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ORIGINAL ARTICLE

Distal femur fractures in elderly treated with internal fixation or distal femoral replacement — retrospective cohort study on 75 patients assessing functional outcomes, reoperations, and mortality

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Abstract

Purpose This cohort study aimed to describe the functional outcomes, complications, and mortality of patients over 65 with acute distal femur fractures treated with open reduction and internal fixation (ORIF) or distal femoral replacement (DFR).
Methods We retrospectively analyzed all patients older than 65, operated consecutively for a distal femur fracture treated with ORIF or DFR. We included 75 patients (9 33A, 5 33B, and 61 33C AO/OTA fractures), 55 treated with ORIF, and 20 with DFR. We used Parker's mobility index (PMI) to assess functional outcomes at 1, 3, and 12 months and study closure. We analyzed complications, reoperations, and mortality at 30 days, one year, and at the end of the study.
Results The PMI was significantly higher in the DFR group at months 1 ($p = 0.023$) and 3 ($p = 0.032$). We found no significant differences between cohorts at one year and the end of follow-up. Postoperative complications were significantly more frequent in the ORIF group (38.10% vs. 10%, $p = 0.022$). Reoperations were similar in both cohorts ($p = 0.98$). Mortality at one month was 4% and 20% at one year, and at the end of follow-up, there were no significant differences between groups.
Conclusion The outcomes of this study suggest that DFR offers a faster functional recovery with lower complication rates than those treated with ORIF. Additionally, both options have similar reoperation and mortality rates. Appropriately designed studies are needed to define the best treatment strategy for this type of patient.

Keywords Distal femur fracture · Geriatric · Internal fixation · Distal femoral replacement

Introduction

Distal femur fractures (DFF) in elderly patients continue to increase as the world population ages [1]. These fractures are likely to occur in "fragile" compromised patients with osteoporosis [1–3]. Their care should be focused on early mobilization, avoiding complications related to recumbency, like pneumonia, pulmonary embolism, urinary tract infections, and venous thromboembolism [2, 4]. Regardless of the treatment, these injuries have been associated with significant complication rates and a high mortality impact [5].

Due to improvements in implant designs and surgical techniques, most of these fractures are treated with open reduction and internal fixation (ORIF) [4, 6, 7]. This approach, especially in patients with poor bone mineral density and comminuted injuries, has been associated with considerable nonunion, fixation failure, and varus collapse, leading to reoperation rates of up to 50% [6–8]. For these reasons, more recently, some surgeons have begun to treat these lesions with distal femoral replacement (DFR) [4, 6, 9, 10]. Unlike ORIF, DFR allows patients prompt mobilization without weight-bearing restrictions, avoiding complications related to bone union. Its main disadvantages are the implant cost and limited revision options in case of failure [4, 9, 10]. There is little evidence regarding the best treatment strategy for these injuries, and few studies have comparatively described the outcomes of the two approaches in older adults

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[2, 8]. Therefore, this study aimed to describe comparatively the functional outcomes, complications, reoperations, and mortality in a series of patients over 65 years of age with acute distal femur fractures treated with ORIF and DFR.

Methods

We analyzed two orthopedic trauma referral center databases retrospectively, identifying patients treated surgically for a DFF between January 2012 and December 2021.

We included patients older than 65 with acute 33 AO/OTA DFF treated with ORIF or DFR. Patients with fractures related to oncologic disease, polytrauma, concomitant fractures in the lower limbs, fractures around a knee prosthesis, non-ambulatory patients, and patients with a follow-up of less than 12 months for a cause other than death were excluded. All patients were managed by surgeons trained in lower limb trauma surgeries such as knee arthroplasty. The treating surgeon was the one who decided, in each case, the type of treatment to be applied. According to the retrospective review of the medical charts, the patients treated with DFR were those who presented some degree of gonarthrosis that had led to pain before the fracture and/or poor bone stock to achieve a predictable fixation. Those treated with ORIF exhibited fracture patterns and bone stock that could potentially be fixed and denied previous symptoms of knee pain (regardless of osteoarthritis present).

Out of 175 patients identified, 100 were excluded (52 for being under 65 years of age, four for non-ambulatory, four with non-surgical treatment, 12 for having periprosthetic total knee fractures, ten related to oncological disease, 12 for presenting concomitant fractures in lower limbs or polytraumas, two for incomplete clinical or radiographic data, and four for being lost to follow-up without being able to confirm the death. (Fig. 1).

