Outcome of surgically treated intraarticular calcaneus fractures—SF-36 compared with AOFAS and MFS

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Background **There is no consensus as to which is the best treatment for intraarticular fractures of the calcaneus. Furthermore, few studies have assessed general health after calcaneus fractures. We therefore measured the state of general health after operation of calcaneal fractures and compared these data with usual foot-scores.**

Patients and methods **We compared the general health of 71 patients with surgically treated calcaneal fractures 2.5 years after injury, with the general health of 71 people from the standard German population (German National Health Survey, 1998) using the SF-36 form. We compared the results of the examination with results of AOFAS Ankle Hindfoot Scale and Maryland Foot Score in the treated patients.**

Results **In patients with calcaneal fractures, there were significant limitations regarding general health in all 9 elements of the SF-36 form. Correlations between SF-36 and foot-scores were strong regarding function and pain scales, but moderate for all other scales.**

Interpretation **Patients face significant limitations regarding general health after calcaneal fractures. The usual foot-scores measure only 2 dimensions of outcome: function and pain. To measure all dimensions of outcome, SF-36 is a better alternative.**

Although some studies with more than 100 cases have demonstrated good results after open reduction and internal fixation of intraarticular calcaneal fractures (Bezes et al. 1993, Sanders et al. 1993, Zwipp et al. 1993), the best choice of treatment remains controversial because prospective randomized studies have not shown convincingly better results after surgery (Parmar et al. 1993, Thordarson and Krieger 1996). However, in the largest prospective randomized trial described to date (309 patients), Buckley et al. (2002) found better results in some subgroups of patients after surgery.

It is difficult to compare outcome between studies since different measures of outcome are often used. Although the patient's perception of general health is considered to be increasingly important, only a few studies on calcaneus fractures have used this as a measure of outcome (Hildebrand et al. 1996, Loucks and Buckley 1999, Heffernan et al. 2000, Longino and Buckley 2001, Stiegelmar et al. 2001, Tufescu and Buckley 2001, Buckley et al. 2002). The SF-36 (Ware 1993) is one of the most widely used instruments for addressing patient self-assessment. Clinical experience of patients with intraarticular calcaneus fractures has shown that limitations in many fields of daily life are to be expected. In this context, the SF-36 form seems to be an ideal way of measuring outcome.

Many countries have published so-called normative data from large sample sizes, which makes it possible to compare data from patients with different orthopedic or other conditions with data from the normal population of the country.

We have been unable to find any studies comparing outcome data of patients with calcaneal fractures and normative data. Our study was designed to determine health status after calcaneus fractures

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and to answer the following questions: (1) Are there differences between patients with intraarticular calcaneal fractures and the normal population? (2) Do patients rated as excellent or good by using conventional outcome measures differ from the normal population? (3) Can classical measures of outcome such as Maryland Foot Score (Sanders et al. 1993) or AOFAS (American Orthopedic Foot and Ankle Society) Ankle Hindfoot Scale (Kitaoka et al. 1994a) show up all limitations after calcaneal fractures?

Patients and methods

Between 1995 and 2001, 143 patients underwent surgery for 161 calcaneus fractures in our department. 82 patients had one-sided intraarticular fractures but no other injuries, and had been treated by open reduction and internal fixation. 71 of these patients (64 men) had a follow-up examination after a median of 32 (11–90) months and formed the patient series for this study. The median age at the time of injury was 42 (22–73) years. The fracture was on the left side in 35 patients and on the right side in 36 patients. 62 fractures resulted from falls and 9 from an heavy impact of the heel in sports or other recreational activities. 39 patients had a work-related injury. Indication for surgery was an incongruous subtalar joint with displacement of 2 mm or more. There were no open fractures in this group.

