Original Articles

Periprosthetic knee fractures in an elderly population: open reduction and internal fixation vs distal femur megaprostheses

Davide De Marco[1], Federica Messina[1], Cesare Meschini[1] [a], Maria Serena Oliva[1], Giuseppe Rovere[1], Giuseppe Maccagnano[2], Giovanni Noia[2], Giulio Maccauro[1], Antonio Ziranu[1]

[1] Department of Orthopaedics, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Università Cattolica del Sacro Cuore Roma, [2] Orthopaedic and Trauma Unit, Department of Clinical and Experimental Medicine, Faculty of Medicine and Surgery, University of Foggia, Policlinico Riuniti di Foggia

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The incidence of periprosthetic fractures of distal femur (PPDFFx) after primary total knee arthroplasties is described around 0.3% and 2.5% and it is increasing as the number of patients with total knee arthroplasty continues to arise. surgical options treatments for PPDFFx include fixation in the form of eather Open reduction and internal fixation (ORIF), or retrograde intramedullary nailing (RIMN), or conventional (non locked) plating, or locked plating such as the Less Invasive Stabilization System (LISS), or dynamic condylar screws. In recent years, however, the use of megaprostheses has been increasing.

Patients with periprosthetic fractures of distal femur after primary total knee arthroplasties treated with ORIF or with the use of Distal femur replacement (DFR) were retrospectively analyzed in this to evaluate differences in intra-operative blood loss, need of blood trasfusion, weight bearing, range of motion, rate of complications, rate of revision surgery and functional outcome according Oxford Knee Score between two groups.

Treatment of Periprosthetic distal femur fracture remains controversial. While ORIF seems to guarantee less percentage of complications and reoperation rate, those treated with megaprosthesis seem to gain better range of motion in a very short post-operative time.

In the future it will be necessary to investigate with greater numbers possible advantages and disadvantages of the various treatments in periprosthetic distal femur fractures.

INTRODUCTION

The incidence of periprosthetic fractures of the distal femur (PPDFFx) after primary total knee arthroplasties is described around 0.3% and 2.5%,[1–3] and it is increasing as the number of patients with total knee arthroplasty continues to arise.[1,4] There are risk factors that predispose to the possibility of fracture, which may occur more frequently as a result of low-energy trauma. Female sex, osteoporosis, chronic steroid use, anterior femoral notching, rheumatoid arthritis, and neurological abnormalities.[2,5]

These fractures typically occur in an elderly senior population. They can have devastating consequences, including loss of ambulatory status, perioperative morbidity, and mortality rates of up to 15% in the first year after surgery.[6]

Several classification systems have been used to standardize the description of Periprosthetic distal femur fractures, such as Rorabeck and Taylor, Su et al.[7] or the OTA/AO. These classifications are used to establish the most appropriate treatment. Parameters such as the presence of displacement, comminution, quality of bone stock in the distal fragment, and the presence of a well-fixed or loose femoral component are the most examined factors. Su et al. classification is an X-ray based system of classification, the most critical parameter in the direction of the fracture line: Type 1, the fracture is proximal to femoral component; Type 2, fracture originating at the proximal end of the femoral component and extending proximally; Type 3, fracture in which any part of the fracture line can be seen distal

a **Corresponding author:**
Cesare Meschini;
cesare.meschini@gmail.com - Department of Orthopaedics, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Università Cattolica del Sacro Cuore Roma, Largo F. Vito 1, 00168 Rome, Italy

to the upper edge of the anterior flange of the femoral component.[7]

There are many treatment possibilities.[8] First of all, we have to distinguish between conservative treatment and surgical treatment: the first option is to be considered for non-ambulatory patients or patients with excessively high operative risk,[9] but this type of treatment is burdened by a high percentage of malalignment, non-union, loss of motion of the knee and displacement of the fracture,[2] surgical options treatments for PPDFFx include fixation in the form of either Open reduction and internal fixation (ORIF) or retrograde intramedullary nailing (RIMN), or conventional (nonlocked) plating, or locked plating such as the Less Invasive Stabilization System (LISS), or dynamic condylar screws.[2,9]

In recent years, however, the use of mega prostheses has been increasing, so the indication is no longer limited to the oncological field.[10,11] In more and more cases, this type of prosthesis is used in case of displaced fractures, massive bone loss, and in some cases of septic or aseptic revision. In addition, this technique may be preferable in elderly patients with loose implants and insufficient bone stock or patients who require short hospitalization and rapid recovery because of low activity levels and multiple comorbidities.[1,12,13]

Fracture pattern and stability of the joint at the time of fracture often dictate treatment choice. However, this decisional process is limited by the absence of solid clinical evidence due to the lack of comparative studies for these existing techniques.[6,14]

The purpose of this study is to evaluate the outcome in patients treated with mega prostheses or internal fixation in periprosthetic fractures of the distal femur in our experience at Policlinico Gemelli.[10]

PATIENTS AND METHODS

Patients with periprosthetic fractures of the distal femur after primary total knee arthroplasties treated with ORIF or with Distal femur replacement (DFR) were retrospectively analyzed.