The final series consisted of 75 patients, 60 (80.0%) women and 15 (20.0%) men. The median age was 78.93 (range 66–97) years, and the follow-up was 36.69 ± 27.87 months. To describe the outcomes, we grouped the series into two cohorts according to the treatment performed.

The cohort treated with ORIF consisted of 55 patients, 41 (74.54%) women, a median age of 78.99 (range 66–92), and a follow-up of 32 ± 15.2 months. Regarding fixation, joint involvement was fixed in all cases with cannulated screws, additionally using a lateral plate in 10 cases, two plates (lateral + medial) in 20, an intramedullary nail in 12 (Fig. 2), and a nail plate combination in 13.

The DFR cohort consisted of 20 patients, 19 (95%) of whom were women. The mean age was 85.45 (range 70–97), and the mean follow-up was 40 ± 17.8 months. The prostheses used were non-conventional, hinged, with femoral and tibial stems and cemented fixation (Fig. 3).

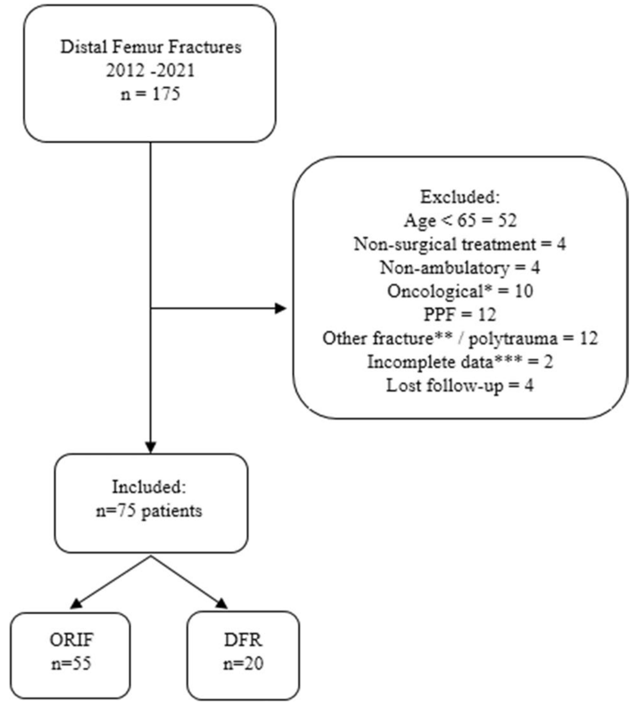

Fig. 1 Flowchart

Regarding rehabilitation, all patients treated with DFR were allowed to walk immediately after surgery without weight-bearing restrictions. While patients in the ORIF group, according to the surgeon's preference, different weight-bearing restrictions were applied, progressing according to the evolution of each case. Table 1 describes the cohort's preoperative characteristics.

We compared the prospectively registered variables in the databases concerning hospital stay (days from admission to surgery, total days of hospitalization), functional outcomes, complications, reoperations, and mortality.

We used Parker's mobility index (PMI) to assess functional outcomes [11]. This index describes whether ambulation is performed with or without assistance and whether inside or outside the home. It was recorded at months 1, 3, 12, and the end of follow-up [11]. The knee's range of motion (ROM) at 12 months postoperatively was measured using a goniometer.

For cases treated with osteosynthesis, we defined bone union as the presence of bone bridges in three of the four cortices in the follow-up AP and L radiographs, together with the absence of pain on weight-bearing [12]. Non-union was defined as the absence of bone bridging on AP and L radiographs in three of the four cortices at nine months after fixation, with pain at the fracture site upon weight bearing [13].

