■ HIP

Health status after periprosthetic proximal femoral fractures

A LONGITUDINAL STUDY

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Aims

Periprosthetic proximal femoral fractures (PFFs) are a major complication after total hip arthroplasty (THA). Health status after PFF is not specifically investigated. The aim of this study is to evaluate the health status pattern over two years after sustaining a PFF.

Methods

A cohort of patients with PFF after THA was derived from the Brabant Injury Outcomes Surveillance (BIOS) study. The BIOS study, a prospective, observational, multicentre follow-up cohort study, was conducted to obtain data by questionnaires pre-injury and at one week, and one, three, six, 12, and 24 months after trauma. Primary outcome measures were the EuroQol five-dimension three-level questionnaire (EQ-5D-3L), the Health Utility Index 2 (HUI2), and the Health Utility Index 3 (HUI3). Secondary outcome measures were general measurements such as duration of hospital stay and mortality.

Results

A total of 70 patients with a PFF were included. EQ-5D utility scores were significantly lower on all timepoints except at six months' follow-up compared to pre-injury. EuroQol visual analogue scale (EQ-VAS) scores at one month's follow-up were significantly lower compared to pre-injury. The percentage of reported problems at two years was higher for all dimensions except anxiety/depression when compared to pre-injury. The mean EQ-5D utility score was 0.26 higher in males compared to females (95% confidence interval (CI) 0.01 to 0.42; p = 0.003). The mean EQ-VAS score for males was 8.9 points higher when compared to females over all timepoints (95% CI 1.2 to 16.7; p = 0.027). Mortality was 10% after two years' follow-up.

Conclusion

PFF patients are a frail population with substantial functional impairment at baseline. Post-injury, they have a significant and clinically relevant lower health status two years after trauma when compared to pre-injury. Health status improves the most between one and three months after injury. Two years after PFF, more patients experience problems in mobility, self-care, usual activities, and pain/discomfort than pre-injury.

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Introduction

Periprosthetic proximal femoral fracture (PFFs) is the third most common cause of revision surgery following total hip arthroplasty (THA).[1-5] Older age and osteoporosis are the principal risk factors for PFF. Other risk factors are patient-specific, such as rheumatoid arthritis or corticosteroid use, or related to surgery such as the use of an uncemented stem or revision surgery.[5-9] As the population ages, PFF is likely to represent an increasing burden for healthcare systems worldwide.[10,11]

Current research regarding PFF is mainly focused on classification systems and treatment methods. The most widely used classification systems are Vancouver classification and the more recently introduced Unified Classification System (UCS).[12-15] Traditionally, patients are offered open reduction and internal fixation (ORIF) when the femoral stem is well-fixed, and stem revision with or without ORIF for loose stems.[16-18] More recent literature suggests that fracture type as well as stem design, type of fixation, and assessment of

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Table I. Baseline characteristics.

Characteristic	Total	BIOS participants	Non-responders	p-value
Patients, n (%)	70 (100)	36 (51)	34 (49)	
Mean age, yrs (SD)	78.8 (10.2)	74.7(11.6)	83.1 (6.7)	0.001
Male, n (%)	22 (31.4)	10 (27.7)	12 (35.3)	0.495
Mean days of hospital stay (SD)	11.7 (6.7)	11.3 (5.6)	12.2 (7.9)	0.618
ASA grade, n (%)				
I	5 (7)	5 (14)	0 (0)	
II	36 (51)	21 (58)	15 (44)	
III	19 (27)	6 (17)	13 (38)	
IV	0 (0)	0 (0)	0 (0)	
Missing	10 (14)	4 (11)	6 (9)	
Educational level, n (%)				
Low	N/A	24 (67)	N/A	
Middle	N/A	4 (11)	N/A	
High	N/A	5 (14)	N/A	
Missing	N/A	3 (8)	N/A	
GFI score, n (%)				
Frail (score ≥ 4)	N/A	5 (14)	N/A	
Not frail (score 1-2-3)	N/A	7 (19)	N/A	
Missing	N/A	24 (67)	N/A	
Mean status score (SD)	0.063 (1.03)	0.144 (0.996)	-0.264 (1.077)	0.502
Place of discharge, n (%)				
Home	22 (31)	14 (39)	8 (24)	
Nursing home	16 (23)	7 (19)	9 (26)	
Rehabilitation centre	15 (21)	8 (22)	7 (21)	
Other hospital	6 (9)	3 (8)	3 (9)	
Other institution	3 (4)	2 (6)	1 (3)	
Missing	4 (6)	2 (6)	2 (6)	
Treatment, n (%)				
Nonoperative	N/A	4 (11)	N/A	
ORIF	N/A	2 (6)	N/A	
ORIF: plate	N/A	17 (28)	N/A	
Stem revision	N/A	5 (14)	N/A	
Stem revision with ORIF	N/A	8 (22)	N/A	
Mortality, n (%)				
< 30 days	2 (2.8)	1 (2.8)	1 (2.9)	0.967
< 1 yr	5 (7.1)	2 (5,6)	3 (8.8)	0.596
< 2 yrs	7 (10)	4 (11.1)	3 (8.8)	0.750