Group A was treated with ORIF, while Group B was treated with DFR.

Inclusion criteria were: patients with periprosthetic fracture of the distal femur (Type 1, 2,3 according to SU classification[7]), age > 50 years.

Exclusion criteria were: patients with periprosthetic fracture of the proximal tibia (Type 1, 2, 3, 4 according to Felix classification[15]), age < 50 years, patients with periprosthetic fracture of distal femur treated with intramedullary nailing (IMN).

Our equipment reviewed the electronic medical record. Patient demographics, medical comorbidities, injury mechanisms at presentation were recorded for each patient. All fractures were radiographically classified according to SU classification. Each patient's postoperative functional and mobility assessments were retrieved from the electronic medical record, including treatment-related complications. Treatment-related variables such as volume of blood loss and need for transfusions were recorded for each patient.

Self-assessment questionnaires were administered to all patients in Oxford knee score to evaluate the impact on the quality of life.

Every patient was checked for comorbidities, and Charlson Comorbidity Index (CCI) was used to evaluate the general clinical conditions of the cohort. CCI is a 10-years survival predictor in patients with multiple comorbidities.

The surgical complications group were included: wound dehiscence, deep infection, revision rate.

In the clinical complications group, pneumonia, urinary tract infection, and deep vein thrombosis were included.

STATISTICAL ANALYSIS

After data collection, fundamental descriptive statistical analyses described the patient population and treatment outcomes. A student t-test or Fisher exact test were used, where appropriate, to determine statistical significance.

Statistical significance was set for $p<0.05$.

RESULTS

According to inclusion and exclusion criteria, thirteen patients were considered eligible and were finally included in the study.

Nine were assigned to Group A (ORIF) and four to Group B (DFR).

The two primary outcomes were: (1) weight-bearing lines in patients treated with distal femur replacement (2) primary postoperative ROM in patients treated with distal femur replacement.

Secondary outcomes were comparing the volume of blood loss and incidence of treatment-related complications between the two groups.

PATIENT DEMOGRAPHIC

Baseline characteristics for the study cohort are reported in *Table 1*. There were 4 males and 9 females, the average age at the time of fracture was 73,4 years old (range 57-87) for the entire cohort. Mean postoperative follow-up was 10,8 months (range 2-48).

For each patient of the cohort Osteoarthritis was the cause for primary surgery. In nine cases the right knee was involved.

In 11 patients PPF was caused by trauma (low-energy falls), in 2 patients by osteolyse. All the PPF involved the distal femur component: one classified as Type 1 according to Su et al., six classified as Type 2, seven classified as Type 3.[7]

Comorbidities were checked for each patient: five of thirteen patients had zero comorbidities, eight of thirteen had various comorbidities such as Diabetes mellitus (DM), Dementia, Congestive Heart Failure (CHF), Chronic Kidney disease (CKD), Chronic Obstructive Pulmonary Disease (COPD), Connective tissue disease and Hemiplegia. Through the collection of comorbidities data Charlson Co-

Table 1. Baseline characteristics.

	TOTAL	ORIF	MEGAPROSTHESIS
PATIENTS	13	9	4
SEX	4 M | 9 F	2 M | 7 F	2 M | 2 F
AGE (YEARS)	73,4 (57-87)	72 (57-83)	76,5 (70-87)
FOLLOW-UP (MONTHS)	10,8 (2-48)	14,3 (3-48)	3 (2-4)

Table 2. Population characteristics.

