Frail Patients Benefit From Less Invasive Procedures

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Abstract

Purpose: A traumatic periprosthetic fracture (PPF) is a long-term complication of total hip arthroplasty. Treatment options include revision, open reposition and internal fixation (ORIF), and minimally invasive techniques (MITs). To select the optimal surgical procedure, the level of frailty has to be considered, especially in patients with geriatric trauma. The aim of this study is to determine whether a frail patient has a better outcome postoperatively after less invasive treatment. Methods and materials: Sixty-three patients with an PPF were analyzed in this retrospective study. The level of frailty was obtained by the complex fracture frailty index (CFFI). The CFFI combines comorbidities, laboratory tests, physical abilities, social factors, and cognitive functions. Primary outcomes in this study include mortality, minor complications, and 3 major complications (deceased, reoperation or immobility after 1 year). Results: Thirty frail patients had lower survival rates (P = .014) and significantly more major complications with a relative risk of 3.7 (P = .02). In the entire group of 63 patients, there were no significant differences detected in the outcome measures; however, when specified in a subgroup of 30 frail patients according to our CFFI, significant differences were found. Patients treated with MIT had significantly less major and minor complications compared to ORIF and revision. Furthermore, patients treated with ORIF experienced significantly less minor complications than with revision surgery (P = .015). Discussion and conclusion: This study shows that frail patients can be adequately detected using our frailty score CFFI and have a lower survival rate, regardless the type of surgery. Another finding is that for frail patients, more invasive surgery has a negative influence on the outcome of the treatment. Therefore, it is of great importance to assess and use the patient’s level of frailty to determine the surgical procedure for a PPF.

Keywords

frailty, periprosthetic fractures, total hip arthroplasty, minimally invasive techniques, frailty index

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Introduction

In the past couple of years, the number of total hip arthroplasty (THA) has exponentially grown and is expected to continue to rise due to increasing life expectancy. As a direct result, the number of patients at risk for periprosthetic fractures (PPFs) of the femur has increased. This research focuses on traumatic PPF, which is accountable for 14% of the indication of hip revision surgery. Periprosthetic fractures are most often classified using the Vancouver classification in which type A fractures are of either the greater (type Ag) or the lesser (type Al) trochanter. Vancouver type B fractures are around the stem and are divided in type B1 with a fixed prosthesis, B2 with a loose prosthesis, and B3 with a loose prosthesis with severe bone loss. Vancouver type C fractures are fractures well below the tip of the stem. This classification provides patient selection for the best treatment option, and several treatment algorithms using the Vancouver classification have been developed over the years. However, it can be extremely difficult to differentiate between the types. Lindahl et al showed that 47.3% of the preoperative classifications based on X-ray were not corresponding with the preoperative findings. Since open reposition and internal fixation (ORIF) often fails in cases

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with a loose femoral component, implant revision surgery has been recommended in every case of possible stem loosening. However, revision surgery is a highly invasive surgery with potential very high risks for the patient’s well-being. Minimally invasive technique (MIT), surgical interventions involving the least possible physical trauma to the patient through a tiny incision, was defined by Oxford University Press. The goal of MIT is to decrease surgical time, improve recovery duration, and plays a major role in treatment of geriatric patients.

The population affected by PPFs is relatively old and frail with an average age of 75 years. Several studies show that frail patients have worse clinical outcome than nonfrail patients in several operative treatments. However, these studies did not account for different surgical techniques. We performed a retrospective study to analyze the differences in outcome between different treatments of Vancouver type B and type C PPFs. The goal of our study is to evaluate whether implant revision surgery for a PPF has a higher complication rate than ORIF and MITs, like retrograde nailing. Furthermore, do frail patients actually benefit from less invasive procedures?

**Materials and Methods**

**Population**

All electronic patient files from patients with an PPF between January 2009 and January 2014 were collected from the Isala Hospital, situated in the Netherlands, a regional trauma center and training hospital. Patients with a Vancouver type A fracture, intraoperative fractures, osteogenesis imperfecta, and atraumatic PPFs were excluded (Figure 1).

**Assessment of Frailty**

Frailty of the patient was calculated using the complex fracture frailty index (CFFI). This is a questionnaire designed by the researchers to preoperatively determine the vulnerability of patients.