ASA, American Society of Anesthesiologists; BIOS, Brabant Injury Outcomes Surveillance; GFI, Groningen Frailty Index; N/A, not available; ORIF, open reduction and internal fixation; SD, standard deviation.

the cement (if present) should also have an important influence on the choice of treatment.[12,19-25] Outcome measurements in the current literature are often mortality, union rate, time to union, subsidence, and operation-specific outcomes, such as blood loss, time of surgery, and adverse events.[17,21,22,24]

There is limited literature concerning patients' functioning and morbidity after PFF, even though this patient group is known to be elderly and frail prior to injury.[9] In observational studies using functional scores such as the Harris Hip Score (HHS) or Oxford Hip Score (OHS),[26,27] poor outcomes have been reported after PFF.[28–30] In a registry matched-pair study, significantly lower OHS scores were revealed for patients with revision for femoral fracture when compared to other causes of revision. Morbidity after PFF is likely to be substantial, with only 27.3% of patients returning to their usual residence after initial discharge.[31] In addition, there is a threefold increased risk of re-hospitalization compared to patients of a similar age undergoing primary THA.[32] Some studies suggest similar short-term mortality outcomes when comparing PFF patients with native hip fracture patients.[31,33,34] Although the health status and psychological distress of native hip fracture patients are known to be severely affected by the injury, there is no specific evidence evaluating health status after PFF.[35–37] Health status is the perceived impact of the disease on a patient's physical, emotional, and social functioning, and is defined by evaluating function levels on health domains needed for daily activities, such as mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[38,39]

To improve patient outcomes after PFF, it is important to understand in which health domains patients experience problems in the short and long term. This can help clinicians inform patients about their expected trajectory after PFF. Furthermore, we can improve care by identifying and addressing potential improvable health domain issues. The purpose of this study is to

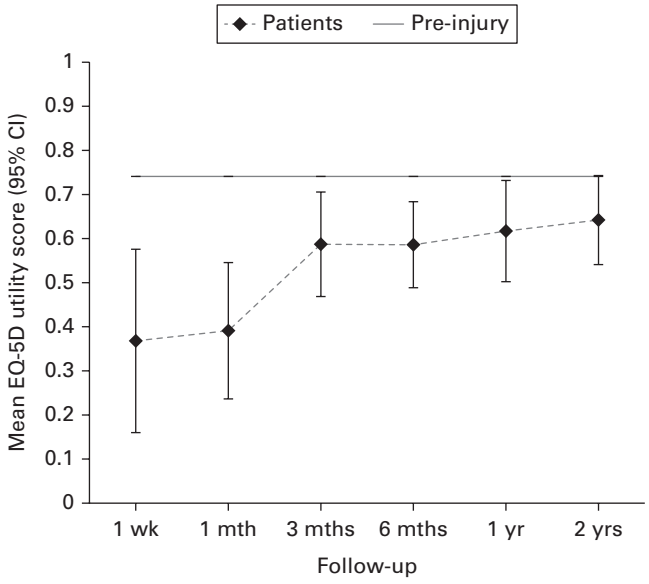

Fig. 1

Patterns of health status over time (EuroQol five-dimension (EQ-5D) utility scores). Data are presented as means with error bars representing 95% confidence intervals (CIs).

