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Case Report

Postoperative early weight-bearing using double plating for periprosthetic, interprosthetic, and interimplant distal femur fractures following total knee arthroplasty: A report of three cases

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ABSTRACT

Background: Distal femur fractures (DFFs) following total knee arthroplasty (TKA) in older patients often require prolonged non-weight-bearing, thereby decreasing their activities of daily living (ADL) and increasing mortality. This report clarifies early weight-bearing safety and utility by using double-plate fixation on medial and lateral sides (LM180 double-plate fixation) for DFFs following TKA.

Case presentation: Three cases of Su Type III periprosthetic, interprosthetic, and interimplant DFFs following TKA, where bone stock was limited, were treated with LM180 double-plate fixation using locking plates through medial and lateral incisions on the distal femur. In interprosthetic and interimplant DFF cases, the proximal section was secured by overlapping the lateral plate +/- medial plate with the proximal femur stem of the intramedullary nail by using monocortical screws and cerclage wires. Early postoperative partial weight-bearing was recommended, and full weight-bearing was allowed 4–5 weeks postoperation. All cases regained independent walking without hardware failure. Average ADL scores, namely, Barthel index (BI) and functional independence measure (FIM), were recovered to 85/100 and 114.7/126, respectively, approaching near-normal values.

Conclusion: LM180 double-plate fixation for DFFs such as Su Type III periprosthetic, Vancouver type C interprosthetic, and interimplant DFFs following TKA with limited bone stock can be used to achieve early weight-bearing without fixation failure and help maintain ADL.

Introduction

With the increasing older population, the incidence of periprosthetic distal femur fractures (PPDFFs) increases, ranging from 0.3 %

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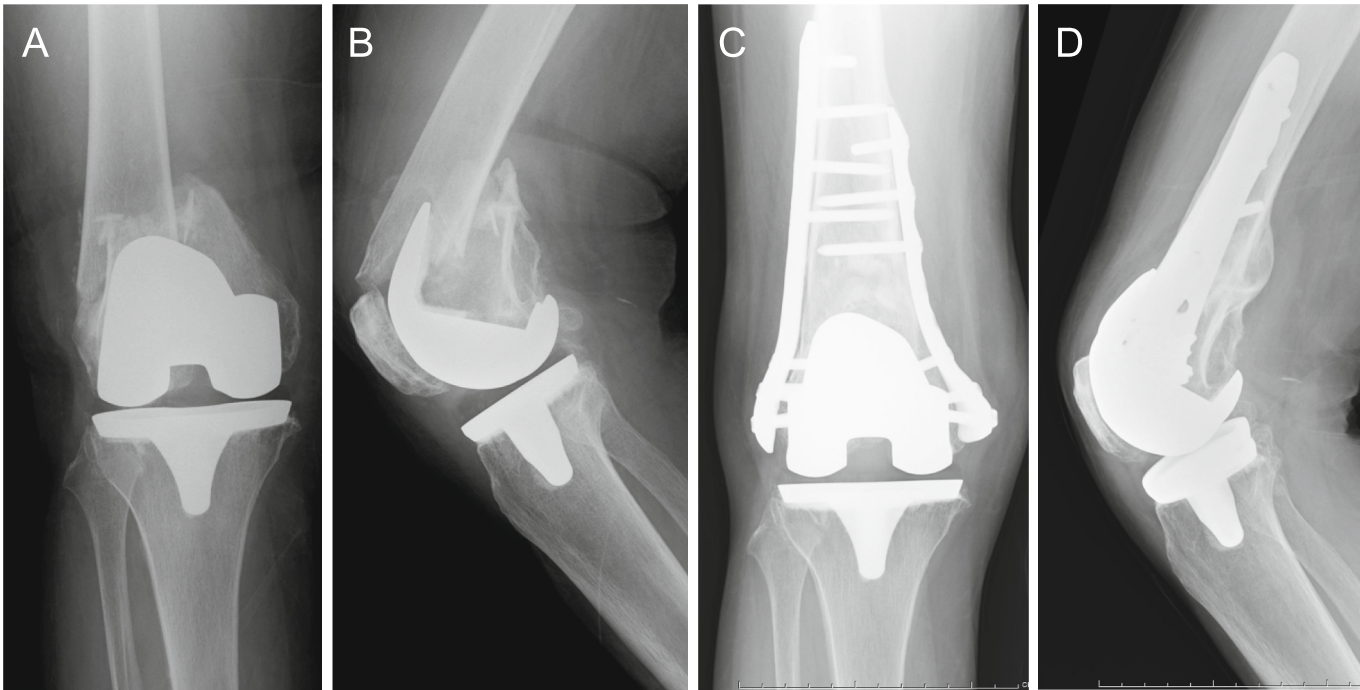


Fig. 1. A-B: Preoperative plain radiograph of a Su Type III periprosthetic distal femur fracture presented in anteroposterior (A) and lateral (B) views. C-D: Plain radiographs showing bone healing without hardware failure 22 months after LM180 double-plate fixation.