This tool was designed to cover all determinants of frailty based on the current literature. The CFFI contains 52 questionnaires about demographics, comorbidities, physical abilities, cognitive function, social factors, and laboratory parameters. A summarized overview of the items can be found in Table 1.

All of the items are scored as “0,” “1/2,” or “1,” with 1 being the least favorable outcome. Questions like “Do you have problems with sight?” have the answers: not at all, a little, or a lot. These outcomes are added and divided by the number of items scored, resulting in an outcome between 0 and 1, with 1 being the theoretical complete frail patient. We classified patients with a score of 0.26 and higher as frail. The reason for using this specific frailty score is because it is suitable for retrospective research, and it includes many different determinants of frailty compared to the Groningen Frailty Indicator (GFI). The CFFI was validated by comparing this frailty indicator to the widely used GFI. The power of this validation was 31 patients. The participants were asked to complete the GFI as well as the CFFI. In this group, 51.6% (n = 16) of the patients were frail according to the GFI. In 90.3% (n = 29) patients, the outcome of the GFI was in line with the bivariate outcome of the CFFI. A Spearman correlation coefficient test showed a correlation of 0.786, which proved the CFFI was a good alternative to the GFI.

The items of the CFFI for the PPF study were extracted partially from the electronic patient file, and the other items were integrated in a questionnaire with 20 items. After approval of the Medical Ethical Board, this questions were asked per phone, e-mail, or letter to the patients or their relatives.

**Patient Groups**

Patients were divided into 4 categories according to the CFFI: not frail (0-0.1), minor frail (0.1-0.25), major frail (0.26-0.4), and severe frail (0.41-1). In the statistical analysis, category 1 (not frail) was excluded since there was only 1 patient in this category. For other analysis, the patients were divided into groups based on the type of surgical treatment: revision of the THA, MIT, or ORIF. When a revision was combined with ORIF, the patient was allocated to the revision group.

Mortality and the number of complications were compared among the subgroups based on frailty score and type of treatment. Complications are divided into minor and major complications. Minor complications are systemic or local complications (implant-related infection, urinary tract infection, pneumonia, need of blood transfusion), which required longer hospital stay or medical treatment. Major complications are mortality within 1 year, reoperation within 1 year (like refractures or implant-related infection.

![Figure 1. Flowchart.](image-url)
Our group of 63 patients with a PPF had a 1-year mortality of 21.7%. At the moment of data analysis, 33.3% of the patients had died with an average follow-up of 30.4 months (Figure 2). Of the 63 patients with a PPF, we were able to retrieve information necessary for the CFFI of 45 patients. These patients (35 females, 77.8%) had a mean age of 78.6 ± 11.2 years. In 9 patients (20.0% of total), the PPF occurred after previous revision surgery. More baseline characteristics of these 45 patients can be found in Table 2. Minor and major complications per group of frailty category are presented in Table 3 and surgery-specific complications can be found in Table 4.

**Table 1. Overview of the CFFI Items.**

| Age | Musculoskeletal Disease | Cognitive Disease | Cooking |
|-----|-------------------------|------------------|---------|
| Hospital admission | Neurological disease | Oriental problems | Eating |
| Body mass index | Endocrinal disease | Walking | Shower |
| Weight loss | Psychiatric disease | Mobility at home | Money management |
| Medication | Malignancy | Tools used for walking | Live independently |
| Help with medication | Other diseases | Ability to walk stairs | Live alone |
| Trauma last 6 months | Pain | Transfers | Help with household |
| Cardiac failure | Sight problem | Playing sports | Daily schedule |
| Vascular disease | Hearing problem | Ability to carry 5 kg | Limitations |
| Hypertension | Speech problem | Shopping | Gloomy |
| Pulmonary disease | C-reactive protein | Kneel down | Tired |
| Gastric intestinal disease | Albumin | Household (light) | Anxious |
| Urogenital disease | Hemoglobin | Household (heavy) | Sleeping problems |

Abbreviation: CFFI, complex fracture frailty index.