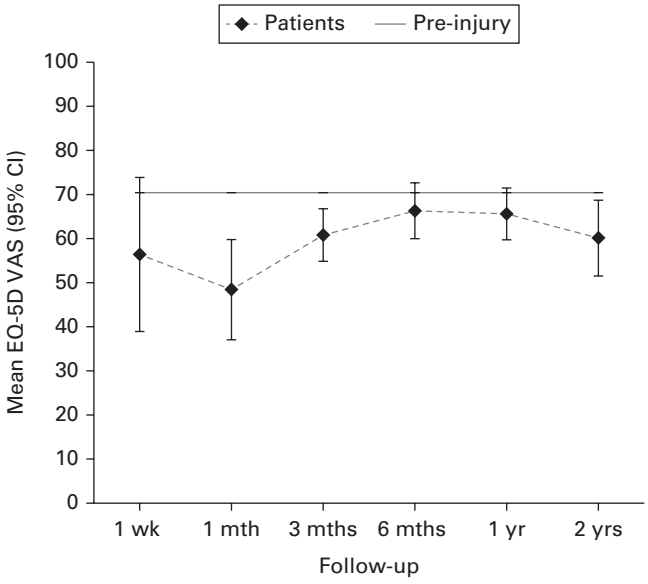

Fig. 2

Patterns of health status over time (EuroQol five-dimension visual analogue scale (EQ-5D VAS)). Data are presented as means with error bars representing 95% confidence intervals (CIs).

evaluate the health status pattern over two years after sustaining a PFF.

Methods

A cohort of patients with PFF after THA was derived from the Brabant Injury Outcomes Surveillance (BIOS) study, which was registered at ClinicalTrials.gov (NCT02508675). The BIOS study protocol has been published previously.[40] This prospective, observational, multicentre follow-up cohort study, was conducted to obtain data by questionnaires pre-injury and at one week, and one, three, six, 12, and 24 months after trauma. Patients were included between August 2015 and November 2016. Inclusion criteria were admission to an intensive care unit or ward in the Noord-Brabant region of the Netherlands within 48 hours after injury, and survived hospital admission. Exclusion criteria were patients with pathological fractures, insufficient knowledge of the Dutch language, the absence of a permanent address, or patients aged younger than 18 years. If patients were unable to complete the questionnaires, these were completed by a proxy where possible. All participating patients and the proxy informants provided signed informed consent. This study was approved by the Medical Ethics Committee Brabant in the Netherlands (NL50258.028.14).

The Brabant Trauma Registry (BTR) compiles injury, pre-hospital, and hospital data of all trauma patients admitted after presentation to the emergency department (ED) in the Noord-Brabant region.[41] The BTR includes ten hospitals, 12 EDs, and one level 1 trauma centre. The BTR was used to complete patients' characteristics.

Techniques for longitudinal cohort studies were used to ensure minimum loss to follow-up. Patient characteristics such as age, sex, educational level, American Society of Anesthesiologists (ASA) grade,[42] socioeconomic status (status score), and pre-injury frailty (Groningen Frailty Indicator (GFI) score ≥ 4) were collected from the questionnaires and the BTR. Status score was based on home postcode. Educational level was measured as the highest completed degree and displayed as low, middle, or high educational level. For additional information we refer to the published BIOS protocol.[40]

Table II. EuroQol five-dimension questionnaire comparison of periprosthetic fracture cohort and native hip fracture cohort.

Timepoint	Periprosthetic proximal femoral fractures		Native hip fractures	
	n	Mean EQ-5D (SD)	n	Mean EQ-5D (SD)
Pre-injury	19	0.74 (0.21)		0.72 (0.28)
1 week	8	0.37 (0.30)	257	0.43 (0.28)
1 mth	17	0.39 (0.32)	642	0.46 (0.26)
3 mohs	23	0.59 (0.29)	511	0.57 (0.25)
6 mths	25	0.59 (0.25)	475	0.63 (0.24)
1 yr	23	0.62 (0.28)	459	0.64 (0.25)

EQ-5D, EuroQol five-dimension questionnaire; SD, standard deviation.

Primary outcome measures were the EuroQol five-dimension three-level questionnaire (EQ-5D-3L), the Health Utility Index 2 (HUI2), and the Health Utility Index 3 (HUI3). Secondary outcome measures were general measurements of duration of hospital stays (days), place of discharge, and mortality.