Classification according to Sanders et al. (1993) showed 33 type II, 27 type III and 11 type IV fractures. According to Zwipp et al. (1993), 9 patients had a 3-part, 42 had a 4-part and 20 had a 5-part fracture. Fractures were treated at a median of 9 (2–20) days after injury until initial swelling had resolved. 15 patients had an open reduction and internal fixation by a combined medial and lateral approach (1995–1997) and 56 by an extended lateral approach (after 1997). In the bilateral approaches, the fracture was fixed by lag screws in the posterior facet of the subtalar joint, combined with an AO 'H-plate' for the medial wall. In lateral approaches, fixation was by a calcaneus plate. All operations were performed by 3 experienced surgeons. Autologous bone grafting was performed in all patients. Full weight bearing was allowed after 6–12 weeks. In 8 cases, further surgery for complications was necessary because of deep infection (5), wound margin necrosis (2), and insufficient reduction of the posterior facet (1). 12 minor complications were treated nonoperatively (10 small wound margin necrosis, 1 superficial infection and 1 hematoma).

40 patients were able to work within 6 months, 28 within 18 months and 3 patients were unable to work. 34 patients could wear any kind of shoe, and 37 needed orthopedic shoes. 24 patients received worker's compensation and in 4 cases further surgery was performed because of painful arthrosis of the subtalar joint. Radiographic evaluation showed a normal Böhler's angle in 37 cases, an angle between 20 and 29 degrees in 6, between 10 and 19 degrees in 23 cases, and 5 patients had a Böhler's angle of less than 10 degrees. The articular surface of the subtalar joint was restored anatomically in 37 patients. 33 patients showed a step or gap up to 2 mm and 1 patient had a step of more than 5 mm. Significant arthrotic changes of the subtalar joint such as osteophytes, subchondral sclerosis, and joint space narrowing were found in 25 cases. 27 patients had only minor changes, without any signs of joint space narrowing. 15 joints had no arthrotic changes and 4 patients had received an arthrodesis of the subtalar joint.

Functional status was assessed by means of the Maryland Foot Score (Sanders et al. 1993) and the Ankle Hindfoot Scale of the American Orthopedic Foot and Ankle Society (AOFAS) (Kitaoka et al. 1994a), and general health status was assessed by use of the German SF-36 form (Bullinger and Kirchberger 1998). Plane radiographs (lateral, axial and Broden's view) were taken in all patients. All follow-up examinations were performed by one of the authors (JPH) who had not been involved in the treatment of the patients.

The data from normal subjects were taken from a German population database (Robert-Koch-Institut 2000), which includes over 7000 people. Each patient was matched to a normal subject using age, gender, social state, comorbidity and place of residence as matching criteria. These criteria have been proven to influence the general health status (Bellach et al. 2000). The socioeconomic level was assessed in both groups by taking income, educational achievement and occupational position

Table 1. Matching criteria of patients against subjects from German normative data

Matching criteria	Specification	Patients	Matched subjects
Age (years)	Minimum	22	21
	Maximum	73	71
	Mean	44	44
	SD	10	10
Gender (N)	Male	64	64
	Female	7	7
Social status (N) [a]	Upper	4	4
	Intermediate	56	56
	Lower	11	11
Place of residence (N)	East Germany	70	70
	West Germany	1	1
Comorbidity (N)	Without	28	28
	One or more [b]	43	43

[a] according to Winkler et al. (1998)
[b] no agreement in either group

into account (Winkler 1998). The normal subjects selected served as the control group.

Matching for age, gender, social state and place of residence was successful for all 71 patients. Matching for comorbidity was successful for 28 patients. The remaining 43 patients had 2 or more additional diseases, in different combinations, so that no corresponding subject could be found in the normal population database (Table 1).

Statistics

Values of the total SF-36 score and of all subscores of both groups were compared by non-parametric Wilcoxon matched-pairs test. The same procedure was performed with patients rated good or excellent according to the Maryland Foot Score and also the AOFAS Ankle Hindfoot Scale. In addition, in order to compare the results of classical outcome measures with results from the SF-36 form, the values of the SF-36 scores were correlated with the values of the Maryland Foot Score and AOFAS Ankle Hindfoot Scale (Spearman correlation coefficient). We used SPSS for Windows (version 11.0) software.

