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Prognostic factors of health-related quality of life in patients after tibial plafond fracture. A pilot study

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ABSTRACT

Background: Tibial plafond fractures are a uncommon injury, and the outcomes described in literature are generally poor. The purposes were to determine the effect of the tibial plafond fractures on general health-related quality of life, and to examine the factors that influence these outcomes.
Methods: Retrospective study of 43 patients with average age of 45.6 (range 18–69) years who were also invited for a clinical and radiological reassessment. The primary outcome measure was quality of life assessed by the Short Form-36 questionnaire. Visual analogue scale for pain, and motion of both ankle and subtalar joints were also assessed. Radiological evaluation was performed to assess bone healing, fracture reduction quality, and tibial alignment.
Results: The mean follow-up at last visit was 8.1 (range, 4–12) years. Patients who had suffered plafond fracture had significantly poorer quality of life compared with age- and gender-matched general population of our country regardless of the treatment method used. Multivariate analyses showed that the age had influence on the emotional outcomes, educational level and fracture pattern on physical outcomes, and marital status, fracture reduction quality, and ankle motion on both physical and mental component summaries.
Conclusion: Tibial plafond fractures have a significant negative impact on general health-related quality of life regardless of the operative treatment used which reflects injury severity. In addition, psychosocial characteristics of patients may influence the outcomes.

Introduction

Tibial plafond fractures are uncommon, and are difficult to manage [1]. These fractures are usually the result of high energy injury, and are typically associated with joint surface comminution, significantly displaced fracture fragments, and often with severe soft tissue closed or open trauma [2]. Various treatment strategies have been proposed for their treatment but no specific method has demonstrated its superiority as compared with others [3]. However, the two-staged procedure, with the use of the external fixation in the first stage and the open reduction and internal fixation in the second, has been widely applied in the treatment of these fractures [4]. Outcomes after tibial plafond fractures depend on multiple factors, such as severity of the trauma, soft tissue conditions, comorbidities, and quality of reduction [3,5]. Treatment of these fractures is challenging because poor functional outcomes have generally been reported in the literature, although with a broad range of results [1]. While successful outcomes can be expected in nearly 80% of low energy fractures, successful outcomes are often less than 60% for high energy fractures [1].

Several studies have investigated the clinical outcomes after tibial plafond fracture but most of them focused on a specific operative technique or complications such as infection, bone healing or posttraumatic osteoarthritis [4,6,7]. However, few studies have focused on the quality of life after these fractures using validated outcome measures to assess specifically the patient's perspective in relation to their health status [2,8,9]. The Short Form-36 Health Survey (SF36) [10] is a validated instrument of general health assessment, and to assess the effect of the fracture on physical and emotional health [11].

The purpose of this study was to determine the effect of the tibial plafond fractures on general health-related quality of life, and to examine the factors that influence these outcomes.

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Materials and methods

A retrospective study was designed to assess quality of life after tibial plafond fracture. Selected patients were also invited for a clinical and radiological additional assessment. The study was approved by our institutional ethics committee, and informed consent was required. All consecutive patients who had been treated for a tibial plafond fracture at our centre between January 2002 and December 2010 were eligible for study. The inclusion criteria were age 18 years or older, unilateral tibial plafond fracture, AO/OTA [12] type 43-A, 43-B or 43-C, displaced fracture surgically treated, and postoperative follow-up for at least 2 years. No other exclusion criteria were considered because of the low prevalence of patients with this fracture.

Forty-three patients met the inclusion criteria, and their characteristics are shown in Table 1. All patients had injury radiographs and CT scans which were reviewed to identify the fracture patterns. Medical charts were used to identify patient characteristics on admission, and operative procedures. All patients had routine clinical and radiological evaluations for at least 2 postoperative years. The average age at surgery was 45.6 (range, 18–69) years. There were 30 males and 13 females. Regarding marital status, 25 were married, 13 unmarried, and 5 divorced or widowed. Educational levels were bachelor's degree in 22 patients, high school diploma in 16, and elementary studies in 5. The cause of injury was a fall from a height in 28 patients, traffic accident in 12, and crushing injury in 3. According to Gustilo system [13], there were 9 open fractures (3 grade-I, 1 grade-II, and 5 grade-III). According to AO/OTA system [12], there were 6 type-A fractures, 19 type-B, and 18 type-C. Nine patients had other associated injuries.

Table 1
Characteristics of patients.

