



The Effect of Calcaneal Fractures on Functional and Economic Outcome in the Industrial Patient

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Abstract

Background: In the working population calcaneal fractures lead to a poor functional outcome frequently followed by a distinct economic impact. The purpose of this study was to investigate on the economic and functional outcome following a calcaneal fracture among the industrial patient population.

Methods: A retrospective study was conducted on industrial patients who sustained a calcaneal fracture. Health related costs were covered by the Workers' Compensation Board. Chart reviews were performed and patients were evaluated clinically and radiographically. Outcome measures included the AOFAS Hindfoot questionnaire, the Short Form 36, time off work, impairment rate and cost.

Results: 85 patients with 93 fractures were included. After an average follow-up of 21 months the mean total AOFAS was 58 points, SF-36 56 points, time off work 208 days, impairment rate 12% and inpatient/outpatient cost 6.172/22.350 euro per patient. Regardless of fracture type non-surgical treatment lead to a significantly better AOFAS score, superior SF-36 score, significantly less time lost from work, lower impairment rate and less cost when compared to surgical treatment. The comparison after stratification of fractures displayed better outcome in all parameters for any extraarticular fracture when treatment was conservative. Intraarticular fractures resulted in better outcome scores (AOFAS, SF-36) but worse socioeconomic parameters when treated surgically.

Conclusion: In the industrial population calcaneal fractures have a perspicuous physical, mental and socioeconomic impact. Fractures not involving the joint lead to a better outcome when treatment is conservative, while intraarticular fractures result in superior functional outcome, but worse socioeconomic parameters when treatment is surgical.

Keywords: Calcaneal fracture; Industrial patient; Workers compensation

Introduction

Fractures of the foot and ankle are common injuries among the working population [1-3]. When compared to privately insured individuals they consistently lead to an unsatisfying outcome causing the highest impairment rate and cost of all work-related fractures [4-8]. It is hypothesized that nonarticular fractures can be expected to heal rapidly and cause only minimal morbidity, while intraarticular fractures often cause long-term sequela [9-13]. Consensus has generally been drawn for treatment of calcaneal fractures among the privately insured collective [4,14,15]. The poor outcome among industrial patients still causes controversy regarding their treatment posing a challenge to the orthopedic surgeon [4,14]. With resulting costs greatly out of proportion to their low incidence they are as well a familiar subject to insurance companies [16,17]. Most fractures involve the joint and occur in male industrial workers in their productive years, typically working on ladders, scaffolding or roofs. Many of them implicate a high morbidity and complication rate which often is followed by a significant economic impact due to long-term sequela and time off work [18-21]. Third party payers, insurance companies, and employers own a little knowledge as to when injured parties will recover from a significant calcaneal fracture [6]. Even fractures with good prognoses may delay return to unrestricted work activities [2]. It is estimated by Sanders that 70% of calcaneal fractures are incurred as on the job injuries and thereby are covered by workers' compensation [22]. Studies on calcaneal fractures from the literature mostly advert the privately insured patient, while only some include a certain percentage of patients that are served by a Workers' Compensation Board (WCB). Most articles revealed the information that individuals on a workers' compensation claim do worse in regard of both functional outcome and return to work when compared to non-WCB

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patients [4,23-25]. However, only limited information is available on the topic of average cost or impairment rate. None has addressed or compared functional and economic outcome of calcaneal fractures solely in the industrial patient population. Contemporaneously optimal treatment recommendations for the injured worker is still a topic of controversy. To date, there is only one multicenter trial handing out the information to non-surgically treat WCB patients suffering from an intraarticular calcaneal fracture on the basis of functional outcome [14]. The aim of this study was to investigate on the functional and economic outcome of different calcaneal fractures treated surgically and non-surgically among the industrial patient population covered by the Workers' Compensation Board.