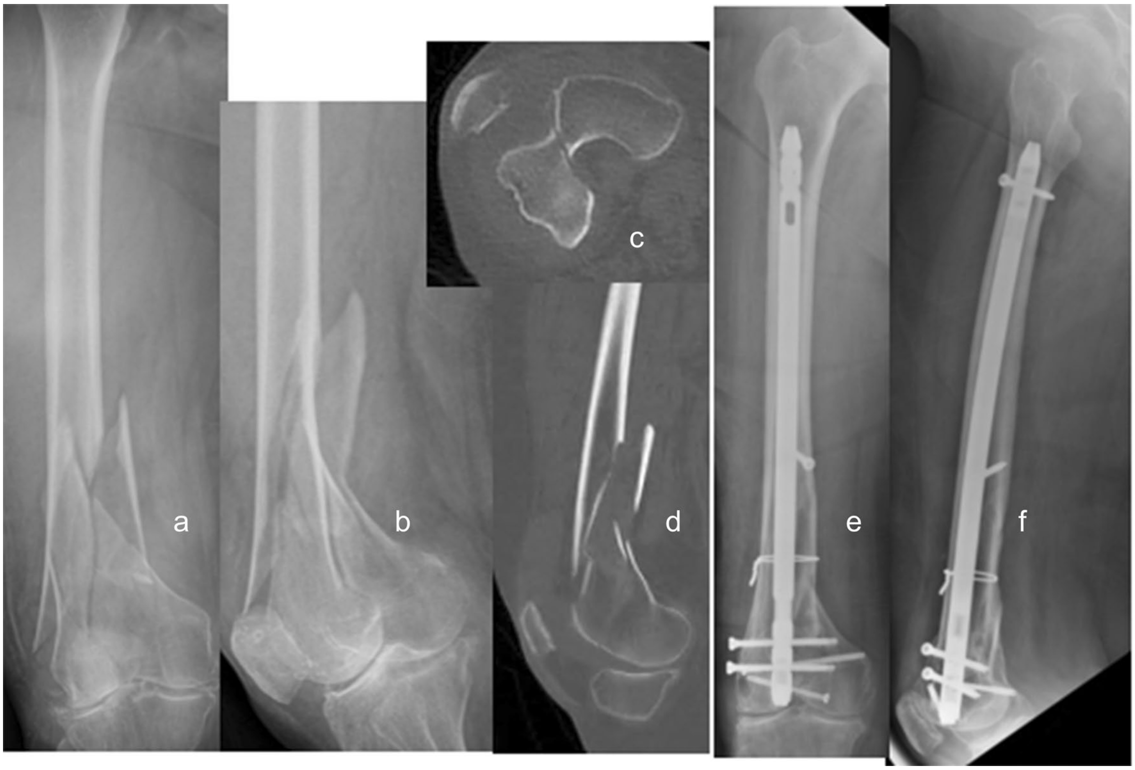

Fig. 2 **a–d** AP and Lat X-ray and CT scan showing comminuted distal femur fracture with articular involvement and osteoarthritis of the knee (no previous pain reported) in an 80-year-old woman. **e–f** AP and L X-ray 36 months after treatment with cannulated screws and retrograde nail, showing bone union

Fig. 3 **a–d** Radiograph and CT scan showing fracture of the distal femur with joint involvement in 82-year-old female. **e** Immediate postoperative AP radiograph showing DFR treatment. **f–g** AP and L radiograph at 48 months postoperative

We used the criteria described by Metsmakers et al. [14] to define postoperative infection in the ORIF group

Table 1 Summary and comparative description of the preoperative variables of the cohorts

	ORIF ($n=55$)	DFR ($n=20$)	p value
$\text{Age}_{\text{mean (range)}}$	77.38 (66–93)	85.45 (70–97)	0.01
Gender $(\text{female})_{n(\%)}$	41 (74.54)	19 (95.9)	0.50
$\text{AO/OTA}_{n(\%)}$			0.64
A	7 (12.72)	2 (10.0)	
B	4 (7.72)	1 (5.0)	
C	44 (80.0)	17 (85.0)	
Open $\text{fracture}_{n(\%)}$	8 (14.54)	0	0.10
$\text{Osteoporosis}_{n(\%)}$	37 (67.25)	14 (70.0)	0.82
$\text{DM}_{n(\%)}$	15 (27.27)	2 (10.0)	0.11
$\text{BMI} > 30_{n(\%)}$	16 (29.09)	6 (30.0)	0.93
$\text{BMI} < 20_{n(\%)}$	3 (5.45)	3 (15.0)	0.17
$\text{CCI}_{n(\%)}$			
< 3	14 (25.45)	4 (20.0)	0.62
≥ 4	41 (74.54)	16 (80.0)	
$\text{ASA}_{n(\%)}$			0.28
1–2	18 (32.72)	4 (20.0)	
3–4	37 (67.27)	16 (80.0)	0.28
Parker Mobility $\text{Index}_{\text{mean-SD}}$	5.78 ± 2.1	4.7 ± 1.9	0.054
$\text{Follow-up}_{\text{mean-SD}}$	32 ± 15.2	40 ± 17.8	0.07

DM, diabetes mellitus; BMI, Body mass index; CCI, Charlson comorbidity index; ASA, American society of anesthesiologists; SD, standard deviation

and the Muskuloesqueletal Society for DFR group [15].

Finally, to describe mortality, we discriminated mortality at 30 days, three and 12 months, and the end of the study.