Table 1
Descriptive data of three cases.

Age gender	Previous surgery for ipsilateral leg and periods (months)	Fracture type	Lewis-Rorabeck	Su	Hardware	Surgical approach	Number of distal screws	Number of proximal screws	Postoperative days until FWB	ROM at follow-up (°)	FIM at discharge	BI at discharge	Follow-up periods (months)
85 F	Right PS TKA (77).	PPDF	II	III	Lateral: NCB-DF plate Medial: NCB-PT plate for the proximal lateral tibia	Medial and lateral incision on the distal femur	9	7	29	0/105	121	95	22
85 F	Left hip hemiarthroplasty (102). Left TKA-PS (97).	IPDF	II	III Vancouver Type C	Lateral: NCB periprosthetic distal femur plate Medial: NCB-PT plate for the proximal lateral tibia	Medial and lateral incision on the distal femur Lateral incision on the proximal part of the lateral plate	9	9	34	0/70	121	95	21
80 F	Simultaneous right PS TKA with stemmed femoral component and ORIF for distal femoral fracture (39). Right intramedurally nailing for proximal femoral fracture (14).	IIDFF	II	II	Lateral: NCB periprosthetic distal femur plate Medial: NCB-PT plate for the proximal lateral tibia Cables: distal x2, proximal x1	Medial and lateral incision on the distal femur Lateral incision on the proximal part of the lateral plate	6	7	30	-5/75	102	65	12

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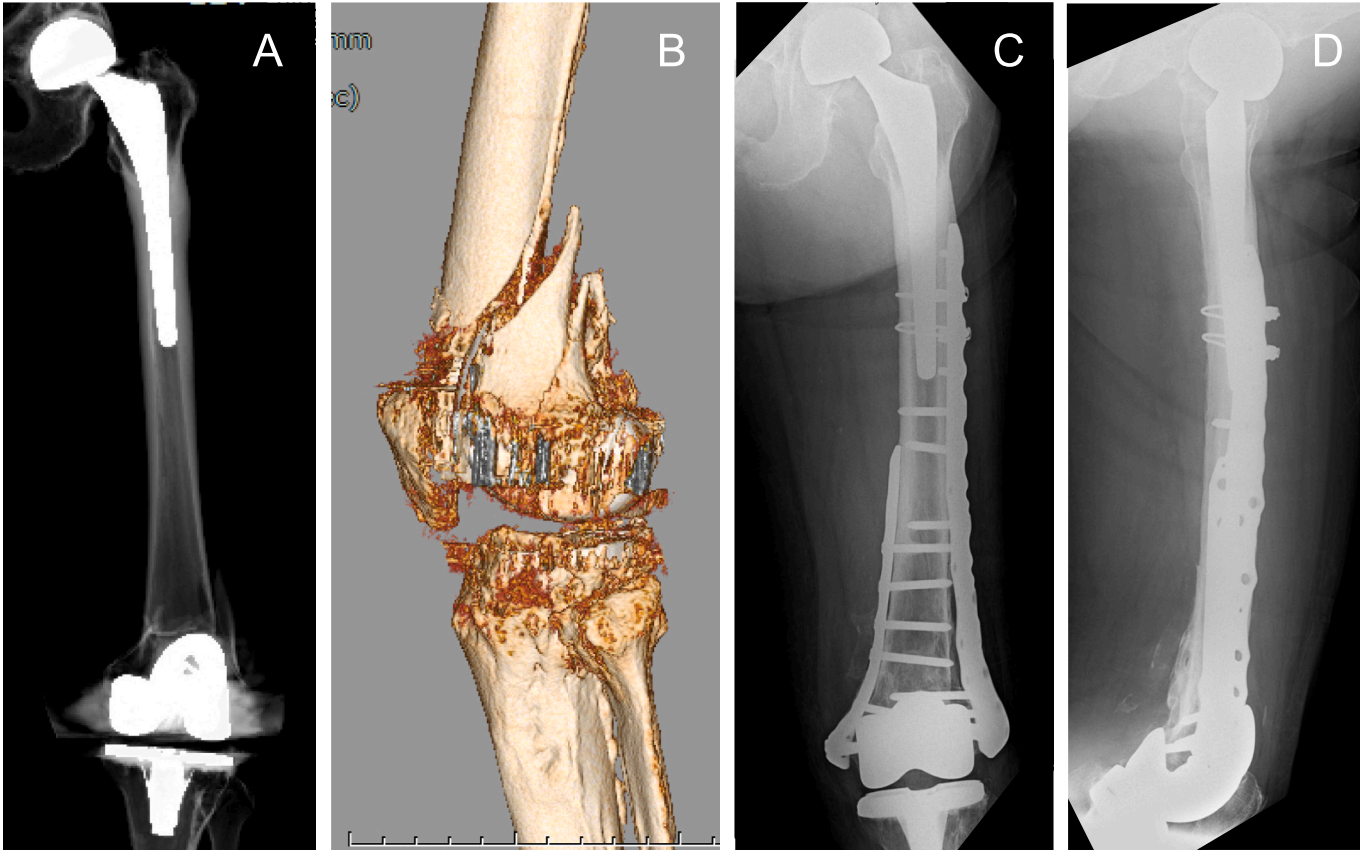