The EQ-5D-3L measures health status. The EQ-5D has two parts. The first is a visual analogue scale (VAS), which measures self-rated health ranging from 0 (worst health status) to 100 (best health status). The second is a questionnaire along five health domains related to daily activities: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[39] For each dimension there were three possible levels: no problems,

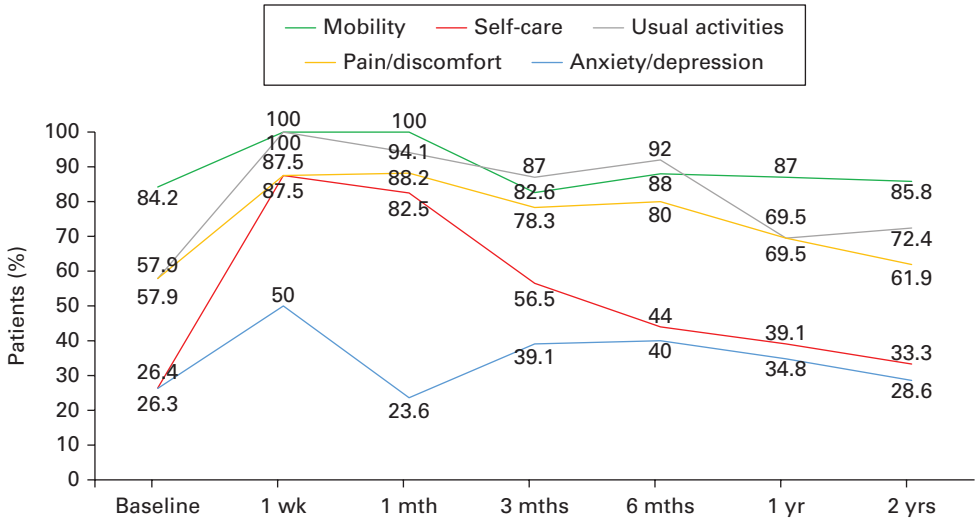

Fig. 3

Prevalence of moderate or severe problems in each EuroQol five-dimension (EQ-5D) domain.

moderate, and severe. A Dutch utility score (EQ-5D utility) was measured. The EQ-5D utility ranged from 0 representing death to 1 for full health, whereas a negative score indicates a health status worse than death.[43] Dutch population norms for the age group older than 75 years are 0.80 for EQ-5D utility and 72.9 for EQ-VAS.[44] The minimal clinically important difference (MCID) is 0.1 for the EQ-5D utility score and seven points for the EQ-5D VAS.[45,46] Differences in health status between trauma patients and proxy responders are found to be random rather than systematic bias.[47]

HUI is a score measuring general health status.[48] The 15 questions are divided between HUI 2 (seven questions) and HUI 3 (eight questions). It covers the main health domains that are affected by injury, with a particular focus on functional capacity. HUI2 and HUI3 health status classification systems are complementary. They describe measures of ability or disability for health-state attributes, and descriptions of comprehensive health status. HUI2 includes seven attributes: sensation, mobility, emotion, cognition, self-care, pain, and fertility. For each attribute there are three to five score levels. HUI3 consists of eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain. Each has five to six score levels. For both scores a utility score was calculated, where 0 represents death and 1 perfect health. A meaningful change in HUI scores starts from 0.05.[48]

The EQ-5D and the HUI have good measurement properties and can be used to measure outcomes for elderly patients after a fracture.[43] The HUI and EQ-5D combination is ideal, as it covers all relevant health dimensions.[43] Together, the HUI and EQ-5D are applicable for all kinds of injury populations and a widely different age range.

Statistical analysis. Descriptive statistics were used to analyze and report baseline characteristics. Missing baseline characteristics and missing sum scores in EQ-5D were completed using mean imputation, because less than 5% was missing at one timepoint. We performed a responder versus non-responder analysis. Univariate analysis was performed for baseline characteristics using parametric (independent-samples *t*-test) and non-parametric (Mann-Whitney U and chi-squared) tests. Patients who completed a questionnaire for at least one timepoint were included in the health status analysis. Means and standard deviations (SDs) were determined for the EQ-5D utility, EQ-VAS, HUI2, and HUI3 scores. Score options for each dimension of the EQ-5D were dichotomized into 0 = no problems and 1 = moderate/severe problems. To evaluate whether the EQ-5D utility score pre-injury differed with follow-up measurements, the Mann-Whitney U test was used after Shapiro-Wilk testing found a non-normal distribution. EQ-5D VAS scores were normally distributed, therefore a paired *t*-test was used to determine if the pre-injury score differed from follow-up scores. The results were considered statistically significant at a level of $p < 0.05$. Linear mixed models were used to assess EQ-5D utility and EQ-VAS differences by sex. All analyses were conducted in SPSS V.28 (IBM, USA).