Results

The mean AOFAS Ankle Hindfoot Score was 72 (range 17–100, SD 18) points, and the mean Maryland Foot Score was 80 (range 35–100, SD 14) points. 35 patients according to AOFAS and 48 patients according to the Maryland Foot Score were rated good or excellent. Because of variations in the rating between AOFAS and Maryland Foot Score, only 32 patients could be classified as having a good or excellent outcome in both systems (Table 2).

Table 2. Results of AOFAS Ankle Hindfoot Scale and Maryland Foot Score for 71 patients

	AOFAS Ankle Hindfoot Scale	Maryland Foot Score
Excellent	10	21
Good	25	27
Fair	29	21
Poor	7	2

In total and in all subscores of the SF-36 questionnaire, patients achieved significantly lower scores than matched subjects from the normal population database (Table 3). Table 4 contains the same data for patients with good or excellent results according to the AOFAS Ankle Hindfoot Scale and the Maryland Foot Score, as well as their matched subjects. Differences between both groups were smaller than in the all-patients group and were statistically significant in 6 of 9 scores.

The highest correlation between AOFAS Ankle Hindfoot Scale, the corresponding Maryland Foot Score and the SF-36 subscores was found for the "physical function" and the "bodily pain" subscore of the SF-36 questionnaire. The Maryland Foot Score showed better correlation when compared to the AOFAS Ankle Hindfoot Scale. All other correlations were weak ($r < 0.5$, Table 5).

Discussion

Several authors have published large series with good or excellent results after surgery of intraarticular calcaneal fractures (Bezes et al. 1993, Sanders et al. 1993, Zwipp et al. 1993). However, most authors have compared their results to historical data and have also used different outcome measures. In addition, complications after surgery were not infrequent, and some of them were serious.

Table 3. Data for all subscores and the total SF-36 score in all patients and controls

	Patients		Normative data		Pairwise difference		P-value [a]
	Mean	SD	Mean	SD	Mean	SD	
Physical functioning	61	25	87	23	26	30	<0.001
Physical role	52	43	86	34	35	44	<0.001
Bodily pain	49	27	76	26	26	36	<0.001
General health	58	20	68	19	10	26	0.002
Vitality	56	20	64	17	7.5	26	0.02
Social functioning	79	23	91	17	12	30	0.002
Emotional role	74	40	92	26	19	46	0.003
Mental health	69	21	77	14	8.7	24	0.004
Total	63	22	81	15	19	23	<0.001

[a] Wilcoxon matched-pairs test (71 cases in each group)

Table 4. Data for all SF-36 subscores and the total SF-36 score in the treated patients with good or excellent AOFAS Ankle Hindfoot Scores and Maryland Foot Scores, and controls

	Patients		Normative data		Pairwise difference		P-value [a]
	Mean	SD	Mean	SD	Mean	SD	
Physical functioning	73	25	90	19	16	26	0.002
Physical role	68	42	96	18	28	42	0.002
Bodily pain	64	28	81	23	17	38	0.02
General health	64	20	70	20	6.0	26	0.2
Vitality	59	21	67	16	7.5	28	0.1
Social functioning	83	20	96	7.9	14	22	0.003
Emotional role	78	39	95	21	17	42	0.04
Mental health	72	21	78	14	5.9	25	0.2
Total	70	22	84	12	14	22	0.004

[a] Wilcoxon matched-pairs test (32 cases in each group)

Table 5. Correlation of AOFAS Ankle Hindfoot Scale and Maryland Foot Score with total SF-36 score and all SF-36 subscores

	AOFAS Ankle Hindfoot Scale [a] r	Maryland Foot Score [a] r
Physical functioning	0.5	0.6
Physical role	0.4	0.5
Bodily pain	0.6	0.6
General health	0.4	0.5
Vitality	0.3	0.3
Social functioning	0.2	0.2
Emotional role	0.2	0.3
Mental health	0.2	0.2
Total	0.4	0.5

[a] Spearman correlation coefficient, 71 cases

Only a few prospective randomized trials comparing surgical with nonsurgical treatment have been published (Parmar et al. 1993, Thordarson and Krieger 1996). Randle et al. (2000) reviewed these studies and could not find sufficient evidence to argue that operative treatment should be recommended. The latest published prospective randomized trial by Buckley et al. (2002), with over 300 patients, confirmed that there were no differences between patients treated operatively and nonoperatively, but they could identify subgroups of patients who might benefit from surgery.

