



High reoperation and mortality rate after distal femoral replacement for periprosthetic knee fracture in the elderly

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Received: 4 November 2021 / Accepted: 3 February 2022 / Published online: 19 February 2022
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Abstract

Purpose To analyze the outcomes of elderly patients with periprosthetic fractures around the knee operated on with a distal femur replacement (DFR).

Methods We performed a retrospective case series study of eleven elderly patients who underwent DFR due to a periprosthetic fracture. Mean follow-up was 30.1 months (SD 28.1). Demographic, clinical and radiological data were reviewed. A descriptive analysis and a study of survival were conducted. Then, a comparative analysis between the patients who needed reoperation and did not need reoperation, and the patients who died and the patients who were alive during the follow-up was performed.

Results Mean age was 77.1 years (SD 13.9). Reoperation rate was 36%, being infection the most common complication (27%). The risk of reoperation increased with a longer time between fracture and surgery. The 36.4% of patients died during the follow-up. Older age, need of blood transfusion and need of early reoperation were related to a higher risk of mortality.

Conclusion DFR could be a valuable option for knee periprosthetic fractures in elderly patients. However, surgeons should be aware of the high reoperation and mortality rate.

Keywords Knee · Frail elderly · Periprosthetic fracture · Knee replacement · Complication · Mortality

Introduction

The incidence of periprosthetic fracture after TKA ranges between 0.3–2.5% [1]. Distal femoral fracture is the most common type [2]. The treatment algorithm for periprosthetic fractures is based on implant stability. Internal fixation is a therapeutic option for fractures with stable implants. Radiographic healing after osteosynthesis can be achieved in the 90% of the cases. However, patients commonly present a worsening in functional outcome, and one-year mortality can be as high as 21% [3]. Postoperative complications are also frequent and can reach 37% [4]. On the other hand, rTKA is required in fractures with loose implants. This procedure allows for early weight-bearing, but as many as

one-third of patients can experience postoperative complications [5]. Finally, when a loose implant is combined with comminution and severe bone loss, treatment options can be allograft prosthetic composite in young patients and distal femoral replacement (DFR) in the elderly [2, 6, 7].

DFR has been indicated since the late 1940s as a limb salvage treatment in bone tumor cases. Many of these first implants ended in failures. Since those early days, introduction of the rotating-hinge design, osteointegration, modularity, new cementation techniques and other innovations have improved their outcomes [6]. Currently, DFR is not only used in tumoral indications, but in primary fractures with comminution and loss of bone stock, as well as periprosthetic fractures and infections [6, 7].

In the current literature, there are only few articles that study the use of DFR in periprosthetic fractures [6–16]. The aim of our study was to analyze the outcomes, risk of reoperation and mortality of elderly patients with periprosthetic fractures operated on with a DFR.

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Methods

Study design

A retrospective case series study was performed. The medical records of all patients who had undergone rTKA with DFR after an acute periprosthetic knee fracture, between 2011 and 2016, were retrospectively reviewed. Patients were identified through our prospective institutional registry. All participants or their relatives provided informed consent. The diagnosis was based on clinical, X-ray, and computer tomography (CT) findings. These examinations allowed us to classify the fracture, to analyze prosthesis loosening and remaining bone stock, and to plan the surgery. In our institution, the selection criteria for using DFR in periprosthetic fractures include elderly patients with a periprosthetic knee fracture with a loose implant combined with comminution and severe bone loss (Rorabeck type III or Su type III [17, 18]), (Fig. 1).