Results

In total, 70 patients with a PFF were included. Table I shows the baseline characteristics of patients. Overall, 36 patients (51%) were included in the BIOS study. For three patients (8%), most questionnaires were filled in by proxies. There was a significant older population in the non-responder group when compared to the BIOS participants. For other patient characteristics such as sex, mean days of hospital stay, and mean status score, there was no significant difference between groups. The mean age of our population was 78.8 years (SD 10.2). The majority was female (68.6%). Mean duration of hospital stay was 11.3 days (SD 6.7). ASA grade was I to II in for 41 patients (59%). The majority of patients were treated surgically (89%) and only four were treated nonoperatively. Mortality was 7.1% in the first year and 10% after two years.

Health status. The mean pre-injury EQ-5D utility score was 0.74 (SD 0.21). One week after sustaining a PFF, the mean

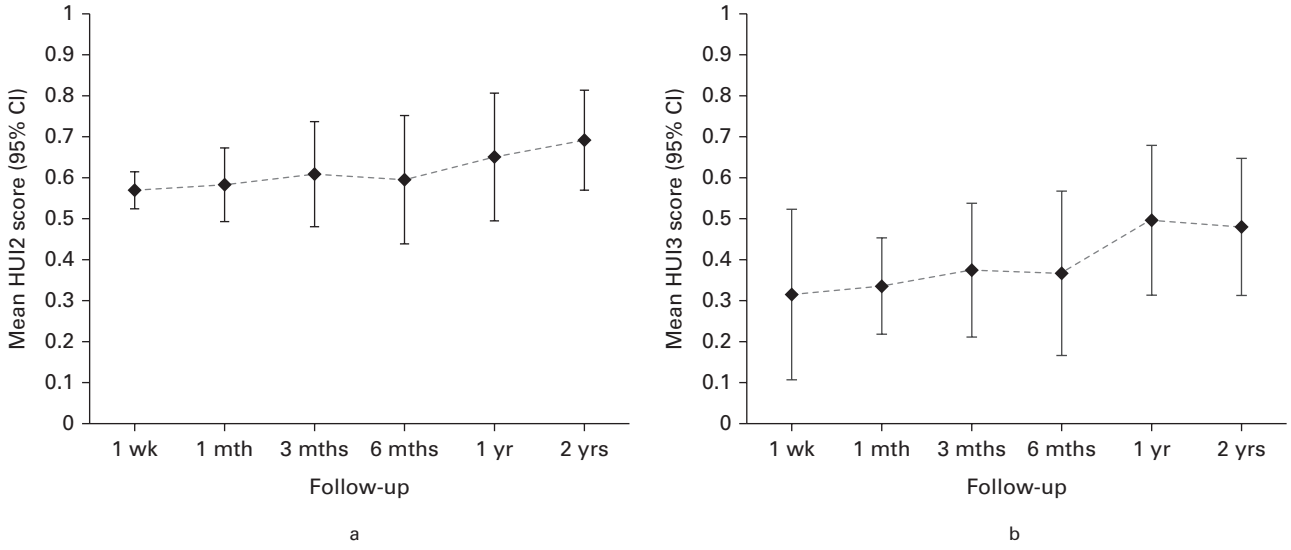

Fig. 4

a) Health Utilities Index Mark (HUI2) scores. b) HUI3 scores. Range of HUI 2/3: 0 to 1. Data are presented as means with error bars representing 95% confidence intervals (CIs).

EQ-5D utility score was 0.37 (SD 0.30). This increased to 0.64 (SD 0.28) at two years' follow-up (Figure 1 and Table II). Patients scored significantly lower on all timepoints except at six-month follow-up when compared to the pre-injury EQ-5D utility score (Supplementary Table i). As shown in both Figure 1 and Supplementary Table i, the EQ-5D utility score recovered mostly between one and three months after injury. After three months, the EQ-5D utility score stabilized and no further recovery was noted. When only including the patient receiving operative treatment, recovering trends did not differ (Supplementary Table ii).

