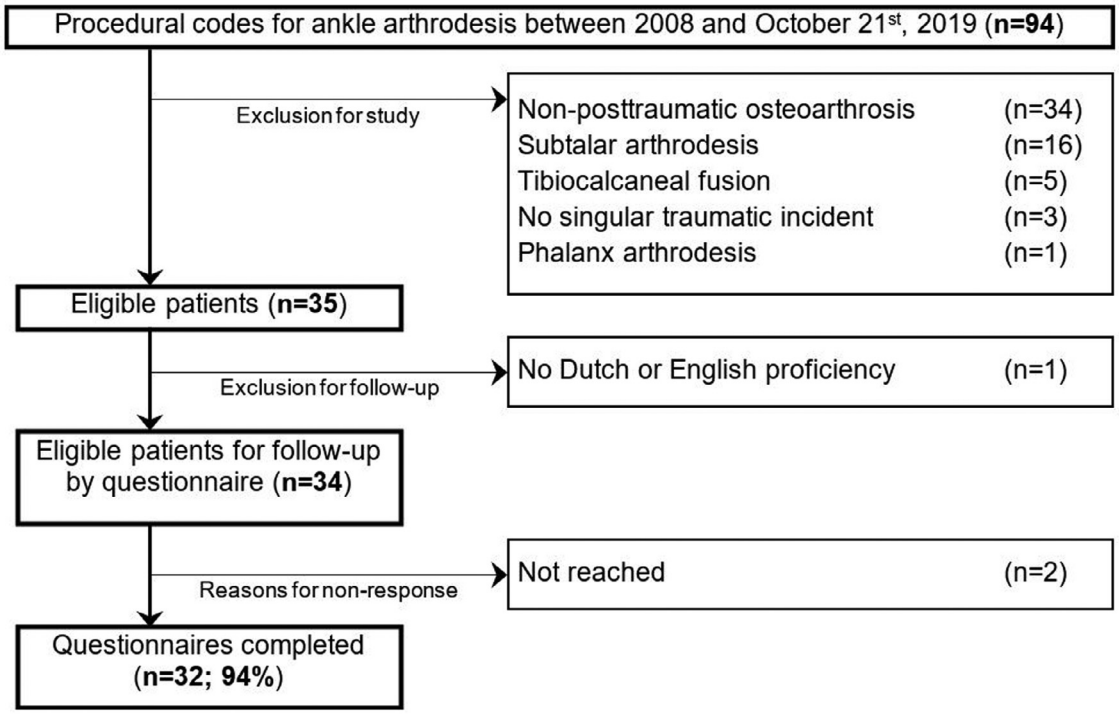

Fig. 1. Flowchart of patient selection. Thirty-five patients were included for retrospective analysis and 34 were eligible for follow-up. The response rate was 94%.

resulting in talocrural fracture-dislocation (5/11). Most fractures were comminuted (14/18, 6 missing, and 9/10, 1 missing), intra-articular (13/21, 3 missing, and 10/11) and/or complicated (11/21, 3 missing, and 8/10, 1 missing) for open and arthroscopic groups, respectively. When all patients were divided into groups according to energy of trauma, the high-energy trauma, low-energy trauma, and crush injury patients sustained concomitant injury in 8/11, 4/14 (1 missing), and 3/6 of the cases, respectively.

Initial therapy consisted of mostly surgical treatment with predominantly open reduction and internal fixation (ORIF; 8/22, 2 missing, for open and 6/11 for arthroscopic surgery) or external fixation prior to ORIF (7/22, 2 missing and 4/11 respectively). Infection complicated initial surgery in 10/24 and 3/11 cases, respectively. The median age at time of arthrodesis was 51 and 52 years (IQR 35-59 and 37-56 respectively), at a median of 3 years after trauma for both open and arthroscopic procedures (IQR 1-8 and 1-9 respectively). Twenty-four out of 35 procedures were performed by an open approach; all other procedures were performed arthroscopically. The procedure indication was predominantly pain due to post-traumatic arthritis (19/24 and 11/11, respectively). The median hospital length of stay was 4 days (IQR 2-5) and 3 days (IQR 2-4) respectively.