Materials and Methods

A retrospective chart review on all industrial patients covered by the local Workers' Compensation Board (Munich, Germany), that had suffered a calcaneal fracture while at work in the urban and suburban area of Munich, Germany between January 1990 and July 2005 has been conducted. All health-related costs caused by the injury were covered by the local Workers' Compensation Board. The study has been approved by an institutional review board of both the Technical University and the Workers' Compensation Board. Informed consent was obtained from each patient.

Patients

Inclusion criteria mandated that all patients be between 18 and 69 years old, had suffered any calcaneal fracture while at work and were served by the local Workers' Compensation Board. Treatment regimens were both surgical and non-surgical. Surgically treated patients were approached either by lateral, by medial or by bilateral incision. Fixation was established by k-wires, cancellous screws, plate fixation, external fixation, primary fusion or a combination of mentioned osteosynthetic procedures. Bone grafting was performed in selected patients. All non-surgically treated patients were managed with ice, elevation, rest and a mobilization cast or orthotic walking device. Exclusion criteria were complications related to the calcaneal fracture, any previous calcaneal injury, a previous calcaneal abnormality, a coexisting foot injury, any previous pathology and/or injury suffered within the same accident leading to an additional impairment rate, altered function, and time off work or cost other than the calcaneal fracture. All patients with calcaneal fractures between 2001 and 2005 attended a specific rehabilitation protocol designed by the local Workers' Compensation Board.

Protocol

From the chart review, age, gender, injury mechanism, fracture type and side, associated injuries, treatment protocol, time to operation, time as inpatient, follow-up time, complications, time off work, resulting impairment rate, inpatient and outpatient cost were identified.

On the last day of follow-up all patients were seen by an independent evaluator that routinely examined the patients according to a standardized protocol in order to determine the rate of impairment for the Workers' Compensation Board. Examination with attention of gait pattern, stability, Hindfoot alignment, and range of motion in respect of the objective part of the American Orthopedic Foot and Ankle Society (AOFAS) ankle and Hindfoot score as well as routine plain radiographs were performed [26]. Patients completed the subjective part of the AOFAS as well as the complete Short Form 36 (SF-36, a general health survey) [27,28]. The maximum obtainable

score is 100 points total on the AOFAS scale and 100 points total (100 points for each of the eight categories) on the general health status scale of the SF-36. The SF-36 scores were matched to the US normative data's 50th percentile. The maximum AOFAS score for patients that had received a subtalar fusion (n=1) was 94 points. These data were statistically adjusted.

Fracture type

All fractures were stratified to three main types. Extraarticular fractures were categorized according to the Rowe classification [29]. Rowe fractures type A (extraarticular type fractures) were classified as fracture type A. Rowe fractures type B (beak and avulsion type fractures) did not occur in our collective of patients. Rowe fractures type C (body fractures not involving the subtalar joint) were classified as fractures type B. All intraarticular fractures were classified as fractures type C. Due to lack of data and a reported high degree of variability and inconsistency in its interpretation a further classification by means of CT scan roentgenography (Sanders classification) was not performed on each patient [30].

Impairment

It is defined by German law that all work related injuries are covered by the Workers' Compensation Board. If an injury causes a permanent disability the worker is categorized in regard of his impairment and compensation costs are paid accordingly when the individual returns to work. It is estimated by precise German evaluation guidelines that a calcaneal fracture as a single pathology can cause between 10% and a maximum of 40% impairment rate. A 10% impairment rate is caused by a slightly decreased Böhler angle and/or mild arthritic changes. A 20% rate is caused by a significantly decreased Böhler angle, mild arthritic changes, a painful semi-rigid subtalar joint, malpositioned Hindfoot in valgus or varus deformity with adequate movement in the ankle joint. A 30% rate is caused by a completely diminished Böhler angle with a severe Hindfoot deformity, semi-rigid subtalar joint and arthritic changes in the ankle joint with diminished function of the foot. A maximum of 40% rate is caused by a non-weight-bearing foot. A subtalar arthrodesis results in a 10% impairment rate under optimal circumstances, all others are rated at 20%.