	Overall	External fixation	Internal fixation	*p*-value*
n	43	17	26	
Age (yr)**	45.6 (16–69)	47.2 (24–65)	46.4 (16–69)	0.921
Male/Female	30/13	12/5	18/8	0.599
Marital status				0.834
Married	25	9	16	
Unmarried	13	6	7	
Divorced	5	2	3	
Education				0.746
Bachelor	22	9	13	
School	16	5	11	
Elementary	5	3	2	
Injury				0.384
Fall	28	4	8	
Traffic	12	11	17	
Other	3	2	1	
AO fracture				0.437
A	6	4	2	
B	19	6	13	
C	18	7	11	
Gustilo				0.012
Open	9	7	2	
Closed	34	10	24	
Complications				0.211
Skin necrosis	4	1	3	
Infection	5	1	4	
Bone healing				
Union time (w)**	12.1	11.7	12.3	0.894
Delayed union	(5–56)	(6–28)	(5–56)	0.419
Malunion	7	2	5	0.640
	2	1	1	
Arthrosis	2	1	1	0.640

* Comparing both treatments.
** Continuous variables as average (range).

On admission, tibial fractures were in initially treated with plaster splint (4 patients) or external fixation (39 patients). The definitive tibial stabilisation was external fixation in 17 patients, and open reduction and internal fixation (locking plates and screws) and bone grafts when necessary in 26 patients. In these last patients, the definitive stabilisation was performed when the skin condition has improved with an average time from injury to operation of 7.9 (range, 6–14) days. Early complications were seen in 9 patients (21%), including skin necrosis in 4, wound superficial infection in 3, and deep infection in 2. There was no significant difference in complication rate between the two treatment methods ($p = 0.211$). All fractures healed in an average time of 16.3 (range, 7–38) weeks. Delayed unions were seen in 3 patients. There was no significant difference for average time to union regarding operative treatment option ($p = 0.894$). Seven tibial malunions and one posttraumatic osteoarthritis were observed in each of the methods of treatment. There was no ankle fusion due to posttraumatic osteoarthritis.

Evaluations

All 43 patients who met inclusion criteria were contacted and were invited to return for clinical reassessment. All patients accepted and they signed an informed consent. A clinical and radiological examination including CT scan was performed at this last visit. The primary outcome measure was the Short Form-36 (SF36) health survey questionnaire validated for our country [14]. The SF-36 is one of the most widely used and evaluated generic health-related quality of life questionnaires. It is a 36-item auto-administered questionnaire that produces scores in eight domains relating to the patient's quality of life. These are physical functioning, role limitation due to physical problems, bodily pain, general health perception, emotional vitality, social functioning, role limitation due to emotional problems and mental health [10]. To calculate every item score, the raw scores were coded and recalibrated following the standard guidelines [15], and then they were transformed to 0 (worst health) to 100 (best health) scale. The SF36 results in each category were compared with gender- and age-matched reference values at our country [16]. Physical and mental component summary scores were also used to identify risk factors for poorer quality of life. Furthermore, a visual analogue scale (VAS) (0: pain-free; 10: worst possible pain) was used. Motion of both the ankle (dorsiflexion and plantar flexion) and subtalar (inversion and eversion) joint was measured bilaterally with a goniometer. Subtalar motion was assessed by the technique described by McMaster [17].

Standard radiographs (anteroposterior, mortise and lateral views) were taken in each visit during the period of followup. At last visit, radiographs and CT scans of both ankles were taken. Quality of reduction was classified as successful or unsuccessful based on the radiological criteria of Teeny and Wiss [5]. Successful reduction was defined as less than 2 mm of joint incongruity and less than 5° of varus/valgus angulation in any plane. Fracture union was defined as radiological callus in two planes. All measurements were performed on digital radiographs using the computed measurement tools, and all were performed by the same observer to minimise error.

Statistical analysis

Statistical analysis was performed using SPSS software v. 10.0 (SPSS Inc., Chicago, USA). In all analysis, statistical significance was considered for p values less than 0.05. Normality was assessed by Smirnov–Kolmogorov test. Preliminary bivariate analyses included parametric and nonparametric two-tailed tests were conducted to examine the primary outcomes according to the patient

characteristics, injury, and treatment. Categorical data were evaluated using chi-square or Fisher's exact tests, and continuous variable by Student *T*-test, Mann–Whitney *U*-test, or analysis of variance (anova). Subsequently, step-wise multiple logistic regression analysis was then used to test for the effect of each factor adjusted for the others. All variables were included in the logistic regression analysis so as not to miss any possible interactions that may show a relationship unseen in bivariate analysis.