Clinical Outcome

Complications and reinterventions are depicted in Table 3a. A median of 1 (IQR 0-3) and 0 (IQR 0-0) complications occurred per patient after the first arthrodesis and any potential reinterventions for open and arthroscopic approach, respectively. This difference between groups was significant (p = .002); so was the difference for total amount of complications counted from initial therapy (p = .018). Focusing on the arthrodesis procedure only, infection was seen in 11 patients with open approach and none with arthroscopic approach. The most severe complication was sepsis after a deep wound infection in 1 patient who had an open arthrodesis approach, ultimately resulting in an amputation of the lower extremity. A re-arthrodesis because of non-union had to be performed in 6 and 1 patients in the open and arthroscopic approach respectively, in one case twice. Definitive union rate was achieved in 22/23 (1 amputation) and 11/11, respectively. One patient with a calcaneal fracture and no ankle injury underwent subtalar fusion prior to secondary talocrural arthrodesis.

Quality of Life and Functional Outcome

Follow-up by questionnaire was achieved for 32 out of 34 eligible patients (94%) (Fig.) at a median of 6.0 years (IQR 2.86-7.58) after arthrodesis for the open approach and 6.5 years (IQR 3.06-8.94) for the arthroscopic surgery (Table 3b). The median EQ-5D-3L™ index scores were 0.78 (range 0.52-1.00) and 0.78 (range 0.02-1.00) respectively. The median EQ-VAS™ scores were 80 (range 50-95) and 88 (range 40-95) respectively, and the median FAOS-DLV 57.0 (range 26.4-80.6) and 63.9 (range 7.0-74.9) respectively. Patients reported a median satisfaction with the final treatment of 90 (range 49-100) and 88 (range 55-100) respectively. Final satisfaction did not correlate with the total amount of complications (p = .604 for open and p = .399 for arthroscopic). The patient who ended up with an amputation of the ipsilateral lower extremity reported a satisfaction of 70.

In the FAOS-DLV subscales, Daily Living and Pain scored best for the open approach with a median of 81.6 and 80.6 respectively, followed by Symptoms (median 53.6), Quality of Life (median 46.9) and Sports and Recreation (median 27.5). For the arthroscopic approach, the order changed to Pain (median 87.5), Daily Living (median 86.0), Quality of Life (median 43.8), Sports and Recreation (median 42.5), and Symptoms (median 41.1).

No significant difference was found between open and arthroscopic procedures concerning the EQ-5D-3L™ index, EQ-VAS™, FAOS-DLV scores, and satisfaction. A trend was not determined.

Table 2
Baseline characteristics (n_{total} = 35) and (surgical) management stratified according to procedure type