Figure 2. Survival curve.

not controlled by antibiotics alone), immobility after 1 year, and major systemic complications, which required complex medical intervention. For statistical analysis, independent sample t tests, χ² tests, and Mann-Whitney U tests were used (SPSS version 20.0) were used. A P < .05 was considered significant.

**Results**

**Baseline Characteristics, Minor and Major Complications, and Overall Mortality**

Our group of 63 patients with a PPF had a 1-year mortality of 21.7%. At the moment of data analysis, 33.3% of the patients had died with an average follow-up of 30.4 months (Figure 2). Of the 63 patients with a PPF, we were able to retrieve information necessary for the CFFI of 45 patients. These patients (35 females, 77.8%) had a mean age of 78.6 ± 11.2 years. In 9 patients (20.0% of total), the PPF occurred after previous revision surgery. More baseline characteristics of these 45 patients can be found in Table 2. Minor and major complications per group of frailty category are presented in Table 3 and surgery-specific complications can be found in Table 4.

**Frailty**

After dividing the patients in categories according to the CFFI, we performed a survival analysis per category (Figure 3). A significant difference in survival was found between category 2 and category 4 (P < .05) and between category 2 and category 3 (P = .004) in favor of category 2.

In frailty category 4, patients had a relative risk (RR) of 3.7 to experience a major complication compared to patients in category 2 (average 0.29 vs 1.06). This difference was found to be significant (P = .02; Figure 4). Additionally, the difference in number of minor complications between category 2 and category 4 was significant (odds ratio [OR]: 2.5, P = .01). Differences in minor and major complications compared to category 3 were not significant.

**Type of Treatment**

Patients were divided according to the type of treatment. Baseline characteristics are to be found in Table 5. An important significant difference was found for the type of treatment, since revision surgery was not performed for Vancouver type C fractures, in contrast to ORIF in both Vancouver B and C type of fractures. No significant differences were found for survival and major or minor complications. A P value of .057 was found for the difference in minor complications between MITs and revision surgery (OR 3.0).

**Type of Treatment in Frail Patients**

Of the 45 analyzed patients, 30 (66.7%) were considered frail on the CFFI (categories 3 and 4). A subgroup analysis was
performed regarding complication rates. Overall survival between groups was not significantly different. The RR for a major complication between MIT and ORIF was significant ($P = .021$). The difference between ORIF and revision as well as between MIT and revision was not significant ($P = .597$ and $P = .076$). In analyzing the differences between the treatment groups for minor complications, all differences were found to be significant (Figure 5). A $P$ value of .019 was found for the RR between MIT and ORIF (RR 5.6). The RR between MIT and revision surgery (RR 11.0) leads to a $P$ value of.007. Also, the RR for minor complications between ORIF and revision surgery (RR 1.9) was significant ($P = .015$).

**Discussion**

In this retrospective study, Vancouver B and C PPFs were analyzed to evaluate if revision surgery for a PPF has a higher

| Table 2. Baseline Characteristics Based on Frailty. |
|-----------------------------|-----------------|-----------------|-----------------|
| Characteristic              | Total           | Category 2      | Category 3      |
| Number, n (%)               | 45              | 15 (33.3)       | 13 (28.9)       |
| Age, years *                | 78.6 ± 11.2     | 71.3 ± 9.2      | 79.8 ± 11.0     |
| Female, n (%)               | 35 (77.8)       | 10 (71.4)       | 10 (76.9)       |
| BMI *                       | 25.3 ± 3.5      | 27.1 ± 3.1      | 24.3 ± 3.8      |
| Left, n (%)                 | 24 (53.3)       | 11 (76.6)       | 5 (38.5)        |
| Follow-up, months *         | 30 (0-80)       | 39 (12-73)      | 31 (6-80)       |
| Vancouver B, n (%)          | 25 (55.6)       | 7 (53.8)        | 6 (35.3)        |
| Treatment, n (%)            | MIT 4 (8.9)     | 0 (0)           | 1 (7.7)         |
| ORIF 29 (64.4)              | 12 (80.0)       | 8 (61.5)        | 9 (52.9)        |
| Revision 12 (26.7)          | 3 (21.4)        | 4 (30.8)        | 5 (29.4)        |
| Time after THP, months *    | 102 (0-282)     | 84 (0-241)      | 69 (1-223)      |
| After primary THP, N (%)    | 36 (80.0)       | 13 (86.7)       | 10 (76.9)       |
| Score CFFI *                | 0.35 ± 0.16     | 0.19 ± 0.05     | 0.33 ± 0.05     |
| Minor complications, * range| 1.3 (0-4)       | 0.8 (0-2)       | 1.2 (0-4)       |
| Major complications, * range| 0.6 (0-3)       | 0.3 (0-1)       | 0.5 (0-1)       |