Cost

In this study measured costs were divided into two parts: Inpatient and outpatient cost. The corpus of outpatient cost is assembled by non-health related cost due compensation cost for time off work. Also included are rehabilitation procedures, orthotic devices or physiotherapy. A certain percentage of patients received further annuity cost to compensate their rate of impairment.

Analysis of the data

The patient questionnaires (AOFAS, SF-36) were reviewed manually for consistency and appropriate codes prior to data entry. Data were analyzed using SPSS software (version 14.0 for personal computers; SPSS, Chicago, Illinois). The data analysis focused on the study objectives through descriptive techniques (frequencies) and comparisons of means using student's t test to examine differences according to the variable of interest (AOFAS, SF-36, time off work, impairment rate and cost). A p value <0.05 was considered significant. Null-hypothesis was defined as no difference among stratified groups.

Results

During the time period between January 1990 and July 2005

Table 1: Functional and socioeconomic outcome overview of all fractures (A, B, C) and fracture type A, which was exclusively treated non-surgically. Annuity is given in percent of patients that received additional annuity cost. P value is given in comparison between non-surgical and surgical treatment of all fractures (A, B, C).

All Fractures A, B, C	All fractures	Non-surgical	Surgical	P value	Fracture A, non-surgical
AOFAS	58	65	49	0.05 *	81
SF-36	56	59	56	0.59	67
MCS	59	58	61	0.63	67
PCS	50	55	46	0.13	61
Time off work, days	208	142	294	0.01 *	38
Impairment in %	12	8	16	0.01 *	0
Inpatient cost, euro	6.172	3.678	9.257	0.001 *	0
Outpatient cost, euro	22.35	13.36	33.469	0.002 *	2.357
% Annuity	64	38	95		

Table 2: Overview of total mean and percent of 50th percentile when compared to US-normative data of SF-36 component subscores divided into fracture types A, B and C.

Fracture	A	A	B	B	C	C
	Mean	% of 50	mean	% of 50	Mean	% of 50
Physical functioning	66	42	62	39	47	33
Physical role	64	45	59	42	47	39
Bodily pain	61	44	53	41	43	38
General health	54	42	59	44	46	37
Vitality	58	46	44	42	43	40
Social functioning	71	43	68	42	63	40
Emotional role	73	47	67	45	55	41
Mental health	65	41	59	40	57	39
Physical component	61	41	55	39	42	33
Mental component	67	43	60	41	56	40

a total of 320 WCB patients sustained a calcaneal fracture in the urban and suburban areas of the city of Munich and were served by the local Workers' Compensation Board (WCB). In this study 85 patients with 93 calcaneal fractures were enrolled. The remaining 235 patients dropped out of the study due to denying consent, because of to complications, multiple injuries, missing data and lost to follow-up. There were 42 right sided, 35 left sided and 8 bilateral fractures in 69 male and 16 female patients. The average age at time of injury was 46.2 years (19 to 69). Mean follow-up was 21 months (6 to 58). Injury mechanisms were jump from a height in 53 cases, supination trauma in 17 cases, and motor vehicle accident in 9 cases and blunt force in 5 cases. From the radiographs obtained on first admission there were 17 extraarticular fractures (fracture type A), 33 calcaneal body fractures with no joint involvement (fracture type B) and 35 intraarticular fractures (fracture type C). A total of 38 fractures were treated operatively and 47 were treated conservatively. In the female population there were eight fractures type A, four fractures type B and four fractures type C. Three female patients were operated whereas 13 were treated conservatively. In the male population there were nine fractures type A, 29 fractures type B and 31 fractures type C, whereof 35 were treated surgically and 34 were treated non-surgically. Patients were treated at different hospitals. The mean time between accident and surgical management was 7.1 ± 12 days (0 to 104) and the mean time to discharge was 12.2 ± 5 (3 to 31) for surgically treated patients. The mean time to discharge for conservatively treated patients was 8.2 ± 3 days (2 to 22). Of all fractures, 30 were approached by lateral, two by medial, five by percutaneous incision and one was managed