	Open (n = 24)	Arthroscopic (n = 11)
	Median (IQR)[missing]	
Age (years)		
At trauma	36 (24-56)[1]	42 (32-55)[0]
At talocrural arthrodesis	51 (35-59)[0]	52 (37-56)[0]
Follow-up (years)	5.98 (2.86-7.58)[2]	6.52 (3.06-8.94)[1]
Body mass index* (kg/m^2)	28.0 (25.4-30.0)[0]	26.5 (21.9-29.4)[0]
ISS	13 (9-17)[17]	9 (5-24)[7]
	n (%)[missing]	
Male	16 (66.7)[0]	5 (45.5)[0]
History of foot/ankle surgery prior to injury	0[0]	0[1]
Smoker*	[0]	[0]
Former	6 (25.0)	4 (36.4)
Current	6 (25.0)	2 (18.2)
Alcohol consumer*	15 (62.5)[0]	7 (63.6)[1]
Relevant comorbidities*	[0]	[0]
Diabetes	3 (12.5)	1 (9.1)
Renal failure	0	0
Osteoporosis	0	1 (9.1)
Compromised immunity	0	0
ASA-classification*	[0]	[0]
I	11 (45.8)	6 (54.5)
II	13 (54.2)	4 (36.4)
III	0	1 (9.1)
Trauma mechanism	[1]	[0]
Fall <3 m	5 (21.7)	3 (27.3)
Fall ≥3 m	4 (17.4)	1 (9.1)
Crush	4 (17.4)	2 (18.2)
Motor vehicle	3 (13.0)	3 (27.3)
Motorcycle	3 (13.0)	0
Sports	2 (8.7)	1 (9.1)
Other	2 (8.7)	1 (9.1)
Injury (location and type)	[0]	[0]
Ankle fracture-dislocation	6 (25.0)	5 (45.5)
Ankle fracture	5 (20.8)	1 (9.1)
Pilon fracture	4 (16.7)	1 (9.1)
Ankle + talar fracture-dislocation	0	2 (18.2)
Pilon fracture-dislocation	1 (4.2)	1 (9.1)
Other	8 (33.3)	1 (9.1)
Comminuted fracture	14 (87.5)[6]	9 (90.0)[1]
Intra-articular fracture	13 (68.4)[3]	10 (90.9)[0]
Complicated fracture	11 (52.4)[3]	8 (80.0)[1]
Gustilo grade	[2]	[1]
I	3 (33.3)	2 (28.6)
II	3 (33.3)	0
IIIA	1 (11.1)	3 (42.9)
IIIB	2 (22.2)	2 (28.6)
Concomitant injury	[3]	[0]
None	8 (38.1)	8 (72.7)
Ipsilateral lower extremity	9 (69.2)	1 (33.3)
Contralateral lower extremity	5 (38.5)	2 (66.7)
Proximal of acetabulum	6 (46.2)	2 (66.7)
Initial treatment	[2]	[0]
ORIF	8 (36.4)	6 (54.5)
External fixator + ORIF	7 (31.8)	4 (36.4)
External fixator + ORIF + fasciotomy	2 (9.1)	0
External fixator	1 (4.5)	1 (9.1)
Other	4 (18.2)	0
Arthrodesis implant type or device	[0]	[0]
Multiple screws	13 (54.2)	11 (100)
Plate fixation	7 (29.2)	0
External fixation	4 (16.7)	0

Abbreviations: ASA, American Society of Anesthesiologists; ISS, international severity score; IQR, interquartile range.
Trauma mechanism was mainly a low fall or motor vehicle accident due to which most patients suffered a talocrural fracture-dislocation. Initial therapy consisted of mostly surgical treatment with predominantly open reduction and internal fixation (ORIF) or external fixation prior to ORIF. The median time until arthrodesis was 3 years after trauma for both open and arthroscopic procedures.
* At time of arthrodesis.

Table 3a
Complications and Reinterventions. Overview of complications (n = 50 in 17 patients and n = 2 in 1 patient) and reinterventions (n = 24 in 9 patients and n = 1 in 1 patient) after arthrodesis for open and arthroscopic procedures, respectively.

	Open (n = 24)	Arthroscopic (n = 11)
Indication for arthrodesis	n (%)	
Pain		
Post-traumatic arthritis	19 (79)	11 (100)
Osteonecrosis	1 (4)	0
Infection*	4 (2)	0
Complications after arthrodesis or subsequent reintervention	n (% of total complications)	
Deep infection	18 (36)	0
Superficial infection	9 (18)	0
Non-union	7 (14)	1 (50)
Wound healing disorder	5 (10)	0
Postoperative hemorrhage	1 (2)	0
Secondary malalignment/dislocation	1 (2)	0
Other	9 (18)	1 (50)
Number of complications	Median (IQR)	
Total†	5 (2-6)	1 (1-3)
Post-arthrodesis only	1 (0-3)	0 (0-0)
Surgical reinterventions	n (% of total reinterventions)	
Surgical therapy for deep infection	13 (72)	0
Re-arthrodesis		
Plate/screw implant	3‡ (27)	1 (100)
Charnley fixator	3 (27)	0
Amputation	1 (9)	0
Other	4 (36)	0

Abbreviation: IQR, interquartile range.
A median of 1 (IQR 0-3; most frequently infection) and 0 (IQR 0-0) complications occurred per patient after the first arthrodesis and any potential reinterventions for open and arthroscopic approach, respectively. This difference between groups was significant (p = .002); so was the difference for total amount of complications counted from initial therapy (p = .018).
* Osteomyelitis, infected non-union, and chronic ulcer with post-traumatic arthritis.
† Excluding post-traumatic arthritis.
‡ One re-re-arthrodesis.

Table 3b
Outcome scores for open (n = 22, 2 missing) versus arthroscopic (n = 10, 1 missing) procedure. Respectively, patients reported a median EQ-5D-3L™ index of 0.775 and 0.775, EQ-VAS™ of 80 and 88, FAOS-DLV of 57.0 and 63.9, and satisfaction of 90 and 88 out of 100 after a median of 6.0 and 6.5 years.