*Mean ± standard deviation.

| Abbreviations: BMI, body mass index; CFFI, complex fracture frailty index; MIT, minimally invasive technique; ORIF, open reposition and internal fixation; THP, total hip replacement.

| Table 3. Minor and Major Criteria Divided Into Groups of Frailty. |
|-----------------------------|-----------------|-----------------|-----------------|
| Characteristic              | Total           | Category 2      | Category 3      |
| Minor complications         |                |                 |                 |
| Implant-related infections  | 11              | 1 (9.1)         | 3 (27.3)        |
| Urine tract infection       | 4               | 0 (0)           | 1 (25.0)        |
| Pneumonia                   | 2               | 0 (0)           | 0 (0)           |
| Blood transfusion           | 34              | 9 (26.5)        | 9 (26.5)        |
| Additional                  | 20              | 7 (35.0)        | 4 (20.0)        |
| Major complications         |                |                 |                 |
| Mortality <30 days          | 2               | 0 (0)           | 0 (0)           |
| Mortality <90 days          | 1               | 0 (0)           | 0 (0)           |
| Mortality <1 year           | 3               | 0 (0)           | 1 (33.3)        |
| Reoperation <1 year         | 8               | 3 (37.5)        | 1 (12.5)        |
| Immobility >1 year          | 10              | 0 (0)           | 1 (10.0)        |

| Abbreviations: MIT, minimally invasive technique; ORIF, open reposition and internal fixation.

| Table 4. Minor and Major Criteria Divided Into Groups of Operation Technique. |
|-----------------------------|-----------------|-----------------|-----------------|
| Characteristic              | Total MIT ORIF Revision |
| Minor complications         |                |                 |                 |
| Implant-related infections  | 11              | 5 (45.5)        | 6 (54.5)        |
| Urine tract infection       | 4               | 1 (25.0)        | 3 (75.0)        |
| Pneumonia                   | 2               | 1 (50.0)        | 1 (50.0)        |
| Blood transfusion           | 34              | 11 (32.4)       |                 |
| Additional                  | 20              | 13 (65.0)       | 7 (35.0)        |
| Major complications         |                |                 |                 |
| Mortality <30 days          | 2               | 1 (50.0)        | 1 (50.0)        |
| Mortality <90 days          | 1               | 1 (100.0)       | 0 (0)           |
| Mortality <1 year           | 3               | 1 (33.3)        | 2 (66.7)        |
| Reoperation <1 year         | 8               | 5 (62.5)        | 3 (37.5)        |
| Immobility >1 year          | 10              | 9 (90.0)        | 1 (10.0)        |

*Mean ± standard deviation.
complication rate than ORIF and MITs. Second, this study aimed to show whether frail patients benefit from less invasive procedures.

The treatment of PPF is complex and has high complication rates reported in the literature, which is also confirmed in this study. Optimization of treatment should be aimed to reduce complications and mortality. Several techniques are designed to provide less invasive procedures for this specific fracture. Large surgical procedures are often harmful and very unwanted in a frail patient group, although these procedures may be biomechanical superior to less invasive systems.

Therefore, another research goal was to determine whether frail patients detected by our frailty score CFFI were more prone to experience complications after more invasive surgery than less debilitated patients. The renewing fact of our study is the observed influence of frailty specifically in PPFs. This has not been clarified in previous reports that often focus on fracture patterns and surgical procedures alone. Furthermore, we considered the different levels of invasiveness of the treatment options, which in our opinion are highly important in these frail patients. The study population had similar baseline characteristics (age, sex, and previous revision surgery) compared to the larger studies available in PPFs. As expected, the results show that frail patients have a lower overall survival compared to healthier individuals (Figure 3). The frailty in this study was measured using the CFFI, which was created and validated by the authors of this study. This score meets an important need in assessing frailty in medical research, since it is the only retrospective frailty score available. Furthermore, the CFFI has a continuous outcome, which is much more in line with the gliding scale of frailty itself. The CFFI is a questionnaire to determine the frailty of patients. For some of the frail patients, it is not possible to complete the questions on their own. Risk of possible bias could lie in the situation where family members of other third persons have to complete the questionnaire. However, this is common in all other scoring systems.