The sample size was assessed for estimation of a relative risk in a cohort study. Using an estimated fracture prevalence of one per thousand (samples ratio of 0.001), assuming a standardised average difference of 0.45 (clinical relevant difference of 15 points in health-related quality of life), and confidence level of 0.95, to obtain a power of 0.80 required 39 patients.

Results

The average time from injury to last visit was 8.1 (range, 4–12) years. There were no significant differences in patient characteristics (Table 1) between the two definitive operative treatments, except in open fracture rate ($p = 0.012$). At the time of injury, 37 patients were workers and 6 retired, whereas at the time of last visit 26 were workers and 17 retired ($p = 0.006$), including 14 who had changed occupation because of ankle injury.

At last follow-up, the average motion in the injured ankle was 9.2° (range, 0–26°) for dorsiflexion, and 26.2° (range, 6–44°) for plantar flexion The range of motion (ROM) on the injured ankle (average 35.2°; standard deviation 18.3°) was significantly lower than on the uninjured ankle (average 60.3°; sd 9.9°) ($p = 0.001$). Regarding subtalar motion in the injured ankle, the average inversion was 9.3° (range, 0–14°), and eversion 7.6° (range, 0–12°). The subtalar ROM on the injured ankle (average 16.9°; sd 9.1°) was significantly lower than on the uninjured ankle (average 30.5°; sd 10.3°) ($p = 0.001$). No significant difference in ROM was found between the fracture types ($p = 0.632$) or treatment methods ($p = 0.567$).

The average VAS-pain during walking was 5.8 (range, 0–10). A lower score of 4 was found in 50% of patients. No significant difference in VAS score was found between the fracture types ($p = 0.784$) or treatment methods ($p = 0.897$).

The SF36 questionnaire was completed by all 43 patients, and the outcomes are shown in Table 2. Comparison with the gender- and age-matched country norms showed significantly worse scores in all categories ($p = 0.001$). In bivariate analyses, there were significant differences in some variables. Significantly lower scores in physical component summary (PCS) (Table 3) were found in divorced patients ($p = 0.035$), type-C fracture ($p = 0.037$), open fracture ($p = 0.042$), and onset of complications ($p = 0.040$). Regarding mental component summary (MCS) (Table 4), significantly lower scores were found in patients whose cause of injury was a fall from a height ($p = 0.008$), who had open fracture ($p = 0.042$), or decreased ankle motion as compared with the uninjured ankle ($p = 0.005$).

However, the multivariate analysis showed other significant differences. Regarding PCS (Table 3), significantly lower scores were found in divorced patients ($p = 0.033$), elementary educational level ($p = 0.004$), type-C fracture ($p = 0.002$), unsuccessful reduction ($p = 0.025$), and decreased motion as compared with the uninjured ankle ($p = 0.015$). Regarding MCS (Table 4), significantly lower scores were found in patients aged over 55 years ($p = 0.028$), divorced ($p = 0.021$), unsuccessful reduction ($p = 0.017$), and decreased motion as compared with the uninjured ankle ($p = 0.001$).

Table 2
SF-36 category values in the study group and gender- and age-matched country norms.

	Fracture	Country norms	*p*-value
Physical function	48.4 (30.9)	90.3 (17.1)	0.001
Role physical	32.5 (41.3)	84.3 (15.8)	0.001
Bodily pain	39.9 (26.2)	81.9 (16.0)	0.001
General health	55.5 (20.4)	70.9 (19.6)	0.001
Vitality	54.5 (20.3)	71.8 (21.0)	0.001
Social functioning	56.9 (26.6)	94.1 (16.6)	0.001
Role emotional	55.0 (45.3)	90.3 (18.2)	0.001
Mental health	60.8 (21.1)	77.9 (18.7)	0.001
Physical summary	44.0 (24.6)	81.9 (16.4)	0.001
Mental summary	56.7 (26.9)	83.6 (18.5)	0.001

Data are shown as average (standard deviation).

Table 3
Multivariate analysis with physical component summary score as dependent variable.