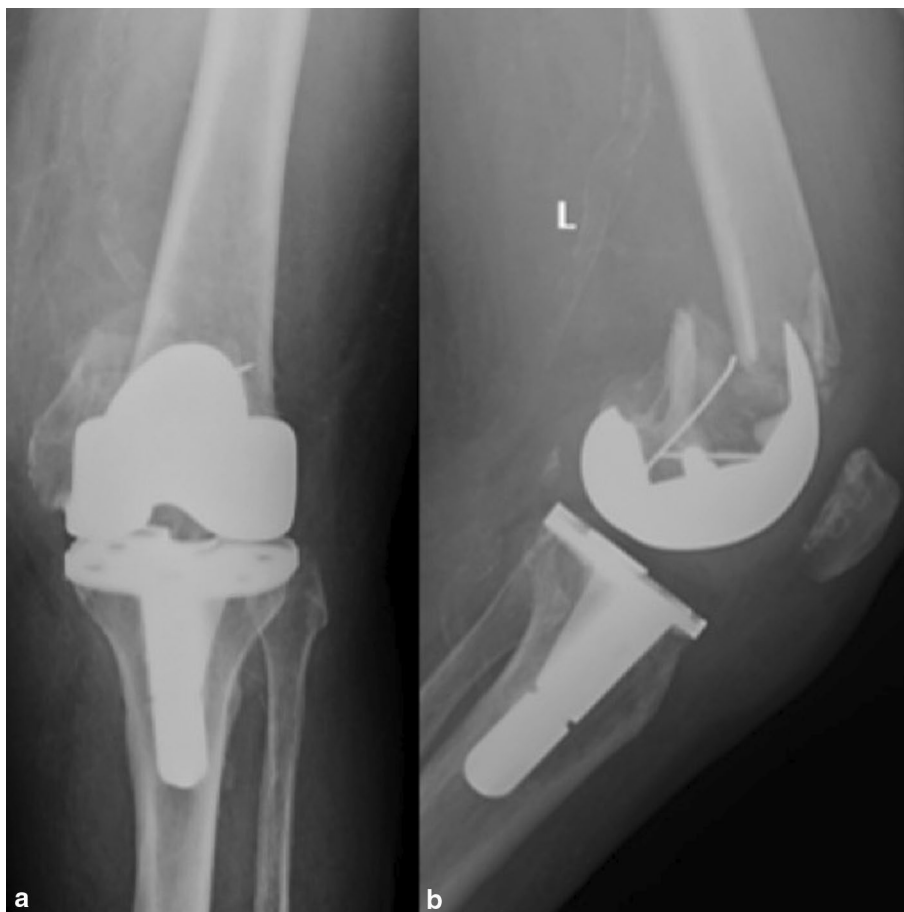
For the final analysis only the patients with the following criteria were included: (a) patients aged > 65 years old; (b) patients with acute periprosthetic knee fracture; (c) patients with X-ray and CT recorded in the electronically

clinical history; (d) patients operated on with a rTKA with DFR at our institution; (e) patients with a minimum follow-up of 24 months (except if the patient had died before). We found 16 patients who had undergone surgery using DFR, five patients were excluded because they did not meet the inclusion criteria.

Surgical technique

A single team of orthopedic surgery specialists performed all procedures. Under antibiotic prophylaxis (intravenous cefazolin: 2 g preoperatively, and 1 g every 8 h for 24 h postoperatively) and spinal anesthesia, the patient was placed in supine position. A skin incision, under tourniquet, was made through the prior approach, using a medial parapatellar arthrotomy extended proximally as needed. No osteotomy of the anterior tibial tubercle was necessary. The distal femur was cut immediately above the proximal extent of the fracture (Fig. 2), and measured to get the proper length and tension to the implant during the reconstruction. By protocol, cultures were taken to rule out infection. TKA with DFR (Endo-Model Modular rotational with DFR component; Waldemar Link®, GmbH, Hamburg, Germany) and fully cemented stem was implanted in the femoral side. Tibia and

Fig. 1 X-ray images showing a distal femoral periprosthetic fracture. **a** Anterior–posterior view, **b** lateral view