Statistical analysis

We perform a descriptive statistical analysis of the variables analyzed. We used the T test to compare continuous variables and Chi-square or Fischer for categorical variables when appropriate. We considered a $p < 0.05$ as significant. We used SPSS software (Chicago, IL, USA).

Ethics

This study was conducted after approval by both institutions' ethics and institutional review committee (protocol number 11860).

Results

Out of the 55 cases in the ORIF group, 51 (92.72%) showed bone union in a mean time of 4.9 ± 1.9 months.

Functional outcomes

As a consequence of mortality, we obtained functional records available for analysis in 54 and 18 patients at months 1 and 3 and in 44 and 16 patients at one year and the close of the study in the group treated with ORIF and DFR, respectively.

Regarding PMI, at 30 days and three months, the DFR group showed significantly higher scores than those treated with ORIF ($p = 0.023$ and 0.03, respectively). This score difference was also observed in favor of the DFR group when we discriminated against patients treated with ORIF who required or did not require reoperations. At one year and the end of the follow-up, the group treated with ORIF (with and without reoperations) presented higher values, although with a non-significant difference. (Table 2, 3).

The global knee mobility range of the series was 105.5 ± 14.1°, with no significant differences between groups at one year. The ORIF group presented 3 (5.45%) patients with an extension deficit greater than 5°, while the DFR group presented it in 2 (10%) cases. Four (7.27%) patients in the ORIF group presented postoperative stiffness, while one (5%) patient in the DFR group did so.

Complications

There were 22 (29.33%) postoperative complications, significantly more frequent in the group treated with ORIF (38.18% vs. 5.0%, $p = 0.022$). The most frequently recorded complication was congestive cardiac failure in 5 (6.67%) cases. The details are described in Table 2.

Reoperations

The overall reoperation rate was 10.66% ($n = 8$). The six (10.90%) in the ORIF group were due to three (5.45%) nonunion, one (1.81%) fixation failure, one stiffness (1.81%), and one (1.81%) infection. One 33B2 fracture fixed with a lateral locked distal femur plate (DFP) evolved with infected nonunion, so after surgical debridement, a 5 cm segmental bone defect was generated and treated with an induced membrane technique. The patient achieved bone union 15 months after fracture. The other two cases (33A3 and 33C1) were aseptic nonunion initially fixed with retrograde intramedullary nails. At reoperation, larger diameter nails were implanted together with bone graft. One showed bone healing six months after the revision (16 months from fracture), and the remaining needed a new surgery six months after the second surgery. In this case, we performed an augmentation with a locked distal femur plate (DFP), achieving bone union six months after the second reoperation. The implant failure and varus collapse of the 33C2 fracture case had been initially fixed with a lateral DFP and was revised to double

Table 2 Hospital stay, functional outcomes, complication, reoperation, and mortality description of the two groups

	ORIF (*n*=55)	DFR (*n*=20)	*p* value
Admission to surgery$_{\text{mean-SD}}$	5.2 ± 2.7	4.1 ± 2.0	0.12
Hospital stay$_{\text{mean-SD}}$	13.4 ± 5.1	8.3 ± 1.1	**0.001**
PMI at 1 month$_{\text{mean-SD}}$	2.8 ± 1.9	4.0 ± 1.5	**0.023**
PMI at 3 months$_{\text{mean-SD}}$	3.3 ± 1.5	4.4 ± 2.0	**0.045**
Functional ability regarding prefracture (3 months)$_{\text{n (\%)}}$	4/51 (7.84%)	14/18 (77.78%)	**0.001**
PMI at 12 months$_{\text{mean-SD}}$	4.83 ± 2.8	3.9 ± 2.4	0.19
Functional ability regarding prefracture (12 months)$_{\text{n (\%)}}$	29/44 (65.09%)	14/16 (87.5%)	0.11
PMI at study closure$_{\text{mean-SD}}$	5.01 ± 2.9	4.20 ± 2.68	0.27
Functional ability regarding prefracture (study closure)$_{\text{n (\%)}}$	32/44 (72.72%)	14/16 (87.5%)	0.31
ROM$_{\text{mean-SD}}$	105.3 ± 12.7	106.2 ± 17.7	0.81
Extension deficit > 5°$_{\text{n (\%)}}$	3 (5.45)	2 (10)	0.88
Stiffness$_{\text{n (\%)}}$	4 (7.27)	1 (5)	0.97
Complications$_{\text{n (\%)}}$	21 (38.18)	1 (10)	**0.022**
CHF	5	–	
Pneumonia	4	–	
UTI	4	–	
DVT	4	–	
PE	-	1	
SST	4	–	
Reoperation$_{\text{n (\%)}}$	6 (10.90)	2 (10)	0.99
Aseptic nounion	2	–	
Septic nounion	1	–	
Fixation failure	1	–	
Infection	1	–	
Stiffness	1	–	
Periprosthetic fracture	–	2	
Mortality$_{\text{n (\%)}}$			
30 days	1 (1.81)	2 (10)	0.17
1 year	11 (20)	4 (20)	0.99
Follow-up $_{\text{mean-SD}}$	39.1 ± 35.1	43.7 ± 42.1	0.23

