Technique Report

OPEN

Medial augmentation of distal femur fractures using the contralateral distal femur locking plate: A technical note

Jaime Andrés Leal, MD, MHPE*

Abstract

Introduction: Lateral locking plates are commonly employed for the fixation of distal femur fractures. However, scenarios involving medial comminution, extremely distal fractures, periprosthetic fractures, or nonunion could necessitate medial augmentation. This study explores the possibility of using lateral distal femoral locking plate systems for medial fixation by employing the contralateral plate.

Methods: This study presents a technical note on the application of lateral distal femur locking systems for medial augmentation in patients as indicated by current literature findings. Postoperative imaging modalities, including radiography and computed tomography (CT), were used to assess the plates' fit to the distal femur. Three cases following the specified technical note are presented.

Results: The various plate systems, all comprising distal femur locking systems, demonstrated adaptability to the medial femur anatomy as confirmed by intraoperative visualization and postoperative radiographs, including two-dimensional and three-dimensional CT scans. It has also been possible to achieve at least 3 independent fixation points regardless of the size of the medial condyle.

Conclusions: Locking distal femoral plates can be a viable option for medial augmentation in indicated cases, achieving anatomical adaptation to the distal femur. This provides robust augmentation without the need for additional instruments beyond those used for the lateral cortex.

Key Words: distal femoral fractures, femoral fracture, fracture osteosynthesis, internal fracture fixation, surgical technique

1. Introduction

Distal femur fractures represent a small fraction of adult fractures (0.4%) but constitute a notable portion (3%–6%) of all femur fractures.[1–3] Early intervention within 48 hours for such fractures is crucial, mirroring the approach for proximal femur fractures, to reduce mortality and complications related to immobilization.[4,5] Stable fixation allowing early weight bearing, especially in elderly patients, is essential for improved clinical outcomes.[6,7] However, lateral locked plate fixation often restricts early weight bearing, particularly in cases with periprosthetic fractures, medial comminution, or very distal fractures.[6–8] Main complications in these scenarios include loss of reduction, nonunion, varus collapse, or material failure.[9,10]

Medial augmentation in distal femur fractures has been proposed to yield better outcomes, particularly in cases with metaphyseal comminution or very distal fractures, effectively reducing risks of collapse and nonunion.[9,11,12] Various systems have been employed for medial augmentation, including Locking Compression Plates (LCP) for the Proximal Tibia, proximal humerus locking plates, cannulated screws, and helical plates through minimally invasive osteosynthesis.[13–18] However, a review of these studies indicates that there is no strong evidence

The author reports no conflict of interest.

Department of Orthopedic and Traumatology, Hospital Universitario de la Samaritana and Hospital Universitario Mayor de Méderi, Bogotá, Colombia

** Corresponding author. Address: Department of Orthopedic and Traumatology, Hospital Universitario de la Samaritana and Hospital Universitario Mayor de Méderi, Carrera 8 #0-29 sur, Bogotá, Colombia. E-mail address: Jaime.leal@javeriana.edu.co (J.A. Leal).*

There are no financial conflicts of interest to disclose.

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 Declaration of Helsinki and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the Hospital Universitario de La Samaritana (Acta 10-23).

Informed consent was obtained from all individual participants included in the study, and patients signed informed consent regarding publishing their data and photographs.

During the preparation of this work, the author(s) used Open AI-CHAT GPT-4 to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

OTAI (2024) e347

Received: 31 January 2024 / Received in final form: 3 June 2024 / Accepted: 27 July 2024
Published online 3 September 2024

http://dx.doi.org/10.1097/OI9.0000000000000347

on absolute indications for augmentation after the external cortex has been stabilized with a plate nor is there definitive guidance on which material is most suitable or provides the most reliable evidence.

This study aims to demonstrate the utility of lateral distal femur locking systems as an option for medial augmentation. This approach consistently requires the use of the contralateral plate and facilitates the use of a single system for both lateral and medial fixation, ensuring anatomical compatibility and offering multiple distal fixation options.

2. Materials and Methods

Ethical approval for this study was obtained from the Hospital's Ethics and Research Committee, which reviewed and approved the informed consents in accordance with minute 10-2023. Patient selection was based on specific criteria that align with current literature, including medial metaphyseal comminution exceeding 2 cm, periprosthetic femur fractures, nonunions, and very distal fractures. Initially, the compatibility of locking systems with the medial femur was tested on synthetic bone models (Fig. 1). This study conforms to the CARE guidelines.[19]

2.1. Operative Technique

In every surgical procedure aimed at medial augmentation of distal femur fractures, the process began by securing the lateral side with a distal femur locking system. With the patient positioned supine on a radiolucent table, medial side augmentation was initiated. The first step involved selecting the appropriate length for the medial plate. Two contralateral distal femur locking plates of varying lengths were tested to ensure fit over the knee and thigh. It was crucial that these plates were shorter than the lateral plate yet featured at least 4 holes above the fracture line on the medial side. Fluoroscopy was used to assist in determining the optimal plate length (Fig. 2).