Fig. 2. A-B: Preoperative plain radiograph (A) and three-dimensional computed tomography (B) displaying a Su Type III interprosthetic femur fracture. C-D: Plain radiographs revealing bone healing without hardware failure 21 months after LM180 double-plate fixation overlapped with the stem.

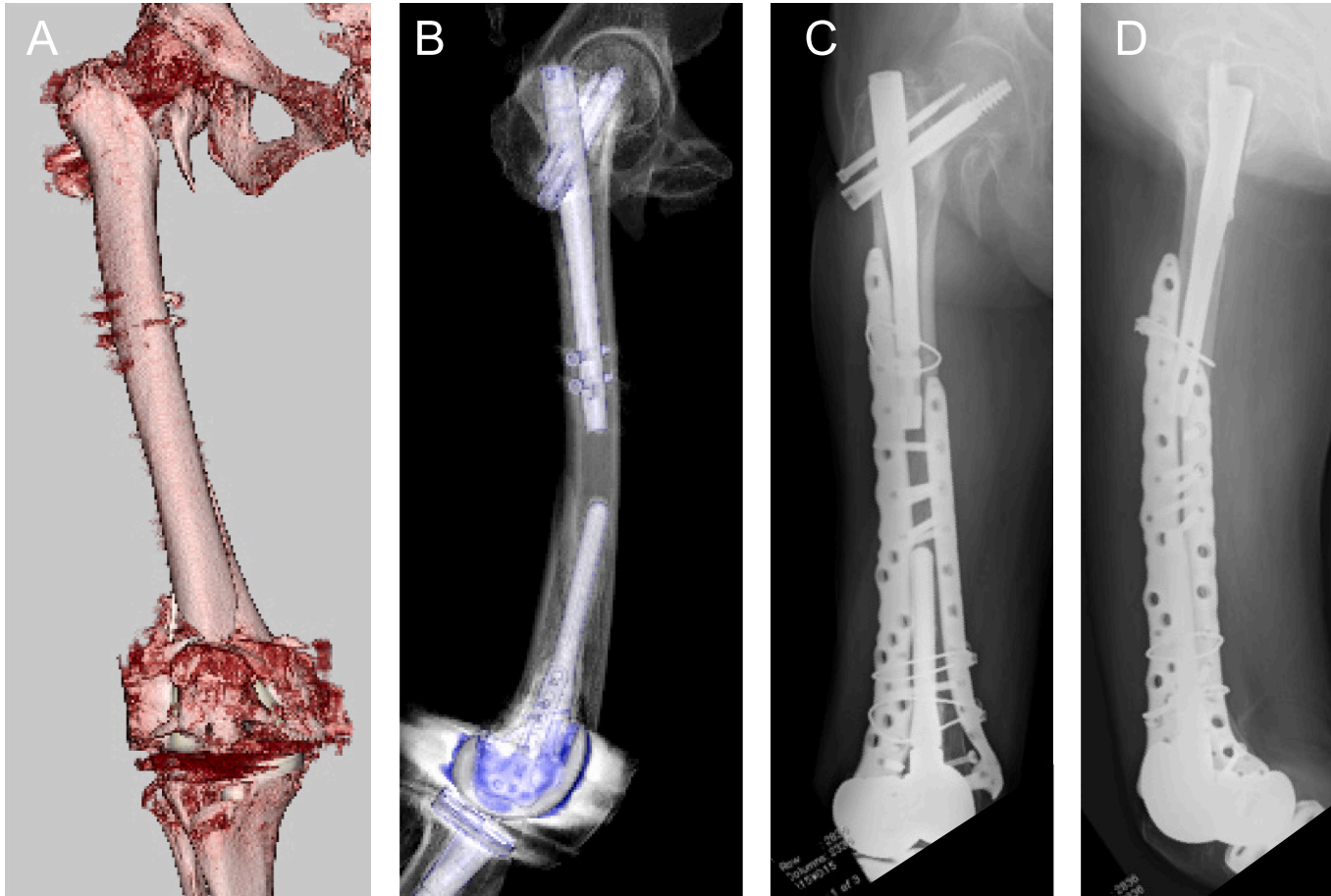


Fig. 3. A-B: Preoperative 3D-computed tomography presenting a Su Type II interimplant distal femur fracture. C-D: Plain radiographs 12 months after LM180 double-plate fixation with cerclage wires, overlapping with the medial and lateral sides on the distal section of the nail.

to 5.5 % after total knee arthroplasty (TKA) [1]. Fractures between the proximal femoral prosthesis or implant and the femoral component of TKA, known as interprosthetic femur fractures (IPFFs) and interimplant femoral fractures (IIFFs), have also increased with high mortality rates [2,3]. They necessitate restricted weight-bearing postoperation, leading to decreased activities of daily living (ADL) and increased mortality rates. Thus, early weight-bearing after surgery is desirable. PPDFs are repaired using internal fixation with lateral locking plates. However, the diminished strength caused by osteoporosis and bone stock with femoral components require a prolonged period of restricted weight-bearing; consequently, the mortality rate and risk of nonunion or implant failure increase [4]. Although IPFFs and IIFFs are repaired with this fixation [3], achieving stable fixation is more challenging.

We performed double-plate fixation from the medial and lateral sides (LM180 double-plate fixation) by using locking plates. This process resulted in the early postoperative weight-bearing of a Su Type III PPDF case and the IPFF and IIFF cases involving the distal femur (IPDF and IIDF, respectively). Postoperative ADLs were evaluated using the Barthel index (BI), functional independence measure (FIM), and the knee's range of motion (ROM).