arthroscopically assisted. Kirschner wires were used in three cases; screw fixation was performed in four cases, plate fixation in 27 cases, combined procedures in three cases and primary arthrodesis in one case. Bone grafting was established in 18 cases. Of all patients 46 received orthopedic shoes for walking following the injury. The total mean AOFAS score for all patients was 58 ± 28 (0 to 100) points, the mean SF-36 for all patients was 56 ± 22 (16 to 97) points, the average time off work 208 ± 265 (0 to 1908) days, the mean impairment rate $12 \% \pm 14$ (0 to 40) % and the resulting mean total inpatient/outpatient cost were 6.172 ± 7.861 (0 to 36.874)/ 22.350 ± 28.445 (323 to 171.576) euro per patient. Of all patients 64% received further annuity cost (Table 1). For all female patients the mean AOFAS was 68 points, mean SF-36 was 58 points, mean time off work was 105 days, mean impairment rate 4.7% and average inpatient/outpatient cost was 5.305/12.967 euro. For all male patients the mean AOFAS was 56 points, mean SF-36 was 57 points, mean time off work 234 days, mean impairment 13.3 % and mean total cost 39.189 euro. Regardless of fracture type non-surgical treatment lead to a significantly better AOFAS score (65 vs. 49, $p=0.05$), superior SF-36 score (59 vs. 56, $p=0.59$), significantly less time lost from work (142 vs. 294, $p=0.01$), significantly lower impairment rate (8 vs. 16.1, $p=0.01$) and significantly less total inpatient/outpatient cost (3.678/13.360 vs. 9.257/33.469, $p=0.01/p=0.02$) when compared to surgical treatment. In 95% of cases following surgical management further annuity cost were paid while annuity was paid in 38% of cases following non-surgical treatment (Table 1) Apportioned values for the SF-36 including the percentage value of the US-normative 50th percentile are

Table 3: Functional and socioeconomic outcome overview of all fractures type B. Annuity is given in percent of patients that received additional annuity cost. P value is given in comparison between non-surgical and surgical treatment.

Fracture B	All Fractures B	Non-surgical B	Surgical B	P value
AOFAS	56	62	49	0.15
SF-36	60	61	59	0.84
MCS	60	58	62	0.64
PCS	55	58	51	0.51
Time off work, days	172	139	212	0.2
Impairment in %	10	9	12	0.66
Inpatient cost, euro	5.644	4.305	7.25	0.29
Outpatient cost, euro	18.485	13.686	24.243	0.16
% Annuity	64	39	93	

shown in Table 2.

With no regard of treatment fractures type A resulted in an average AOFAS of 81 points, mean SF-36 of 67 points, mean time loss from work of 38 days, mean total outpatient cost of 2.357 euro and no resulting impairment rate or annuity cost (Table 1). All type B fractures lead to an average SF-36 of 60 points, mean AOFAS of 56 points, mean time lost from work of 172 days, an average impairment rate of 10.4%, mean total inpatient/outpatient cost of 5.644/18.485 euro and annuity payment in 64% of cases (Table 3). All fractures type C resulted in an average AOFAS of 48 points, mean SF-36 of 51, mean time lost from work of 329 days, mean impairment rate of 18.5%, and mean total inpatient/outpatient cost of 9.664/35.757 euro and an annuity payment in 91% of cases. When intraarticular fractures (fractures type C) were treated surgically a mean total AOFAS of 48 points, mean SF-36 of 54 points, mean time off work of 348 days, and an average impairment rate of 19.13% and mean total inpatient/outpatient cost of 10.565/39.487 euro resulted. Intraarticular fractures (fractures type C) treated non-surgically lead to an average AOFAS of 48 points, mean SF-36 of 43 points, mean 294 days off work, an average impairment of 17.5% and mean total inpatient/outpatient cost of 7.935/28.609 euro (Table 4). Between the years 2001 and 2005 a total of 46 patients (fracture type A: 13, B: 17, C: 16; 28 conservatively and 18 operatively treated) received a specific rehabilitation management whereas the remaining 39 patients (fracture type A: 4, B: 16, C: 19; 19 conservatively and 20 operatively treated) between 1990 and 2000 did not. Mean total AOFAS was 49 without and 65 with ($p=0.015$), mean total MCS/PCS was 55/46 without and 63/54 with ($p=0.139/p=0.214$), mean time lost from work 261 days without and 167 days with ($p=0.126$), mean rate of impairment 15.2% without and 8.7% with ($p=0.042$) and mean total inpatient/outpatient cost of 7.108/29.085 euro without and 5.379/16.640 euro with ($p=0.315/p=0.044$) the specific rehabilitation management. In 77% of cases without and in 52% of cases with rehabilitation management annuity was paid. With the numbers available, no significant difference could be detected in all subcategories after stratification of data.