A minimally invasive medial approach, as outlined by Nayagam et al and validated by Jiamton and Apivatthakakul, was then employed[20,21] (Fig. 2). The plate was temporarily fixed distally with a wire and proximally with a loosely fitted cortical screw. Its position was verified by AP and lateral fluoroscopy. A periarticular bone clamp, placed in the empty distal holes of both plates, ensured full contact of the medial plate with the medial condyle (Fig. 2).

On satisfactory positioning, fixation was achieved with 3 locking screws distally. Then, the clamp was removed, and an additional proximal cortical screw was added and tightened. The distal screws on both plates were fixed in both condyles, ideally interdigitating to form a stable construct that supported early weight bearing, withstood loads, and prevented premature failure, akin to the O'Driscoll[22] method for the distal humerus.

Various plate systems were used, including the VA-LCP Curved Condylar Plate (DePuy Synthes, 325 Paramount Drive, Raynham, MA), the AxSOS 2 Distal Lateral Femur (Stryker Corporation, 2825 Airview Boulevard; Kalamazoo, MI), and the PERI-LOC Periarticular Locked Plating System (Smith and Nephew, 1450 East Brooks Road, Memphis, TN).

To describe this technique and demonstrate the anatomical fit, postoperative assessment involved computed tomography (CT) scans with metal suppression and 3D reconstruction to evaluate the plate's adaptation to the medial surface of the distal femur in every case.

3. Results

To date, 15 patients have undergone medial plating augmentation. While this publication does not aim to present a comprehensive case series, it has been observed that medial comminution exceeding 2 cm was the primary indication in 53.8% of cases, followed by very distal fractures (38.5%) and nonunion (7.7%).

Three cases are highlighted to illustrate the versatility of distal femur locking plates in adapting to the medial distal femur. In each instance, the patients achieved satisfactory weight bearing and knee motion postoperatively, without any complications associated with the medial plate. Moreover, all 3 cases have been followed up for a minimum period of 12 months, ensuring a robust evaluation of the long-term outcomes.

3.1. Case 1

A 33-year-old male patient sustained an AO 33C3.3 fracture. Surgical management entailed direct joint reduction using 3.5 mm

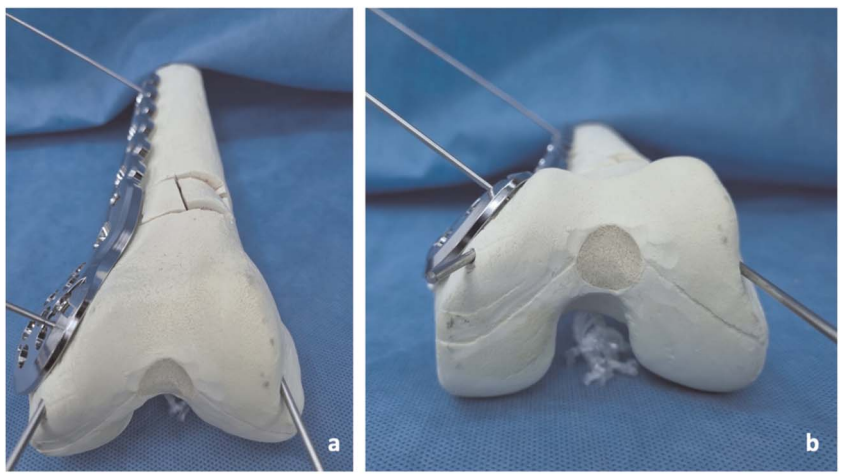

Figure 1. A and B, Bone model demonstrating from different views the appropriate contact of the contralateral lateral plate of the distal femur on the medial condyle and the anteromedial aspect of the femur.