N°	Sex	Age	Side	Reason for primary TKA	Cause of Fracture	Fracture classification (Su et al.)	Treatment	Comorbidities	CCI
Group A									
1	M	66	R	OA	Trauma	Type 3	ORIF	Hemiplegia, CKD	6
2	F	66	L	OA	Trauma	Type 2	ORIF	Dementia	3
3	M	67	R	OA	Trauma	Type 3	ORIF	DM	3
4	F	79	R	OA	Trauma	Type 2	ORIF	DM, COPD, CKD	7
5	F	83	L	OA	Trauma	Type 2	ORIF	DM, COPD; dementia, Hemiplegia	8
6	F	71	R	OA	Trauma	Type 1	ORIF	None	3
7	F	76	R	OA	Trauma	Type 2	ORIF	None	3
8	F	83	R	OA	Trauma	Type 3	ORIF	DM, Dementia	6
9	F	57	R	OA	Trauma	Type 2	ORIF	None	1
Group B									
1	M	74	L	OA	Osteolyse	Type 2	DFR	None	3
2	F	75	R	OA	Trauma	Type 3	DFR	CHF, Connective tissue desease	6
3	F	87	L	OA	Osteolyse	Type 3	DFR	COPD, Dementia	6
4	M	70	R	OA	Trauma	Type 3	DFR	None	3

morbidity Index was determined, as result we got CCI 1, 7, and 8 for only one patient each, CCI 3 for six patients and CCI 6 for four patients of the population.

A detailed description of all data is shown in *Table 2.*

Mean intraoperative blood loss was 483 cc (range 200-800cc) in the group treated with ORIF and 550 ccs (range 300-1000cc) in the group treated with DFR. There were no significant statistical differences in blood loss outcome between those two groups, p-value 0.65. For each patient of the population, at least one perioperative blood transfusion was needed, exception made for one A group patient.

Patient mobilization was carried out under full weight-bearing from the first postoperative day in three cases and partial weight-bearing for 14 days in one case only in the group of those treated with DFR; in this case, we preferred to wait wound healing before forcing rehabilitation because due to patient's overall frailty to avoid complications. An entire group of those treated with ORIF were subject to non-weight bearing for a minimum of 30 to a maximum of 60 days.

The mean Range of motion obtained was 71.1° (range 50-90°) in Group A (ORIF), and 82.5° (range 50-100°) in Group B (DFR). The comparison didn't bring up any significant statistical difference, p-value 0.33.

Complications including Pneumonia, Wound healing disorders, wound infection, implant failure occurred in one of nine patients from group A (percentage of 11.1%). This patient was treated with implant removal and distal femur replacement. Regarding group B, complications such as wound healing disorders and wound infection were recorded in two of four patients (percentage of 50%). These two patients needed revision surgery in the form of a skin graft and muscle flap of the gastrocnemius. There were no

Table 3. Outcome data collection.

N°	Blood loss (cc)	Need for transfusion (Y/N)	Weight bearing (WB)	Range of Motion (ROM)	Complications	Revision surgery	Oxford Knee Score (OKS)
Group A							
1	700 cc	Y	Non-WB for 40 days	0-50°	None	None	18
2	800 cc	Y	Non-WB for 60 days	0-60°	None	None	15
3	600 cc	Y	Non-WB for 30 days	0-90°	None	None	30
4	350 cc	Y	Non-WB for 40 days	0-80°	Pneumonia Wound Infection Implant failure	Implant of megaprosthesis	19
5	300 cc	Y	Non-WB for 30 days	0-90°	None	None	41
6	300 cc	N	Non-WB for 40 days	0-80°	None	None	36
7	500 cc	Y	Non-WB for 40 days	0-60°	None	None	31
8	600 cc	Y	Non-WB for 30 days	0-50°	None	None	15
9	200 cc	Y	Non-WB for 40 days	0-80°	None	None	28
Group B							
1	300 cc	Y	Full-WB	0-100°	None	None	45
2	1000 cc	Y	Partial-WB for 14 days	0-50°	Wound healing disorder	Escharotomy and skin graft	23
3	500 cc	Y	Full-WB	0-80°	Wound infection	Wound revision and muscle flap	20
4	400 cc	Y	Full-WB	0-100°	None	None	45

significant statistical differences between the two groups, p-value 0.20. Despite the different number of patients in the two groups, the highest complication rate in patients of group B (50% vs. 11%) is due that the DFR it's a more invasive, longer procedure than ORIF, associated with increased bone loss and risk of post-operative anemia.

As previously described, we provided self-assessment questionnaires in the form of Oxford Knee Score to evaluate the after-surgery quality of life. The mean result was 25.9 in patients treated with ORIF, 33.5 in patients treated with DFR. No significant statistical difference was pointed out, p-value 0.28.

A detailed description is provided in *Table 3* and *4*.

DISCUSSION

A periprosthetic distal femur fracture is a devastating injury after total knee replacement, and the optimal treatment remains controversial.[3]

We performed this retrospective study on periprosthetic distal femur fractures to evaluate the role of mega prostheses on functionality and surgical complications onset.