Case presentation

Case 1. An 85-year-old female with a right Su Type III PPDF following an ipsilateral posterior-stabilized (PS) TKA underwent LM180 double plate fixation using NCB locking plates (Zimmer Biomet) with a β -TCP graft (Fig. 1). The day after surgery, the patient had partial weight-bearing (PWB) and progressed to full weight-bearing (FWB) as tolerated for 4 weeks. A near-normal ADL score, with a regained independent walk, was recovered 2 months postoperation (Table 1). Bone union was completed without hardware failure and with a 115-degree knee flexion angle 22 months postoperation.

Case 2. An 85-year-old female with a left IPDF following an ipsilateral bipolar hemiarthroplasty and PS TKA underwent LM180 double-plate fixation. The proximal section was secured with an 8 cm overlap of the lateral plate with a stem by using monocortical screws and cerclage wires. PWB was initiated 1 week postoperation, and FWB was allowed after 5 weeks. Knee flexion angles before and 21 months after surgery were 90 and 70 degrees, respectively; near-normal ADL scores were recovered (Table 1). Bone union was completed without hardware failure (Fig. 2).

Case 3. An 80-year-old female sustained a right distal femur fracture (DFF). The patient had a history of an ipsilateral DFF and underwent simultaneous PS TKA with a femoral stem and an internal fixation with a buttress plate. She also had intramedullary nailing after a subsequent ipsilateral femoral trochanteric fracture. LM180 double-plate fixation was conducted with monocortical screws and cerclage wires at the distal part; the proximal part was overlapped with lateral and medial plates with screws and cerclage wires (Fig. 3). The day after surgery, PWB was initiated, and FWB was allowed after 4 weeks. The knee flexion angle 1 year postoperation was 75 degrees, and the ADL score indicated a functional level with the ability to walk independently (Table 1).