Discussion

Our data show that among patients on a workers' compensation claim already extraarticular fractures (fracture type A), where treatment exclusively was conservative, resulted in an impaired mental and physical function. There are no comparable data from the literature concerning extraarticular fractures among WCB patients. The socioeconomic impact remained within normal limits and as well is comparable to data reported by Campbell investigating on a

Table 4: Functional and socioeconomic outcome overview of all fractures type C. Annuity is given in percent of patients that received additional annuity cost. P value is given in comparison between non-surgical and surgical treatment.

Fracture C	All Fractures C	Non-surgical C	Surgical C	P value
AOFAS	48	48	49	0.88
SF-36	51	43	54	0.11
MCS	56	46	60	0.09
PCS	42	39	43	0.7
Time off work, days	329	294	348	0.6
Impairment in %	19	18	19	0.75
Inpatient cost, euro	9.664	7.935	10.565	0.31
Outpatient cost, euro	35.757	28.609	39.487	0.35
% Annuity	91	83	96	

similar patient population with a similar fracture [2]. Extraarticular body fractures (fracture type B), where treatment was both surgical and non-surgical, consequentially resulted in a worse functional and socioeconomic outcome when compared to fractures type A. Conservative management lead to savings of over 13.502 euro, an average 73 days less off work and superior functional results. Even though differences between treatment groups were not significant our results show that extraarticular calcaneal fractures benefit from conservative treatment when functional and economic outcome is concerned. For intraarticular fractures (fracture type C), with a total mean AOFAS of 48 and SF-36 of 51 points, our study revealed a severely affected functional and mental outcome. AOFAS scores following an intraarticular calcaneal fracture among privately insured individuals from the literature vary between 71 and 88, while bilateral fractures or primary subtalar fusion resulted in a mean score of 71.8 and 72.4 points [31-34]. Reported SF-36 values in the literature following an intraarticular fracture vary between 63 and 73 points, while Buckley and Tough reported on an average score of 64.7 after non-operative and 68.7 after operative treatment in a collective that included industrial patients [14,23,33,35-37]. Even though with the numbers available differences between surgical and non-surgical treatment were not significant less time off work, less rate of impairment and less total cost following non-surgical treatment clearly has an economic impact. In contrast, surgical treatment resulted in a better outcome in the mental function score with a trend to significance and superior values in the AOFAS and PCS scores. In regard to our data treatment recommendations from a clinical standpoint may prefer surgical management, while superior economic outcome can be reached with non-surgical treatment. This information is partially applicable to data revealed by Tufescu who could show that operative compared with non-operative treatment of intraarticular calcaneal fractures among WCB patients lead to better SF-36 scores (54.80 vs. 48.99) but worse functional outcome parameters (Rowe score: 54.81 vs. 58.24) [6]. In contrast, Buckley concluded on the basis of functional outcome non-surgical treatment to be the best option for industrial patients suffering from an intraarticular fracture. Alternatively he suggested to immediately perform subtalar fusion in this patient collective, which is information that is similar to suggestions performed by Cszyi, but is not applicable to the functional outcome presented by us [14,38]. Concerning the economic standpoint our information is in contrast to a study from Brauer who recommends to surgically treat patients following an intraarticular fracture. However, as with most studies from the literature, patients were predominantly non-industrial (63%) [18]. Coughlin, though, investigating on the same