After analysis of frail patients in our series, significant differences were found in major and minor complications, indicating that in these individuals more invasive surgery results in more complications. This emphasizes the need for less invasive procedures in this particular group.

What needs to be mentioned in this retrospective study is that the baseline characteristics showed a significant difference in fracture type. In the revision group, more patients were treated for a Vancouver type B fracture. Because of the current treatment guidelines, this could not be overcome, but nonetheless this difference might have biased our results.

This study with 60 patients is among the largest studies in PPFs available, with a clear focus on the extent of an operative procedure and frailty. We were able to look at more patient-specific data in our cohort and derive the influence of frailty on complications and amount of surgery. The assessment of frailty in patients with an PPF is mandatory to select the appropriate surgical procedure. In all patients with PPF, we suggest an assessment of frailty with the CFFI questionnaire preoperatively to measure the frailty of the individual. This tool can help the surgeon to choose the best operation technique for the individual patient. A prospective study will be conducted to evaluate a preoperative plan tailor made using the CFFI in the patient group with an PPF. Quality of life after the different types of treatment will be measured as well.


**Table 5. Baseline Characteristics Based on Treatment.**

| Characteristic                  | Total | MIT | ORIF | Revision |
|--------------------------------|-------|-----|------|----------|
| Number, n (%)                  | 45    | 4 (8.9) | 29 (64.4) | 12 (26.7) |
| Age, years<sup>a</sup>         | 78.6 ± 11.2 | 76.5 ± 8.3 | 80.5 ± 10.6 | 74.8 ± 13.1 |
| Female, n (%)                  | 35 (77.8) | 4 (100.0) | 24 (82.8) | 7 (58.3) |
| BMI<sup>a</sup>                | 25.3 ± 3.5<sup>c</sup> | 23.3 ± 4.6<sup>c</sup> | 25.9 ± 3.3<sup>c</sup> | 24.7 ± 3.6 |
| Left, n (%)                    | 24 (53.3) | 3 (75.0) | 15 (51.7) | 6 (50.0) |
| Follow-up, months<sup>b</sup>  | 30 (0-80) | 25 (18-61) | 27 (0-80) | 31 (0-63) |
| Time after THP, months<sup>b</sup> | 25 (55.6) | 1 (25.0) | 12 (41.4) | 12 (100.0) |
| After primary THP, n (%)       | 36 (80.0) | 4 (100.0) | 22 (75.9) | 10 (83.3) |
| Score CFFI<sup>p</sup>         | 0.35 ± 0.16 | 0.45 ± 0.11 | 0.34 ± 0.17 | 0.34 ± 0.14 |
| Frail patients, n (%)          | 30 (66.7) | 4 (100.0) | 17 (58.6) | 9 (75.0) |
| Minor complications,<sup>a</sup> range | 1.3 (0-4) | 0.3 (0-1) | 1.2 (0-4) | 2.1 (0-4) |
| Major complications,<sup>a</sup> range | 0.6 (0-3) | 0 (0-0) | 0.8 (0-3) | 0.6 (0-2) |

**Abbreviations:** BMI, body mass index; CFFI, complex fracture frailty index; MIT, minimally invasive technique; ORIF, open reposition and internal fixation; THP, total hip replacement.

<sup>a</sup>Mean ± standard deviation.

<sup>b</sup>Median (range).

<sup>c</sup>Missing data.

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**Figure 5. Relative risk of complications by treatment.**

**Conclusion**

This study shows that frail patients with a PPF have significantly more minor complications after more invasive surgery. These findings emphasize the importance of assessing the frailty preoperatively and using this assessment in determining the optimal treatment strategy.

**Declaration of Conflicting Interests**

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