	Total $n = 43$	Bivariate		Multivariate	
		Average (SD)	*p*	OR (95% CI)	*p*
Gender					
Male	30	43.4 (27.3)		Ref	
Female	13	46.0 (28.4)	0.177	1.0 (0.7–1.4)	0.764
Age					
≥55 years	15	40.0 (26.0)		Ref	
<55 years	28	48.2 (28.6)	0.361	0.9 (0.8–1.0)	0.245
Marital					
Married	25	49.0 (18.3)		Ref	
Unmarried	13	46.2 (28.0)	0.035	0.7 (0.9–1.3)	0.651
Divorced	5	34.1 (13.8)		1.4 (1.0–1.9)	0.033
Education					
Elementary	5	39.0 (28.3)		Ref	
Other	38	48.0 (24.4)	0.450	1.5 (1.6–2.4)	0.004
Injury					
Fall	31	40.6 (22.3)		Ref	
Other	12	52.0 (25.4)	0.155	0.9 (0.5–1.4)	0.293
Fracture type					
A	6	52.8 (17.6)		Ref	
B	19	51.1 (22.5)	0.037	1.1 (0.7–3.2)	0.624
C	18	31.0 (12.2)		1.7 (1.0–2.1)	0.002
Open fracture					
Yes	9	36.2 (20.9)		Ref	
No	34	50.6 (18.5)	0.042	1.0 (0.8–1.3)	0.456
Treatment					
External Fixation	17	40.8 (22.4)		Ref	
Internal fixation	26	46.2 (27.5)	0.503	1.0 (0.9–1.0)	0.590
Complication					
Yes	9	32.6 (22.7)		Ref	
No	34	47.9 (18.4)	0.040	0.7 (0.6–1.4)	0.327
Union time					
>20 weeks	9	38.5 (20.4)		Ref	
≤20 weeks	34	49.0 (24.2)	0.240	1.5 (0.4–10.2)	0.621
Reduction					
Unsuccessful	14	38.2 (19.7)		Ref	
Successful	29	50.0 (20.2)	0.077	0.7 (0.2–0.9)	0.025
ROM[a]					
Asymmetric	35	42.7 (26.4)		Ref	
Symmetric	8	61.3 (23.6)	0.075	0.8 (0.3–0.9)	0.015
Arthrosis					
Yes	2	42.7 (23.2)		Ref	
No	41	44.4 (28.5)	0.934	1.0 (0.7–12.9)	0.721

SD: standard deviation. CI: confidence interval. OR: Odds ratio. Ref: reference value.
[a] Range of motion compared with uninjured ankle.

Discussion

Tibial plafond fractures are severe injuries difficult to treat, and often result in poor functional outcomes [1], which can have a significant impact on health-related quality of life. In a multicentre review of more than 300 fractures treated surgically only 38% of

Table 4
Multivariate analysis with mental component summary score as dependent variable.

	Total $n=43$	Bivariate		Multivariate	
		Average (SD)	p	OR (95% CI)	p
Gender					
Male	30	58.5 (28.0)		Ref	
Female	13	52.9 (29.5)	0.556	0.8 (0.4–1.4)	0.627
Age					
≥55 years	15	50.1 (20.1)		Ref	
<55 years	28	60.3 (28.4)	0.224	1.3 (1.0–1.9)	0.028
Marital					
Married	25	59.5 (27.0)		Ref	
Unmarried	13	57.4 (31.0)	0.129	1.1 (0.5–2.3)	0.735
Divorced	5	38.8 (29.1)		1.7 (1.0–3.2)	0.021
Education					
Elementary	5	42.9 (30.3)		Ref	
Other	38	57.8 (28.6)	0.282	0.8 (0.6–1.4)	0.758
Injury					
Fall	31	35.6 (32.6)		Ref	
Other	12	67.5 (37.0)	0.008	0.8 (0.6–1.4)	0.159
Fracture type					
A	6	57.8 (24.5)		Ref	
B	19	54.6 (35.0)	0.052	0.7 (0.3–2.7)	0.625
C	18	36.9 (29.5)		0.8 (0.2–1.9)	0.438
Open fracture					
Yes	9	35.7 (24.1)		Ref	
No	34	58.1 (26.8)	0.042	0.7 (0.4–1.0)	0.053
Treatment					
external	17	57.3 (23.3)		Ref	
Fixation	26	52.4 (30.4)	0.575	0.6 (0.1–12.5)	0.496
Internal fixation					
Complications					
Yes	9	47.0 (22.2)		Ref	
No	34	58.3 (26.3)	0.244	0.8 (0.5.7.4)	0.551
Union time					
>20 weeks	9	44.1 (20.4)		Ref	
≤20 weeks	34	58.5 (29.3	0.174	1.1 (0.3–2.4)	0.583
Reduction					
Unsuccessful	14	39.5 (22.6)		Ref	
Successful	29	55.2 (25.5)	0.056	1.7 (1.1.–2.6)	0.017
ROM[a]					
Asymmetric	35	37.8 (20.5)		Ref	
Symmetric	8	61.2 (18.3)	0.005	2.1 (1.1–1.9)	0.001
Arthrosis					
Yes	2	53.9 (10.3)		Ref	
No	41	57.4 (21.6)	0.974	0.6 (0.2–1.4)	0.561