The pre-injury EQ-VAS score was 70.4 (SD 18.0). At one month after injury the EQ-VAS score was 48.4 (SD 23.2), which was significantly lower compared to pre-injury (Figure 2). When comparing the pre-injury EQ-VAS score to EQ-VAS scores of one week, three months, six months, 12 months, and 24 months, there is no significant difference (Supplementary Table iii).

EQ-5D domains. With regard to the individual domains of the EQ-5D, problems with mobility, self-care, usual activities, pain/discomfort, and anxiety/depression were reported for all timepoints (Figure 3 and Supplementary Figures aa to ae). The percentage of reported problems at two years is higher for all dimensions except anxiety/depression when compared to pre-injury.

Problems with usual activities were especially high at two years. Overall, 15 patients (72.4%) reported problems at two years versus 11 patients (57.9%) at pre-injury. Problems with mobility were substantial at pre-injury with 16 patients (84.2%) reporting difficulties. After one month, 18 patients (100%) reported problems with mobility; at three months this declined to 82.6%, which is comparable to pre-injury. Pain/discomfort was a problem in 20 patients (80%) up to six months after trauma and this remained a large group, with 16 patients (69.5%) experiencing pain/discomfort after one year. Compared to 11 patients (57.9%) reporting pain/discomfort at pre-injury, this shows the prolonged period of pain complaints after PPF. Feelings of anxiety/depression are high one week after trauma and slowly resolve over two years to pre-injury levels. Problems in this dimension stay relatively high at three, six, and 12 months, with 8 to 10 patients (35% to 40%) of patients experiencing problems.

HUI2 and HUI3. HUI2 outcomes remained on a constant level for all timepoints. After six months, there was a slight increase in score, which continued up to two years (Figure 4a). HUI3 scores increased between six months and one year and showed no further improvement (Figure 4b).

Longitudinal association between sex and health status. There were significant differences in health status between males and females during all timepoints. The mean EQ-5D-utility score was 0.26 higher in males compared to females (95% confidence interval (CI) 0.01 to 0.42; $p = 0.003$, linear mixed models). Males had a higher mean EQ-VAS score (8.9) when compared to females over all timepoints (95% CI 1.2 to 16.7; $p = 0.027$, linear mixed models).

Discussion

This study is the first time that health status in patients with PFFs has been evaluated longitudinally with long-term follow-up. We show that EQ-5D utility scores are persistently lower than pre-injury up to two years after sustaining a PFF. This difference regarding EQ-5D utility exceeded the MCID of 0.10 for all timepoints and is clinically relevant. EQ-VAS scores were significantly lower at one month compared to pre-injury. This difference was also clinically relevant, with a 22-point difference, which exceeded the MCID of seven points. Health status improves the most between one and three months after injury. Males had significantly higher health EQ-5D utility scores and EQ-VAS scores over all timepoints when compared to females.

All patients reported problems with mobility within the first month, which is expected after such an injury. Less expected was the high number of patients (84.2%), who experienced moderate to severe problems with mobility pre-injury. Problems with self-care and pain/discomfort remained higher compared to pre-injury until six months to one year. Problems with usual activities persisted for 72.9% of patients until two years after trauma when compared to 57.9% pre-injury, showing a prolonged disabling effect after PFF. Moreover, the high pre-injury incidence of problems with mobility and usual activities demonstrates the vulnerability of the PFF patient group pre-injury.

Problems with anxiety/depression are frequent in the first week after trauma and seem to slowly resolve over two years to pre-injury levels. The first year after trauma, 35% to 40% of PPF patients in our cohort experienced problems with anxiety/depression. Anxiety after orthopaedic trauma is reported in 10% to 55% of patients in the literature, and is associated with other symptoms such as pain, depression, and post-traumatic stress disorder.[49] These factors can influence mental health and functional outcomes for patients.

With our data, we conclude that patients have poor health status even two years after sustaining a PPF. To improve care for this patient group, it is important to know the considerable variation in the clinical care delivered.[50] Centres differ in the amount of available expertise in treating PFFs, the number of specialists available for surgery, the time to surgery, and the routine discussion of PFF patients at local and regional multidisciplinary team meetings. Even surgical decision-making was highly varied between centres in England and Wales. Differences were outlined by reviewing a theoretical case of a Vancouver 2B fracture around a cemented, taper-slip stem THA. ORIF was suggested by 75 centres, while 45 centres proposed revision surgery and 48 centres suggested ORIF with revision. Utilizing network care and implementing guidelines can help to reduce the variability of care and improve our understanding of treatment methods and their correlation with patient outcomes.