Previous studies have used classical functional outcome measures such as AOFAS Ankle Hindfoot Scale (Thordarson and Krieger 1996, Ebraheim et al. 2000), or Maryland Foot Score (Sanders et al.

1993, Laughlin et al. 1996). Others have performed gait analysis (Mittlmeier et al. 1993, Kitaoka et al. 1994b, Siegmeth et al. 1996, Kinner et al. 2002) or an extensive radiographic analysis (Richards and Bridgman 2001).

Although research on outcomes has shown that patient-oriented instruments are very suitable in many fields of orthopedics, only a few studies have been done using the SF-36 form in patients with intraarticular calcaneal fractures (Hildebrand et al. 1996, Loucks and Buckley 1999, Heffernan et al. 2000, Longino and Buckley 2001, Tufescu and Buckley 2001, Buckley et al. 2002). Buckley et al. (2002) found a mean SF-36 score of 64 points in nonoperatively treated patients and 69 in operatively treated patients, but the differences were not statistically significant. The mean score in our patients was 5 points less than in the analysis of Buckley. The mean score of matched subjects from the German normal population was 81 and the mean score from the US normative data of men between 25 and 65 years of age is 89 points (Ware 1993). Thus, differences between patients and subjects from normal populations are comparable in both countries. Hildebrand (1996) could demonstrate similar results with a mean score of 63 in 15 patients with intraarticular calcaneal fractures treated operatively or nonoperatively. Stiegelmar et al. (2001) matched 28 multiply injured patients with foot injuries to 28 similar patients without foot injuries, and found a mean SF-36 score of 49 in the first group and of 69 in the latter group. All of these studies and our own findings confirm the clinical experience that patients with intraarticular calcaneal fractures should expect strong limitations in many aspects of their general health.

Differences between normative data and patients rated excellent or good according to widely used scores were smaller, but significantly so, in 6 of 9 scores. Functional and pain scores in the patients showed the highest differences compared to normal population. This means that a good result achieved with the AOFAS Ankle Hindfoot Scale or Maryland Foot Score is good in a population with intraarticular calcaneal fractures but does not provide the same general health status as in a comparable normal population. Thus, the SF-36 questionnaire can detect limitations to be expected in general health after intraarticular calcaneus fractures. Since similar analyses have not been published before, further studies are necessary to confirm our findings.

Only "physical functioning" and "bodily pain" were reproduced appropriately by the AOFAS Ankle Hindfoot Scale and the Maryland Foot Score when compared with the SF-36. Similar results have been reported by Heffernan et al. (2000). These findings confirm that the SF-36 detects more limitations in general health status than other classical instruments.

Our study has some limitations. The study design should eliminate factors affecting general health by matching the treatment group to identical subjects of the normal population. Full matching was successful in 4 out of 5 criteria and only partially for the fifth criterion: comorbidity. However, Bellach et al. (2000) have shown that comorbidity may have an effect on general health status. Another methodological problem may be that we used 2 surgical approaches, but we assume that this had no major effect on our results.

The SF-36 form is not a disease-specific instrument; therefore, it is not capable of detecting specific symptoms and limitations after calcaneal fractures, such as walking distances or restricted range of motion. It can only provide the state of general health. To review sequelae of intraarticular calcaneal fractures completely, disease-specific or region-specific instruments should also be applied. AOFAS Ankle Hindfoot Scale or Maryland Foot Score are possible instruments, and patient-oriented region-specific or disease-specific instruments are already available (Hildebrand et al. 1996, Morin et al. 1998).

No competing interests declared.

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