	Open (n = 22)		Arthroscopic (n = 10)	
	Median (IQR)			
EQ-5D-3L™	0.775	(0.693-0.869)	0.775	(0.625-0.855)
EQ-VAS™	80	(74-85)	88	(72-92)
FAOS-DLV	56.95	(49.67-63.52)	63.92	(45.03-72.09)
Symptoms	53.57	(42.86-64.29)	41.08	(32.14-58.03)
Pain	80.56	(60.42-94.44)	87.50	(75.00-93.75)
Daily living	81.62	(61.39-91.55)	86.03	(65.81-96.33)
Sports and recreation	27.50	(12.50-42.50)	42.50	(18.75-55.00)
Quality of life	46.88	(35.94-57.81)	43.75	(29.69-70.31)
Satisfaction with treatment	90	(74-96)	88	(60-100)
Return to work (n = 15/19* resp 7/8*)	90	(49-100)	80	(60-100)
Return to sports (n = 5/10* resp 3/5*)	60	(35-95)	85	(70-†)

Abbreviations: EQ-5D-3L™, EuroQol 5-dimensional 3-level; EQ-VAS™, EuroQol Visual Analog Scale; FAOS-DLV, Foot and Ankle Outcome Score Dutch Language Version; IQR, interquartile range.
* Denominator signifies n with work/sports preinjury.
† Incalculable.

Discussion

This is the largest series of patient-reported outcomes after arthrodesis for post-traumatic osteoarthrosis using validated questionnaires. Six years after open or arthroscopic arthrodesis, patients scored

moderate on long-term functionality and quality of life, with a satisfaction score of 90 and 88 out of 100, respectively. For functionality, patients in both groups scored relatively poor on FAOS-DLV Sports and Recreation, Quality of Life and Symptoms subscales and better on Pain and Daily Living subscales. There seemed to be a trend towards higher activity level in the arthrodesis group when considering the FAOS Sports and Recreation subscale and return to work scores. This may explain the higher FAOS Pain subscale in this group. For quality of life, the median EQ-5D-3L^{TM} index was 0.775 for both groups. In comparison, the general Dutch population of the same age group upholds an EQ-5D-3L^{TM} index norm mean of 0.890, which is still better than even the third quartile of both current populations (20). Nevertheless, our patients were relatively satisfied. It is remarkable to note that, despite the differences in complication rates for both groups, the patient-reported long-term outcomes do not seem so different.

Trauma patients are often provided with a substantial variability of outcome-related information (21). It has been shown that inadequate explanation and thus expectation management concerning the type of injury and long-term outcomes by the treating physician are predictive of subsequent lower satisfaction levels (22). The heterogeneity of the current study groups reflects the need for broad expectation management. Because of the high satisfaction rate in this study, expectation management was likely performed adequately. The values on functionality and quality of life found in this study are important to consider when setting patient expectations regarding talocrural arthrodesis and recovery endpoints. Additionally, the subscale values may help preoperatively in weighing the intervention's advantages and disadvantages for an individual patient.

Both the total amount of complications and the amount of complications after arthrodesis showed a significant difference between open versus arthroscopic arthrodesis procedures. This may be attributed to one of 3 reasons: coincidence due to lack of randomization, the influence of confounders, or the approach itself. Possible confounders such as soft tissue status, severity of deformity, type of injury, ongoing infection, and the need for implant removal may have influenced the choice of approach, in which case the approach itself may not influence complication rates at all. For example, the open approach group included ongoing infection as indication for arthrodesis, while the arthroscopic approach group did not. Interestingly, not only the complication rates after arthrodesis, but also the rates since initial therapy differ. Due to the retrospective character of the study, a definite conclusion cannot be drawn. To date, no randomized controlled trial has been performed investigating the preferred surgical approach in talocrural arthrodesis. A recent systematic review and meta-analysis performed by Mok et al found no difference in complication occurrence or infection rate between the 2 approaches (23). Nonetheless, they did find a higher fusion rate and better recovery for patients undergoing arthroscopic arthrodesis compared to open surgery. However, a systematic review by Park et al found the contrary: fewer complications, better clinical scores, and shorter hospital stay for the arthroscopy groups and similar union rates and reoperation rates (24). In our opinion, the 2 approaches should be viewed as complimentary to each other by creating different management options rather than speaking of superiority of either approach.