PMI, Parker mobility index; ROM, range of motion of the knee; UTI, urinary tract infection; CHF, congestive heart failure; DVT, distal venous thromboembolism; PE, pulmonary embolism; SST, superficial surgical site infection; SD, standard deviation

Table 3 Comparative analysis between patients treated with DFR and ORIF with and without reoperation

	ORIF (*n*=49)	ORIFr (*n*=6)	DFR (*n*=20)	*p* value
PMI at 1 month$_{\text{mean-SD}}$	2.8 ± 1.1	2.8 ± 0.9	4.2 ± 1.3	**0.0004**
PMI at 3 months$_{\text{mean-SD}}$	3.6 ± 1.2	3.0 ± 1.1	4.2 ± 1.3	**0.0017**
Functional ability regarding prefracture (3 months)$_{\text{n (\%)}}$	3/43 (6.97%)	0/6 (0%)	14/18 (77.78%)	**0.0001**
PMI at 12 months$_{\text{mean-SD}}$	5.6 ± 2.0	6.7 ± 1.8	4.8 ± 1.4	0.12
Functional ability regarding prefracture (12 months)$_{\text{n (\%)}}$	27/39 (69.23%)	2/5 (40.0%)	14/16 (87.5%)	0.10
PMI at study closure$_{\text{mean-SD}}$	5.7 ± 2.2	6.5 ± 1.7	5.2 ± 1.8	0.06
Functional ability regarding prefracture (study closure)$_{\text{n (\%)}}$	32/39 (82.05%)	4/5 (80.0%6)	14/16 (87.5%)	0.08
ROM$_{\text{mean-SD}}$	106.7 ± 9.7	94.2 ± 26.1	106.2 ± 17.7	0.11
Extension deficit > 5°$_{\text{n (\%)}}$	3 (5.45%)	0	2 (10%)	0.75
Follow-up$_{\text{mean-SD}}$	24.3 ± 8.3	37.5 ± 23.9	43.7 ± 42.1	0.16

ORIF, ORIF treated patients without reoperation; *ORIFr*, ORIF treated patients with reoperation; *PMI,* Parker mobility index; *ROM,* range of motion of the knee plate at five months, healing at eight months after revision. The postoperative infection case was reoperated three weeks after fixation, and a surgical debridement without osteosynthesis replacement and systemic antibiotic therapy according to intra-operative cultures and antibiogram was performed. The patient evolved with bone union and infection control without subsequent recurrences. Finally, the patient with stiffness required open arthrolysis and intensive physical therapy, achieving 100° ROM.

In the DFR cohort, we recorded two (10%) reoperations caused by a periprosthetic femoral fracture at 72 months and 42 months postoperatively, respectively. Both were treated with replacement of the femoral component with one of greater length.

Comparatively, there was no significant difference between groups in the reoperation rate.

Mortality

The overall mortality of the series at the end of the study was 20% ($n=15$).

We recorded no significant differences between cohorts regarding mortality at one, three, and twelve months and until the end of the study.

Discussion

Our study's main finding was that the DFR approach in elderly patients with distal femur fractures allowed a faster functional recovery and lower complication rates than those treated with ORIF. Additionally, both treatments had similar reoperation and mortality rates.

Regarding function, our analysis confirms what has been reported by other similar series that highlight that DFR allows faster rehabilitation and recovery of pre-fracture function than ORIF [16, 17]. We understand this occurs because it will enable mobilization without weight-bearing restrictions from the immediate postoperative period. It is uncommon in most patients treated with ORIF, especially in comminuted and osteoporotic fractures [4].

This benefit in functional recovery in favor of DFR was found at 30 and 90 days, even when we subanalyzed ORIF-treated patients who did not undergo reoperations.