patient collective (industrial) revealed a similar trend as determined by us. Total average cost of non-surgically treated patients following a calcaneal fracture (extra- and intraarticular) were lower than those for surgically treated patients [3]. In regard to time lost from work Brauer reported about 120 days following surgical and 172 days following non-surgical treatment which also is in contrast to our data, where surgically treated patients required at 348 days an average 54 days longer than conservatively treated individuals to return to work [18]. Also Randle calculated less time lost from work following surgical treatment again investigating among privately insured patients (165 vs. 264 days) [15]. More similar data were given by Coughlin who summarized on an average time off work following an intraarticular fracture to be an average 245 days following surgery and 126 days after conservative management among WCB patients [3]. General information on impairment rate from the literature reflects the same trend that was detected by us at resulting impairment rates between 15% and 40% following a calcaneal fracture [20]. The data show that information regarding optimal treatment following an intraarticular calcaneal fracture when functional and economic outcome is concerned cannot be deployed from the privately insured individual to the WCB patient and vice versa. Both patient collectives and their optimal treatment protocol in regard to outcome have to be handled independently. Furthermore regional differences may play a role in the varying results between studies. Nevertheless reasons for the reported poor functional outcome remain unclear and therefore have been widely discussed in the literature [14,24]. An injured blue-collar worker to be unique in general, losing his main profession, his physical ability, by fracturing the calcaneus, the involvement of multiple parties during the healing process or pain when the individual returns to work may play a role in the poor outcome of WCB patients [38]. Paley noted that the characteristics of patients that were associated with an unsatisfactory outcome following an intraarticular calcaneal fracture were an age of more than fifty years, work involving strenuous labor and increased time missed from work due to the injury [39]. According to MacKenzie higher rates of return to work include younger age, higher education, higher income, the presence of strong social support, and employment in a white-collar job that was not physically demanding [40]. Dooley reported about patients whose injury was not associated with a WCB claim demonstrated significantly better subjective outcomes for the SF-36 and a visual analogue scale [41]. A trend that has been of notice in previous reports and as well in our study when outcome is compared to data of privately insured individuals from the literature [6,14]. Thornes et al. reported about significantly worse outcome scores as well as longer time off work in litigants concluding an unreliability of subjective evaluation in determining outcome in the face of litigation. Reported time off work after a calcaneal fracture in litigants was more than twice that of non-litigants concluding litigation to be the major determinant of outcome following calcaneal fracture repair [42]. In a study by Filan it took patients receiving compensation more than twice as long as privately insured individuals to return to work after scaphoid internal fixation [43]. Secondary gain as a well-defined barrier may be an important factor for WCB patients to return to work [5]. On that account WCB patients may require a different approach than the privately insured individual. It was previously reported that a customized approach, specific rehabilitation management, to injured WCB patients is of positive assistance in obtaining improved results [44]. This information holds true for the data from our collective where clearly improved clinical and socioeconomic results could be seen in patients who attended a specific rehabilitation management

program.

Conclusion

Many reasons for the poor outcome among the industrial patient following a calcaneal fracture may be identified; nevertheless, it is clearly evident that this population requires a customized treatment protocol. The severity of the fracture, the patient's work environment, the surgeon's experience as well as case managers and insurance companies have to be involved in treating the patient creating an individualized approach for optimal recovery, rehabilitation and final workplace limitations. Additionally, in consideration of steadily rising health costs, alternative schemes, such as incentives to return to work, change of workplace and workload as well as better occupational safety, need to be introduced to decrease redundancy. Specific rehabilitation programs already in use for the injured WCB patient have been shown to have a positive impact in regard of both functional and socioeconomic outcome. Not only doctors but also health care managers can find assistance when treating calcaneal fractures among industrial patients, where information in the literature is scarce and optimal treatment options still cause controversy. Further studies with larger patient populations need to be investigated to create treatment guidelines for the worker suffering from an intraarticular calcaneal fracture.

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