The different overviewed techniques appear to be equal in terms of perioperative blood management. Even though DFR is a more invasive surgical technique with a longer operative time, consistent blood loss and need for transfusion during perioperative time seem to occur in patients under-

Table 4. Statistical analysis.

	A (ORIF)	B (Megaprosthesis)	p value (p<0.05)
BLOOD LOSS (mean)	483cc (200-800)	550 (300-1000)	0.65
RANGE OF MOTION (mean)	71.1° (50-90°)	82.5° (50-100°)	0.33
COMPLICATION (%)	11.1 %	50 %	0.20
QUALITY OF LIFE (OKS)	25.9	33.5	0.28

going ORIF as well. Our primary outcome was to evaluate the existing differences in weight-bearing and range of motion between patients treated with ORIF or DFR. As previously shown, none of the ORIF group managed to be back to full weight-bearing until at least 30 days. On the contrary, all the DFR groups managed to be on full weight-bearing in the first day after surgery. Considering the mean age of patients in which periprosthetic distal femur fracture tends to occur, the advantage of DFR kind of treatment to shorten recovery time this much is really important. This prevents patients from being bedridden and its outcomes such as thrombosis, worsening of dementia, negative impact on independence and autonomy, and the quality of life.

The Range of motion conquered by the DFR group of patients, although any significant statistical differences between groups emerged, tend to be almost entirely obtained. The lack of statistical significance could be related to the lower number of populations treated with distal femur replacement and to the shorter time of follow-up linked to the proximity of the date of surgery.

Meluzio et al. already pointed out the importance of ROM, functional assessment and complications in their systematic review. Thirteen articles were screened and one hundred-four patients with distal femur fractures treated with the use of mega prosthesis were collected. They concluded that the use of knee mega prosthetic implants could represent a valid treatment option aiming to reduce patients' immobilization and hospital stay. Good clinical outcomes, especially ROM and faster weight-bearing, with low rate of complications were reported by all included studies.[5]

The importance of full weight-bearing and range of motion is stressed out through the oxford knee score assessment administered to all patients. The best results came out in patients treated with mega prostheses, despite the lack of statistical significance.

David A. Quinzi et al. conducted a study where ORIF, retrograde intramedullary nail (IMN) and distal femoral replacement (DFR) were compared as the eligible treatment for periprosthetic distal femur fracture. They compared 1205 cases treated with ORIF, N 272 cases treated with IMN and N 353 cases treated with DFR and none statistically significant results were pointed out in terms of major complications or reoperations rate.[6] Deep infection rates were higher in DFR relative to internal fixation[6,16–18] malunion rates were higher in IMN versus ORIF.[6]

Harsh wadhwa group showed interest in the treatment of Periprosthetic distal femur fracture, they conducted a systematic review and meta-analysis to describe the complication rates and functional outcomes of periprosthetic distal femur fractures managed with either DFR or ORIF. They collected fifty-eight studies for an amount of 1484 patients and found out that those considered parameters were comparable.[3]

David A. Quinzi et al compared the outcomes of ORIF with plate and mega prosthesis treatment, noting any significant differences in postoperative ROM and in complications rate. About the costs between the two treatments, these are comparable because the higher cost of the mega prosthesis is associated with a lower average hospital stay. As a result, according to Quinzi et al. distal femoral replacement is a good treatment for elderly patients, with fractures that preclude internal fixation, with a loose implant, or minimal distal periprosthetic bone loss.[19]

In line with the literature, our study did not point out any significant statistical differences in terms of complication or reoperations rate between the two different types of treatment considered in this study. This particular element outlines the need for improvement of literature studies and meta-analyses in order to better standardize the treatment of PDFFs.

LIMITATIONS

This study has some limitations. This study has some limitations. First of all, patient selection and differences in observation time are well known biases of retrospective studies. Moreover, surgery-related complications are hardly defined and often remain unknown.

CONCLUSION

Treatment of Periprosthetic distal femur fracture remains controversial. While ORIF seems to guarantee less percentage of complications and reoperation rate, those treated with mega prostheses seem to gain a better range of motion in a very short post-operative time. However, the limited number of patients in our population study didn't give us any significant statistical differences. Further studies with a larger number of patients are needed to establish whether the underlined trends in results are to be confirmed.

Ultimately, in the future, it will be necessary to investigate with greater numbers of possible advantages and disadvantages of the various treatments in periprosthetic distal femur fractures.

CONTRIBUTIONS

The authors contributed equally.

CONFLICT OF INTERESTS

The authors declare no potential conflict of interest.

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