Postoperative complications recorded in this series were nearly 30%, consistent with prior series that highlight the high impact on the morbidity of these fractures in this population [5, 17]. We observed that these were significantly higher in the ORIF cohort ($p=0.022$), even though this group of patients was younger, although with similar comorbidities. It could be related to prolonged hospitalization and slower mobilization than the DFR-treated group. Both hospital stay and restricted postoperative mobilization have been shown to impact the postoperative complication rate [4]. Comparatively, our findings contrast with a recent study, which reported that the percentage of readmissions for DVT, PE, and infection was significantly higher in patients treated with DFR versus those managed with ORIF.

The reoperation rate in the present study was 10.66%, which is relatively low relative to other similar series that report rates of up to 50% [8]. Comparing both treatments, we did not observe significant differences between groups. It could be influenced by the low rate of bone healing problems and fixation failures in the ORIF group (7.57%), which has been reported to be close to 20% [8, 17]. There was also the absence of postoperative infection in the DFR group, which has been reported to be 0 to 20% [10]. The lack of statistical differences in reoperations between groups in the present study aligns with those reported by Salazar et al. and Ponugoti et al. in their meta-analysis [18, 19]. At the same time, it contrasts with the greater need for reoperations in patients treated with ORIF (50%) than DFR (10%), as reported by Tibbo et al. in their series of 30 patients [8].

It should be pointed out that the two reoperations for periprosthetic fractures in the DFR group required revision of the femoral component. This type of revision can be technically demanding, requiring trained hands and experience. As we described previously in the ORIF group, we used different types of fixation. It is a consequence of the fact that the treating surgeon decided on the type of implant to be used and that the study covered a prolonged time. During the first part of the study period, most patients were fixed with a single implant, unlike the later patients for whom the implant combination was more frequent. It is a consequence of a better understanding of the behavior of these fractures, their mechanical complications, and the evolution of their treatment [20]. Indeed, the four patients who showed nonunion or loss of fixation had been treated with a single implant, showing an 18.18% (4/22) failure rate, while none of those fixed with two implants did so. Regarding the type of fracture, 14.28% (1/7) of type A fractures, 25% (1/4) of type B fractures, and 4.54% (2/44) of type C fractures evolved with bone healing failure. According to the type of fixation used, 20% (2/10) of the lateral plates and 16.66% (2/12) of the nails failed.

The mortality of 4% at 30 days and 20% at one year and the end of the study was comparable to the 22% reported by Dekeyser et al. [10] and 25% reported by Streubel et al. [21] and lower than the 34% reported by Jennison et al. [22].

Although 30 and 90 day mortality was higher in the DFR group (10% vs. 1.81% and 10% vs. 5.45%), this difference did not reach statistical significance. Likewise, at one year and the end of the study, we did not observe significant differences in this item. It partially agrees with what was recently reported by Dekeyser et al. [10]. These authors informed that they did not find significant differences in mortality at 30 and 90 days in patients treated with ORIF or DFR, but they did find them in patients treated with DFR one year after treatment.

Treatment of distal femur fractures in elderly patients can be challenging, and there is currently no clear consensus on the optimal treatment strategy. Our study confirms that DFR offers a faster return to pre-fracture ambulatory activity than patients treated with ORIF, whether or not they require additional surgery to achieve bone healing. It also highlights a higher incidence of clinical complications in the group treated with ORIF, an item little addressed in previous studies.

The study's limitations are inherent to a retrospective design and few patients. Nevertheless, the number of patients analyzed was equal to or higher than that of a similar series previously reported. Another limitation associated with the study's retrospective nature is the absence of randomization in the treatment, where the treating surgeon decided to perform one or another approach. It also meant that the cohorts presented some differences in their preoperative characteristics, such as age. However, they shared similarities concerning gender, comorbidities (ASA, CCI, osteoporosis, DM, BMI), and fracture type (AO/OTA). Another limitation is the unequal number of patients in each group, which could have affected the statistical significance of the comparative analysis (type 2 error).

Conclusions

The outcomes of this study suggest that both ORIF and DFR represent valid treatment options for acute distal femoral fractures in elderly patientsQuery. While DFR offers faster functional recovery with lower postoperative complication rates, both options had similar reoperation and mortality rates.

Author contributions All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by German Garabano, Andres Juri, and Sebastian Pereira. The first draft of the manuscript was written by German Garabano. All authors read and approved the final manuscript.

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Data availability All data generated and analyzed during this study are included in this published article and are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. (Project number 11860).

Informed consent Informed consent was obtained from all individual participants included in the study.

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