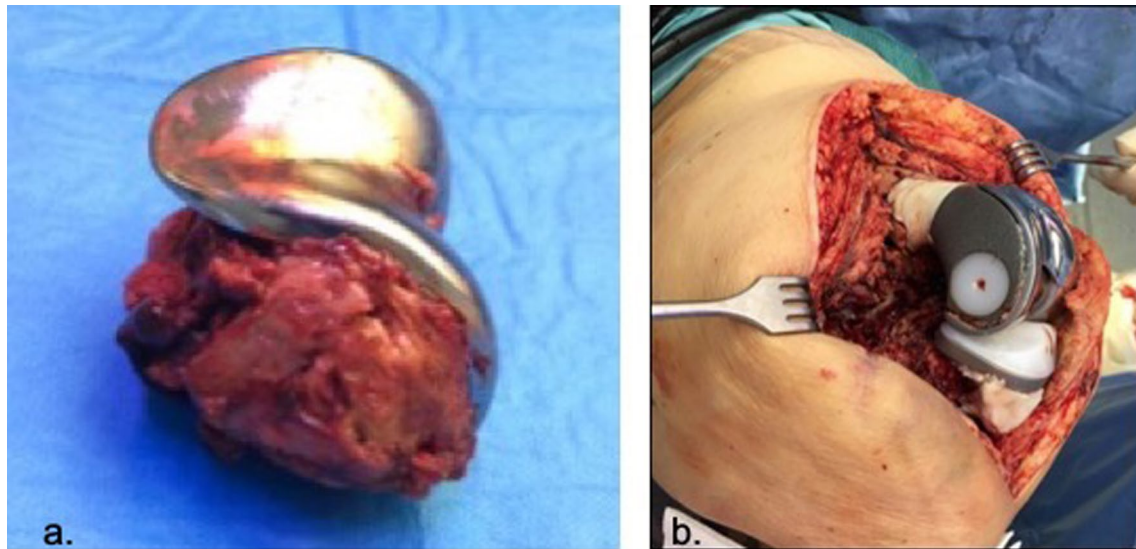


Fig. 2 Intra-operative images. **a** The removed primary femoral component, **b** lateral view of the final implanted prosthesis (DFR)

patella were also revised, using a long and fully cemented stem for tibia. In all cases, antibiotic-loaded cement was preferred (Vancogenx®, Tecres, Verona, Italy). Distal plug, pulsatile lavage, cement gun and cement pressuring devices were used. Finally, hemostasis was reviewed before wound closure. Drains were not used. Postoperatively, immediate full weight-bearing was allowed as tolerated. Rehabilitation was conducted under supervision, and range of motion (ROM) advanced progressively. Initially, gentle passive and active-assisted exercises were allowed. After two weeks, full ROM was encouraged without limitation.

Patients were reviewed at two weeks, one, three, and six months after surgery. Thereafter, they were controlled annually. Operated knees were examined to assess surgical wound, stability, ROM and pain. Anteroposterior and lateral knee X-ray and lower limb telemetry were performed (Fig. 3). Radiographic controls were considered adequate if no complications were observed (osteolysis, loosening, radiolucent lines, etc.).

Follow-up and outcome measures

Patient's demographic, clinical, and radiological data were collected preoperatively, postoperatively, and during the follow-up period (1, 3, 6, 12, and 24 months postoperatively) or until death. The latest data from each patient were used for analysis. Demographic and clinical data included: patient's age at the time of surgery, gender, injury mechanism and ASA (American Society of Anesthesiologists) classification. Each patient's hospitalization, time to surgery, time to first ambulation, length of hospital stay and discharge destination data were collected. We also recorded any severe medical complications that required support from other medical

specialties, and any necessity for blood transfusions. Reoperation or death during follow-up were analyzed.

A descriptive analysis and a study of survival were conducted. A comparative analysis between the patients who needed reoperation and did not need reoperation, and the patients who died and the patients who were alive during the follow-up was performed too.

Statistical analysis

Descriptive statistics were used to present the cohort's characteristics. The categorical variables were compared with Fisher's exact test. For the comparison of means, Student T-test were used. Statistical analysis was conducted using IBM SPSS v. 20.0 (IBM Corp., Armonk, NY, USA). Differences with P values < 0.05 were considered statistically significant. Likewise, survival and risk function were studied, considering reoperation and mortality of the patients as the final event.

Results

Eleven patients met our inclusion and exclusion criteria and were available for analysis (Table 1). There were eight women (73%) and three men (27%). Mean age was 77.1 years (SD 13.9) at the time of surgery. The mean follow-up was 30.1 months (SD 21.8). The mechanism of injury was a ground-level fall in all patients (100%). The mean time between fracture and surgery was 10.2 days (SD 5.7). No intraoperative complication was recorded. The mean need for blood transfusion during hospital stay was 1.9 units (SD 1.2) per patient. Mean time to first full

Fig. 3 X-ray images showing the outcome of the implanted DFR. **a** Anterior–posterior view, **b** lateral view