To our knowledge, the largest series to date in existing literature evaluating functional outcomes on talocrural arthrodesis after post-traumatic osteoarthritis were published by Giannini et al in 2007 and Buchner et al in 2003, counting 58 and 48 patients respectively who completed the American Orthopaedic Foot and Ankle Society (AOFAS) Score (6,9). The results seemed promising: Giannini et al found a mean postoperative AOFAS Score of 77.5 ± 8 out of 100 compared to 28.8 ± 11 preoperatively ($p < .05$). Buchner et al found a postoperative AOFAS Score of 73.6 (range, 27-96), an increase of 34.2 points compared to a retrospectively ascertained preoperative score. However, the AOFAS Scores have not been proven to be adequately valid, reliable, and responsive (25). The AOFAS themselves no longer endorse its use (26). In 2001 and 2003 respectively, Coester et al and Fuchs et al presented a series of 23 and 17 patients in the same category who completed both condition-specific and general patient-reported outcome measures (5,10). However, Coester et al primarily studied acceleration of secondary osteoarthritis in adjacent joints after fusion, failing to report on specific outcome scores for functionality. This impedes adequate comparison to other studies and hinders explicit expectation management. Fuchs et al questioned only 17 patients, documenting a mean condition-specific Olerud Molander Score of 59.4 out of 30 to 100 (standard deviation ± 16.85) after a mean of 23 years follow-up. They used a limited questionnaire and excluding all patients who had not been followed up for 20 years or longer and failing to report on the loss to follow-up. They presented the generic Short Form-36 score as subscales only, showing worse scores for 3 out of 8 subscales compared to the general population adjusted for age: emotional disturbance, pain, and physical limitation, respectively. Interestingly, although nongeneric, in our series the FAOS-DLV Pain subscale was scored the highest in the arthroscopic group and second highest in the open approach group.

The greatest strength of this study is that, to our knowledge, it is the largest series on patient-reported outcomes for the current population using validated questionnaires. The FAOS is a widely studied patient-reported outcome measure originally developed for ankle and hindfoot arthrodeses. It has shown good content and construct validity and reliability (27). Additionally, the Dutch Language Version is a reliable and valid questionnaire to assess symptoms and functional limitations of the foot and ankle after surgery (28). Other strengths of this study include the high response rate, the broad range of functional items assessed and the collaboration between the trauma and orthopedic surgery departments, since most trauma research conducted in the Netherlands is done within one of these specialties. Furthermore, the heterogeneity of the population is represented adequately. Confounding by indication could have played a role while analyzing the difference between the open and arthroscopic procedures. Another limitation includes the possible misclassification bias due to the retrospective nature of the study. For the same reason, the prearthrodesis state was not determined for paired comparison analysis. Future research should focus on the different treatment modalities and their patient-reported outcomes in order to make an adequate comparison.

In conclusion, this study shows that long-term functionality and quality of life after open and arthroscopic talocrural arthrodesis for post-traumatic osteoarthrosis is moderate. Pre- and postfusion complication rates were higher in the open group compared to the arthroscopic group. Whether this was due to trauma-related factors, patient-related factors, or exclusively the type of approach remains unknown. Nevertheless, patients in both groups experience a high level of satisfaction. Scores for pain, often the indication for surgery, are relatively high. Using the current data, future patients' expectations could be managed preoperatively concerning both generic quality of life and foot and ankle-specific functionality within the various subscales, of which pain is one. Future studies should prospectively focus on subgroup analysis for injury and treatment characteristics in a large study population. The results of the current investigation could be used in the development of such studies.

Authors' Contributions

Thirza Berk: Study design, questionnaire administration, data collection, analysis, writing, critical revision
Mark Van Baal: Study design, analysis, critical revision
Joran Sturkenboom: Critical revision
Arie van der Krans: Critical revision
Roderick Houwert: Critical revision
Luke Leenen: Critical revision

Ethical Considerations

Ethical approval from the local board was obtained prior to conducing this study.

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