SD: standard deviation. CI: confidence interval. OR: Odds ratio. Ref: reference value.
[a] Range of motion compared with uninjured ankle.

successful clinical results with only 28% of patients walking without pain were found [18]. Pollak et al. [9] reported that 35% of their patients had substantial ankle stiffness and pain, with 29% reporting persistent swelling. These fractures have been widely studied, but the most of previous studies focused on the improvement of treatment methods or complication rate [4,19]. However, few studies have examined the patients' quality of life after fracture with a well-validated assessment tools [2,8,9].

In the present study a validated, self-administered questionnaire of general health was used to assess specifically the patient's perspective on their health status after fracture. Our main outcome was that the patients who had suffered tibial plafond fracture had significantly poorer quality of life as compared with the age- and gender-matched general population regardless of the treatment method used. Multivariate analyses showed that the age had influence on the emotional outcomes, educational level and fracture pattern on physical outcomes, and marital status, fracture reduction quality, and ankle motion on both physical and mental component summaries. Thus, also a critical result was the importance of the psychosocial impact on the outcomes.

In the literature, outcome after tibial plafond fracture depend on multiple factors. However, comparisons are difficult to perform because of variability of the samples, fracture types, and outcome measurements. With the use of SF36, Sands et al. [2] reported poorer outcomes than the general population in all SF36 categories despite adequate reductions achieved after surgery, particularly with regard to physical function and the role of physical function. Pollak et al. [9] reported also significantly lower patient scores than aged-matched controls, especially for role disability due to physical health problems. Conroy et al. [8] reported similar findings. Their outcomes were significantly lower in physical function and role physical, as well as in physical component summary as compared with the USA norms, but not in the other categories of the SF36, or the mental component summary. Marsh et al. [19] found that only the SF36 categories for physical function, physical role, and bodily pain were significantly decreased.

In this study, age over 55 years negatively influenced the mental health score, which was similar to other studies [19]. Nilsson et al. [20] found the patients older 65 years had lower scores as compared with the general population in physical function, role physical, and role emotional categories. Williams et al. [21] reported that female gender led to better ankle scores.

In the present study, better SF36 scores were achieved in married patients or with higher education level, which indicated the importance of the psychosocial component on the outcomes in our study. Ware et al. [10] reported that psychosocial factors increased pain severity, and emotional distress. Other studies [9,21] also found that college graduation, and no involvement in workmans' compensation led to better ankle scores, and that level of education was the primary predictor in returning to work.

Despite adequate treatment of type C fractures with joint reconstruction and restoration of distal tibia alignment, outcomes were not always favourable in our study, which was similar to other [3,8]. Contrary, Kormak et al. [7] found no significant correlation between functional score and fracture type, although functional score was significantly related to the quality of reduction. Williams et al. [6] also reported that injury severity and quality of reduction were less important than patient demographic factors in predicting the outcome.

The onset of posttraumatic arthritis is a controversy factor because its effect on clinical outcome was not clear. Similar to our study, other authors found a poor association between radiological degenerative changes and functional outcomes [9,19]. However, the quality of reduction and ankle motion were predictive factors for poor quality of life in our study. Ovadia and Beals [22] found that the most important factors affecting the clinical results were the type of the fracture, method of treatment, and quality of the reduction. Korkmaz et al. [6] reported that the most important factor was the quality of reduction.

Limitations of this study include the intrinsic weakness of a retrospective study. Although the sample size was relatively small, we obtained a reasonable statistical power. However, the power calculation was only based on the main outcome measure, and could be a lack of statistical power for some of the other variables. On the other hand, the SF36 questionnaire is a validated instrument for assessing overall outcomes and has been used in previous studies of patients with tibial plafond fractures [13,14]. However, the SF36 can have a limited effect to identify patients who have functional problems after ankle fracture when the measured variable has little variability [11].

In conclusion, with use of a validated outcome measure we found that tibial plafond fractures had a significant negative impact on general health-related quality of life regardless of the operative treatment used. This finding reflects injury severity. In addition, psychosocial characteristics of the patients may influence

the outcomes. Larger and longer studies are needed to validate these findings.

Conflict of interest

The authors declare that they have no conflict of interest.

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