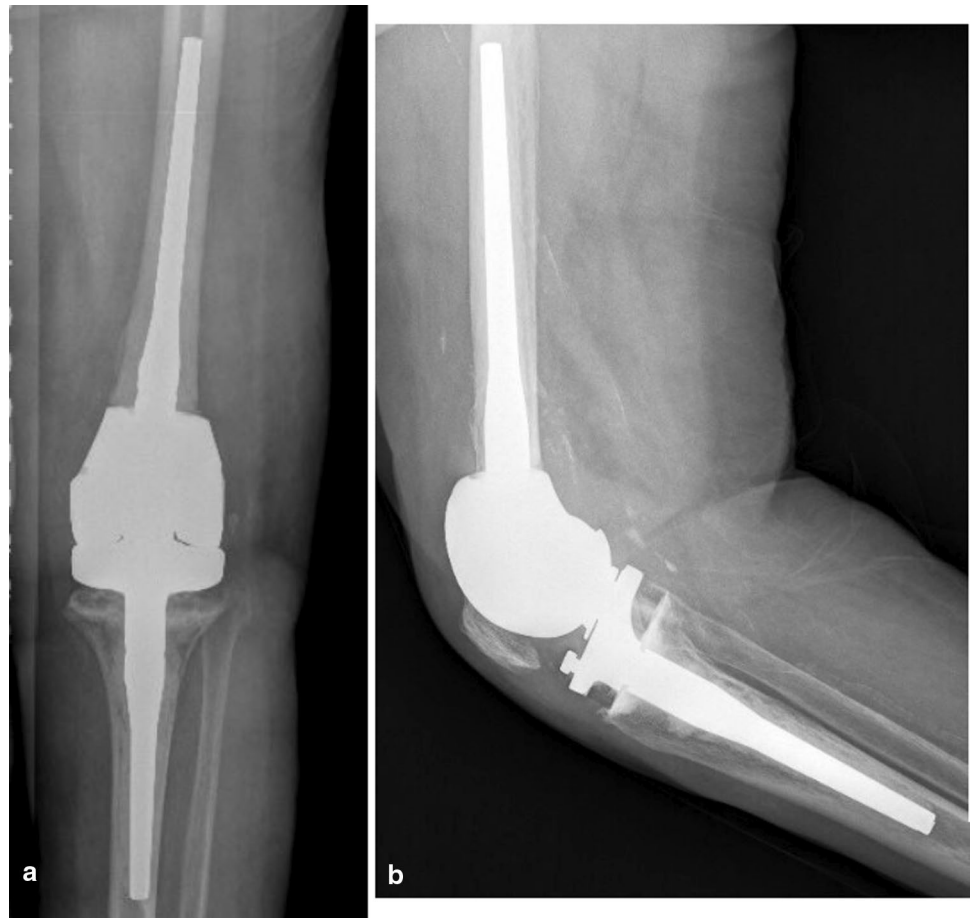


Table 1 Summary information of the patients in our study

Patient	Age (years)	Time to surgery (days)	Medical complications	Need of blood transfusion (units)	Follow-up (months)	Reoperation	Time to reoperation (months)	Death	Time to death (months)
1	80	6	No	1	59	No	–	No	–
2	89	10	Stroke	5	1	No	–	Yes	1
3	52	6	No	2	36	No	–	No	–
4	62	8	Angina pectoris, Pneumonia	2	31	PJI	17	No	–
5	60	22	No	1	32	Aseptic loosening	15	No	–
6	73	5	No	1	25	No	–	No	–
7	76	11	Hypotension	3	3	PJI	3	Yes	3
8	94	20	No	2	33	PJI	3	Yes	33
9	86	6	No	1	74	No	–	Yes	74
10	92	8	APE	2	12	No	–	Yes	12
11	84	11	UTI	1	25	No	–	No	–
Mean	77.1	10.2	–	2	30.1	–	9.5		24.6
SD	13.9	5.7	–	1.27	21.8	–	7.5		30.4
Range	52–94	5–22	–	1–5	1–74	–	3–17		1–74

SD Standard deviation, APE Acute pulmonary edema, UTI Urinary tract infection, PJI Periprosthetic Joint Infection

weight bearing ambulation was 6.2 days (SD 2.7). Average length of hospital stay was 17.5 days (SD 7.9). Five patients (45.5%) presented severe postoperative medical complications which required support from other medical specialties during their hospital stays. These medical complications included stroke, angina pectoris, pneumonia, hypotension, acute pulmonary edema and urinary tract infection.

The two major complications studied were reoperation and mortality (Table 2). Reoperation rate was 36%, being periprosthetic joint infection (PJI) the most common complication (27%). The mean time to reoperation was 9.5 months (SD 7.6). The survival rate of the implant without complication at 12 months was 81.8%, and at 24 and 36 months were 63.3%. A longer time between fracture and surgery was related to a higher risk of reoperation (15.2 days versus 7.3 days; $p = 0.02$). The 36.4% of the patients died during the follow-up, with a mortality rate of 27.8% at 12 months. Older age (87.6 years versus 71.1 years; $p = 0.04$), need of blood transfusion (3.1 units versus 1.2 units; $p = 0.01$) and need of early reoperation (3 months versus 16 months; $p = 0.006$) were related to a higher risk of mortality.