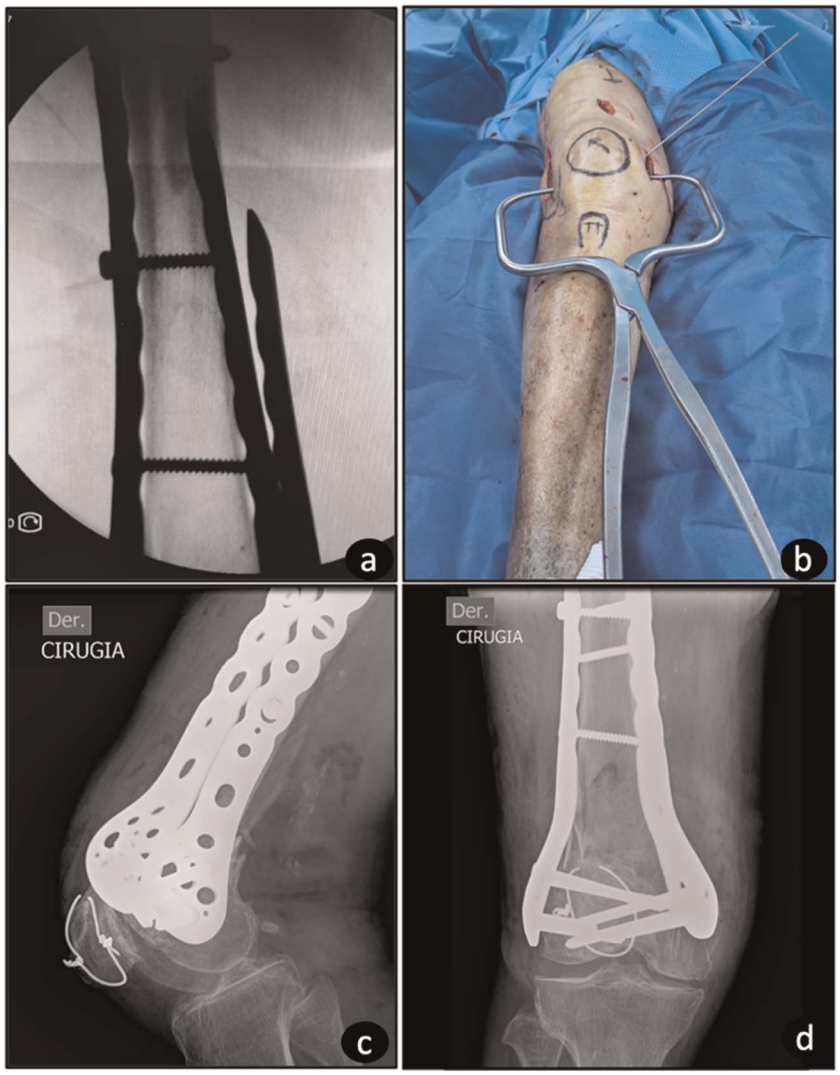

Figure 2. Images of the surgical technique: (A) Overlaid plates on the thigh during the selection of appropriate length. B, Clinical image showing the medial approach and the clamp used to improve plate-bone contact. C and D, Final radiographs displaying lateral and medial fixation using the same distal femur locking plate system.

headless cannulated screws for articular fragments and 4.5 mm screws for intercondylar fixation. A femoral distractor was used to achieve closed reduction of the metaphysis, maintaining alignment with crossed 2.5 mm pins. A long lateral plate was inserted using a minimally-invasive osteosynthesis (MIO), supplemented by medial fixation following the described technique, achieving anatomical fit with 3 distal locking screws and 2 proximal cortical screws. Initial weight bearing was restricted because of joint compromise, but after 8 weeks, gradual weight bearing was permitted (Fig. 3).

3.2. Case 2

A 40-year-old female patient, following a motorcycle accident, presented with a right distal femur fracture. The surgical approach involved fixing the femur with a lateral plate using a MIO. Given poor distal fixation and varus stress instability, medial augmentation was executed, achieving anatomical adaptability with 3 locking screws in the distal medial part. She attained full weight bearing with walker assistance within 1 week (Fig. 4).

3.3. Case 3

A 72-year-old female patient presented with a left distal femur fracture (AO 33A2.2) and underwent fixation using a lateral plate through a MIO. Because of the very distal fracture line at the lateral condyle, which exhibited insufficient fixation and varus instability, medial augmentation was implemented to enhance fixation stability, achieving anatomical adaptability and planned proximal and distal fixation as described. Two weeks post-operatively, she managed full weight bearing with a walker, and at 6 months, she achieved a range of motion from 0 to 128 degrees (Fig. 5).

These case studies exemplify the application of distal femur locking plates and underscore their adaptability and effectiveness in various fracture scenarios. Each case highlights distinct clinical challenges and the tailored approaches undertaken to optimize patient outcomes.