The mortality rate after PFF in our cohort is 7.1% at one year and 10% at two years. This is slightly lower than suggested in earlier research where mortality was up to 13.8% to 20.1% at one year.[31,33,34,51–53] Higher six-month mortality rates for periprosthetic fracture patients versus aseptic revisions were already described by a register study from New Zealand.[30] In their register, the six-month mortality was 7.3% in periprosthetic fracture patients compared to 0.9% in the aseptic revision group. The 30-day mortality in our dataset was 2.8%, which is comparable to the 30-day mortality of 3% to 4% in other studies.[33,34]

In an earlier study by van de Ree et al,[36] health status after a hip fracture was outlined. The pre-injury scores of patients in this study were comparable with our PFF group. The mean age in the native hip fracture group was 80.3 (SD 8.6) vs 78.8 (SD 10.2) in our cohort. Pre-injury EQ-5D utility scores were 0.72 (0.28) in the native hip fracture group versus 0.74 (SD 0.21) in our PFF cohort (Table II). Pre-injury EQ-VAS scores were 69.7 (SD 20.6) in the native hip fracture cohort versus 70.4 (SD 17.9) in the PFF cohort. With comparable scores pre-injury, this demonstrates the level of frailty present pre-injury in patients with PFF. Pre-injury scores were also below Dutch population norms for the same age group (0.80 for EQ-5D utility and 72.9 for EQ-VAS). Health status remained similar between both groups during follow-up. At one-year follow-up, the EQ-5D utility score was 0.64 (SD 0.25) in the native hip fracture group versus 0.62 (SD 0.28) in our PFF cohort. Hip fracture patients are widely accepted as a vulnerable population. With our data, we confirm that PFF patients are similar regarding health status.

Males had significantly higher EQ-5D utility and EQ-VAS scores for all timepoints. When adjusting for age, the mean EQ-5D utility score remained significantly higher in males. Earlier research in hip fracture patients showed the same results.[54] When cognitive function was intact, more males were walking independently two years after hip fracture.[55] No differences in admission or hospital stay were observed.[56] However, during geriatric rehabilitation males recovered more from depressed mood and had significantly better improvement on the Functional Independence Measure on discharge from rehabilitation.[54,56] Females were more functionally dependent in locomotion, transfers, and sphincter control compared to males.[56]

This study has several limitations. Participants may not recall their health status prior to injury accurately. This might influence the result of the EQ-5D and EQ-VAS scores pre-injury. The health status data were only collected for patients included in this study until one month had passed. Also, to avoid further lengthening the questionnaires, HUI2 and HUI3 scores were not scored pre-injury. Another limitation is attrition bias; this older population has major disabilities. Systematic differences between patients lost who continued or discontinued in the study may have been present.

Although it is unique to have longitudinal data with two-year follow-up in this patient category, the numbers are relatively small. Future research should focus on different patient categories in order to delineate the optimal treatment strategy for patients depending on their pre-injury status.

PFF patients have a significant and clinically relevant lower health status to two years after trauma when compared to pre-injury. Reported problems are frequent on all domains until one year after trauma. At two years' follow-up, patients experience more problems in mobility, self-care, usual activities, and pain/discomfort than pre-injury. Of the five domains of the EQ-5D, problems with usual activities persevere. This can be used to inform patients about their expected rehabilitation after PFF. By identifying the different domains in which problems persist after PFF during rehabilitation, we might create new treatment and rehabilitation strategies for improvement of care.

Take home message

- Periprosthetic femoral fracture (PFF) patients are a frail population with substantial functional impairment at baseline.
- PFF patients have a significant and clinically relevant lower health status to two years after trauma when compared to pre-injury.
- Reported problems are frequent in all domains until one year after trauma. At two years' follow-up, patients experience more problems in mobility, self-care, usual activities, and pain/discomfort than pre-injury.

Supplementary material

Bar graphs and tables showing EuroQol five-dimension questionnaire (EQ-5D) utility scores and EQ-5D visual analogue scale (VAS) scores, along with the absolute numbers of patients experiencing mild or severe problems for each EQ-5D dimension.

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