Discussion

The major findings of this study were that 45.5% of patients had medical complications during their hospital stay; 27.8% of patients died at 12 months of follow-up; and reoperation rate was 36.7% at 24 months. A longer time between fracture and surgery was related to a higher risk of reoperation. Older age, need of blood transfusion during hospital stay and need of early reoperation were related to a higher risk of mortality.

Our literature review found reports to be homogenous and consistent with our own outcomes in terms of demographics values, time until first ambulation and length of hospital stay [11–13]. The 45% of our patients presented medical complications during hospital stay. Due to patient characteristics, other studies have also emphasized the risk of medical complications after this surgery and the importance of perioperative optimization [11–14, 19]. Mortazavi et al. and Jassim et al. found a rate of severe medical complications similar to ours (30% and 45.6% of their patients, respectively) [13, 14]. Therefore, we think that these patients need an orthogeriatric unit management, like in

Table 2 Data analysis depending on the reoperation and mortality

	Reoperation			Mortality		
	YES ($n = 4$)	NO ($n = 7$)	<i>P</i> value	YES ($n = 5$)	NO ($n = 6$)	<i>P</i> value
<i>Age (Years)</i>						
Mean (SD)	73 (15.7)	79.4 (13.6)	0.49	87.8 (8.1)	71.1 (13.2)	0.04*
<i>Sex</i>						
Male— <i>n</i> (%)	1 (25)	2 (28.6)	0.89	0 (0)	4 (57.1)	0.13
Female— <i>n</i> (%)	3 (75)	5 (71.4)		4 (100)	3 (42.9)	
<i>Laterality</i>						
Right— <i>n</i> (%)	2 (50)	6 (85.7)	0.2	2 (50)	6 (87.5)	0.2
Left— <i>n</i> (%)	2 (50)	1 (14.3)		2 (50)	1 (14.3)	
<i>ASA score</i>						
II— <i>n</i> (%)	2 (50)	5 (71.4)	0.47	2 (50)	5 (71.4)	0.47
III— <i>n</i> (%)	2 (50)	2 (28.6)		2 (50)	2 (28.6)	
<i>Time to surgery (days)</i>						
Mean (SD)	15.3 (6.8)	7.4 (2.3)	0.02*	12.2 (5.3)	9.1 (6.1)	0.41
<i>Blood transfusions (units)</i>						
Mean (SD)	2 (0.8)	1.9 (1.5)	0.86	3.1 (1.4)	1.3 (0.4)	0.01*
<i>First ambulation (days)</i>						
Mean (SD)	5.8 (3.3)	6.4 (2.6)	0.71	5.3 (2.4)	6.7 (2.9)	0.41
<i>Length of stay (days)</i>						
Mean (SD)	19.3 (1.5)	16.6 (9.9)	0.61	21.5 (11.4)	15.3 (4.7)	0.22
<i>Time to reoperation (months)</i>						
Mean (SD)	9.5 (7.5)	NA	NA	3 (0)	16 (1.4)	0.006*
<i>Time to death (months)</i>						
Mean (SD)	18 (21.2)	29 (39.4)	0.75	12.3 (14.6)	NA	NA

SD Standard deviation; *n* number; ASA American Society of Anesthesiologists; NA Not applicable

*A *p* value < 0.05 was considered statistically significant

elderly patients with hip fractures. Patients who have had a hip fracture are at risk for cardiovascular, pulmonary, thrombotic, infectious and bleeding complication, resulting in a very high mortality rate (10% at one month and 36% at one year) [20]. It has been reported that morbidity and mortality rates are lower in a geriatric hip fracture unit [21].

Reoperation rate was 36%, being PJI the most common cause (27%). Mortality rate at 12 months was 27.8%, and 36.4% of the patients died during the follow-up. Some papers presented promising results without need for reoperation and low mortality rate, while others reported complication rates as high as our own (Table 3) [6–16]. In a systematic review of 241 DFRs for non-tumoral indications (68 periprosthetic fractures), the authors found a mortality rate of 22% and a reoperation rate of 17% (like us, PJI was the most common complication, causing 49% of the failures) [6]. Another recent systematic review (51 periprosthetic fractures treated with DFRs) also found that the most common complication was infection (29% of patients), but they did not report on patient mortality [8]. Also, in their systematic review (144 patients), Windhager et al. found revision rates ranged from 0 to 55%, and mortality rates ranged from 6.6% after one year to 45% after 34 months [7]. After reviewing the current literature, we have observed that the outcomes of the different studies are quite heterogeneous, making comparison and summary difficult. However, it seems that reoperation and mortality rates are not negligible, and that PJI is the most common cause of complication.