Discussion

Fixation with lateral locking plates followed by postoperative weight-bearing restriction has been widely used for PPDF, IPDF, and IIDF cases following TKA. However, more stable fixation enabling postoperative early weight-bearing is recommended to prevent nonunion, implant failure, secondary fracture, and mortality [4]. The rate of bone union with double-plate fixation in PPDF is higher than that with single lateral plate fixation [5]. Although early postoperative weight-bearing following double-plate fixation in PPDF, IPFF, and IIFF has not been examined, Beeres et al. [6] utilized a lateral locking plate and a helical plate. In the present study, LM180 double-plate fixation followed by postoperative early weight-bearing was performed. Although this technique is limited by the lack of a comparison between single- and double-plate fixations, it would benefit PPDF, IPDF, and IIDF treatments. All cases achieved bone healing without any hardware failure and had a functional level of ADL with the ability to walk independently.

Studies have demonstrated the biomechanical advantage of double-plate fixation against single lateral plates or plate–nail constructs and suggested the potential for postoperative early weight-bearing with double-plate fixation [7]. Through LM180 double-plate fixation, bone damage during fragile bone reduction is minimized by using forceps to bind medial and lateral plates with reduced fragments. Several locking plate products can also be used to insert many screws by placing multiple polyaxial locking screws (Table 1). In IPFF of Vancouver type C, >6 cm overlap of the proximal prosthesis and the lateral locking plate is recommended to prevent secondary fractures [8]. In Case 2, an 8 cm overlap was applied. As in Cases 2 and 3, a stable fixation can still be achieved by adding cerclage wiring [9].

Alternative IIDF treatments involve lateral plating with or without replacing the pre-existing intramedullary nail [3]. However, replacement with a long nail is a contraindication in IIDF involving a TKA femoral stem (Case 3) because of an increased risk of secondary IIFF between proximal and distal implants. Combining nail removal and lateral plating carries the risk of femoral head fracture. Another alternative is adding a locking plate perpendicular to the lateral plate for stiffer fixation [10]. However, LM180 double-plate fixation is mechanically more advantageous than perpendicular double-plate fixation because the femoral fracture site is subjected to compressive force on the medial section, where the cortex is fragile and can be comminuted. If an implant of TKA that allows for the insertion of a retrograde intramedullary nail is being used, the combination of an intramedullary nail and a lateral plate, which is performed for DFFs in elderly patients with severe osteoporosis, may achieve similar objectives as double-plate fixation. However, in cases where a retrograde nail cannot be inserted or where the distal bone fragment is too small to expect adequate fixation with a nail, LM180 double-plate fixation, which can grasp the bone fragments from both the medial and lateral sides and provide a buttress effect, is a good indication. Therefore, the indication for LM180 double-plate fixation includes all cases of periprosthetic

fractures around TKA where early weight-bearing is desired, and it can be applied to almost all such cases. The authors also believe that it is a good indication for cases of nonunion following periprosthetic fractures around TKA or THA stems.

Through LM180 double-plate fixation with minimally invasive plate osteosynthesis, an easy and safety plate overlap can be made onto the proximal implant by subperiosteally inserting the plate along the bone because femoral and deep femoral arteries on the medial side are anatomically distant from the femur, especially in the distal 60 % of the femur [7]. Early postoperative weight-bearing and ROM exercises were allowed, followed by FWB 4–5 weeks postoperation. Consequently, the Su Type III PPDF in **Case 1** achieved a 115-degree knee flexion angle; all cases could independently walk. **Cases 2 and 3**, respectively presenting IPDF and IIDFF, had <90-degree knee flexion range possibly because of the volume of the plates and the preoperative stiffness of the knee's soft tissue adhesion attributed to previous surgeries. However, ADL approached normal levels in all cases, with the ability to walk independently. Therefore, LM180 double-plate fixation followed by postoperative early weight-bearing is promising for ADL recovery.

In conclusion, LM180 double-plate fixation using locking plates with multi-polyaxial locking screw placement can be safely applied to achieve early postoperative weight-bearing even in challenging cases, such as Su Type III PPDF, Vancouver type C IPDF, and IIDFF with limited bone stock; thus, pre-injury walking capabilities and normal ADL scores can be recovered. Particularly, it benefits older patients because it reduces the need for prolonged postoperative weight-bearing restrictions affecting mortality and ADL outcomes.

Ethics

All patients were informed and consented to the publication of this study.

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None.

CRediT authorship contribution statement

Nobuyoshi Watanabe: Visualization, Project administration, Data curation, Conceptualization. **Yoshiteru Kajikawa:** Validation, Data curation. **Tadahiko Yotsumoto:** Validation, Data curation. **Takuro Kanda:** Visualization, Data curation. **Ryosuke Ikeda:** Visualization, Data curation. **Genji Takehara:** Data curation. **Yasushi Oshima:** Validation. **Kenji Takahashi:** Validation. **Yoshinobu Watanabe:** Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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