A longer time between fracture and surgery was related to a higher risk of reoperation. In the patients of our study, the reason of longer time until surgery was soft tissue compromise and need for preoperative medical optimization. Scars

from prior surgery, the extensive exposure, long operative times and comorbidities in an older patient contribute to make infection the most common postoperative complication in DFR [19]. In periprosthetic knee fracture we also have to add the soft tissue damage due to the fracture. Soft tissue compromise can be detected by the presence of edema, deep skin contusions and blisters. Immobilization with a splint, limb elevation and rest could help to improve its state. Currently, there is not a consensus regarding how much time have we to wait for the soft tissue envelope to heal before implanting a DFR in periprosthetic knee fracture. Sellan et al. [22] found no relationship between time to surgery and medical complications or mortality, but they did not report on reoperation risk. Furthermore, in these frail elderly patients, preoperative medical optimization is critical. So, sometimes, surgery should be delayed for medical management. Although we recommend to operate on these patients as early as possible, soft tissue envelope need to be healed, patient has to be medically optimized and a specialized surgery team has to be available.

An older age, need of blood transfusion during hospital stay and need of early reoperation were related to a higher risk of mortality. The literature also highlighted the old age and considerable comorbidities of these patients, noting their susceptibility to medical complications [2, 7, 8]. However, age is a non-modifiable variable. It has been reported that in patients aged 80 years and older, the incidence of preoperative anemia and thus the transfusion rate is almost twice as high as in patients under 80 years of age [23]. Moreover, it is known that blood transfusion increases the risk of PJI [24]. We think that blood management optimization is an important factor to be analyzed in future studies of elderly patients who underwent DFR. The need of medical and blood optimization highlights

Table 3 Reoperation and mortality rate after periprosthetic knee fracture operated on with a DFR

Author, year	N	Mean age (years)	Follow-up (years)	Reoperation rate	Mortality rate at 1 year (%)
Pujol et al., 2022 (Our institution's experience)	11	77.1	2.5	36%	27.8%
Chen et al. [16], 2013	36	77.3	3.1	16.7%	34.3%***
Drew et al. [10], 2015	17	78	1.5	17.6%	13.1%
Gan et al. [15], 2018	7	76.7	3.7	0%	0%
Girgis et al. [11], 2018	14	82	2.3	7.1%	7.1%*
Jassim et al. [14], 2014	11	81	2.8	0%	9.1%
Mortazavi et al. [13], 2010	20	69.5	4.9	25%	10%
Ross et al. [9], 2021	27	78.8	3.8	0%	13%
Saidi et al. [12], 2013**	7	80	0.5	0%	0%
Windhager et al. [7], 2015	11	81	3.3	45%	36%

*They excluded four patients that died during follow-up because they referred that death causes were unrelated to the DFR operation

**Follow-up was only 6 months

***Mortality rate at 2 years of follow up

the importance of an orthogeriatric unit management in these patients.

The limitations of this study include its retrospective nature, the lack of a comparison group, the relatively small sample size and the relatively brief follow-up. Our series is small because it studies an infrequent scenario; other monographic articles report comparable sample volumes. The follow-up examined in our study is similar to that in other studies and limited by the high general mortality of this population. Larger cohorts and longer follow-ups are necessary for better definition of outcomes.

In summary, DFR could be a valuable therapeutic option for distal femoral periprosthetic fractures in elderly patients. However, surgeons should be aware of the high risk of medical complications during hospital stay, high mortality rate at 12 months of follow-up, and high reoperation rate at 24 months. A longer time between fracture and surgery was related to a higher risk of reoperation. An older age, need of blood transfusion during hospital stay and need of early reoperation were related to a higher risk of mortality.

Acknowledgements We thank Russell Williams of RoundlyWorded.com for his editorial recommendations.

Author's contributions All authors contributed equally to this work. All authors contributed to the study conception and design, material preparation, data collection and analysis. The first draft of the manuscript was written by Oriol Pujol and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Declarations

Conflicts of interest The authors declare that they have no conflict of interest.

Ethics approval We consulted our Center's Ethics Committee (CEIC). Due to the retrospective and observational nature of our study, it did not need the specific approval of the committee.

The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

Consent to participate Informed consent was obtained from all individual participants included in the study or their relatives.

Consent to publication Patients or their relatives were informed that data concerning their cases might be submitted for publication, and they gave their consent.

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