4. Discussion

We have found this fixation strategy to be potentially beneficial, providing stability with a 4.5-mm implant that anatomically

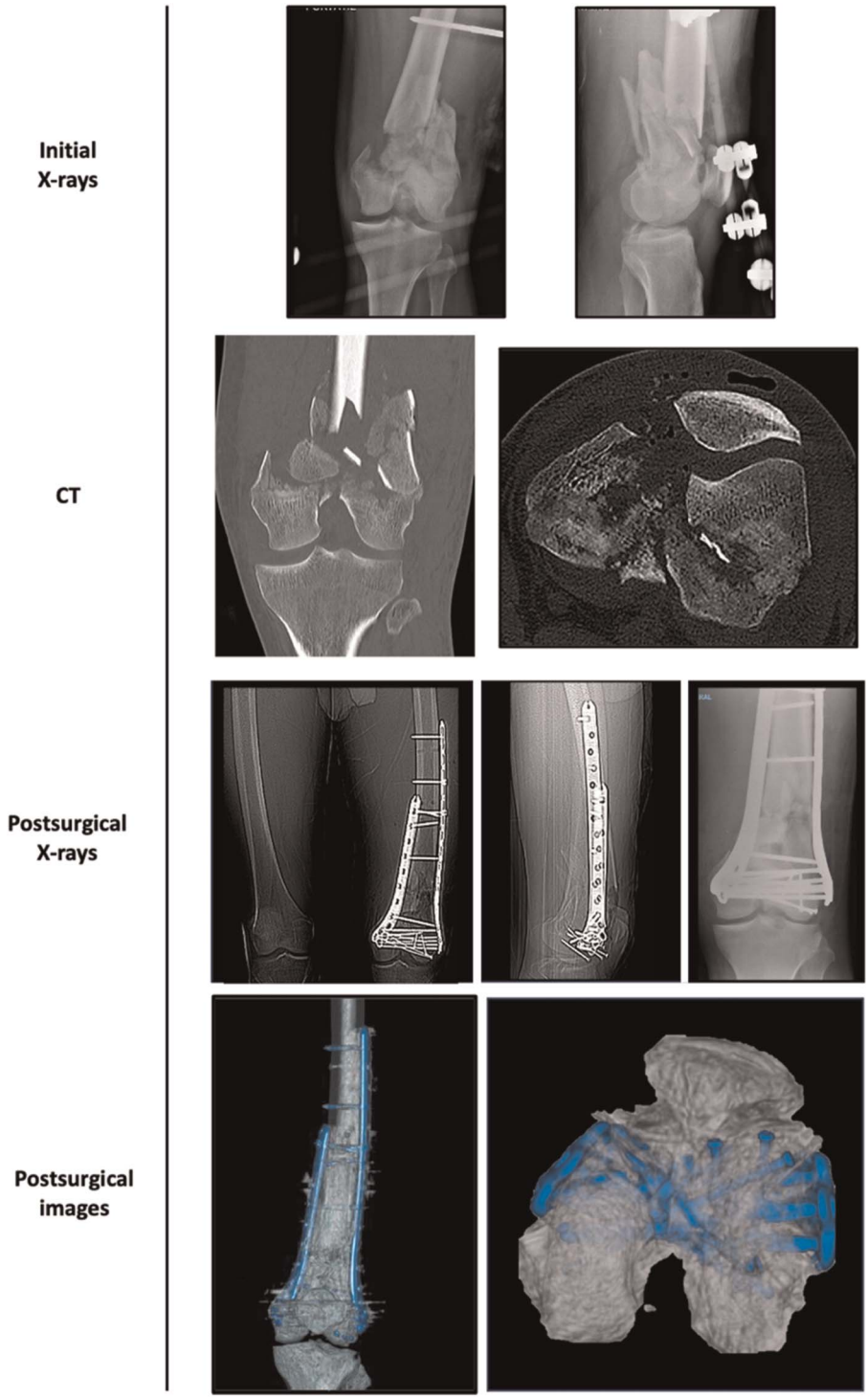

Figure 3. Case 1: Initial radiographs showed metaphyseal comminution and bone loss on the medial side. CT images demonstrated joint compromise and metaphyseal comminution. Postsurgical X-rays displayed lateral and medial distal femoral plates. Postsurgical images with 3D CT reconstruction demonstrated adequate adaptation of the plate to the medial anatomy of the distal femur. CT, computed tomography.

conforms to the medial distal femur. It uses a single instrument set for both lateral and medial fixation of the distal femur where augmentation is indicated.

Existing literature specifies indications for patients who may benefit from medial augmentation in distal femur fractures. A systematic review by Tripathy et al[23] identified key indications, which include fractures with articular or metaphyseal comminution, periprosthetic fractures involving metaphyseal comminution, fractures in geriatric patients, and the management of nonunions. These indications were used to select our cases, including those presented in this report.

Despite these well-documented indications, uncertainties remain in clinical practice regarding when and for which patient double-plating fixation should be applied. There is a noticeable

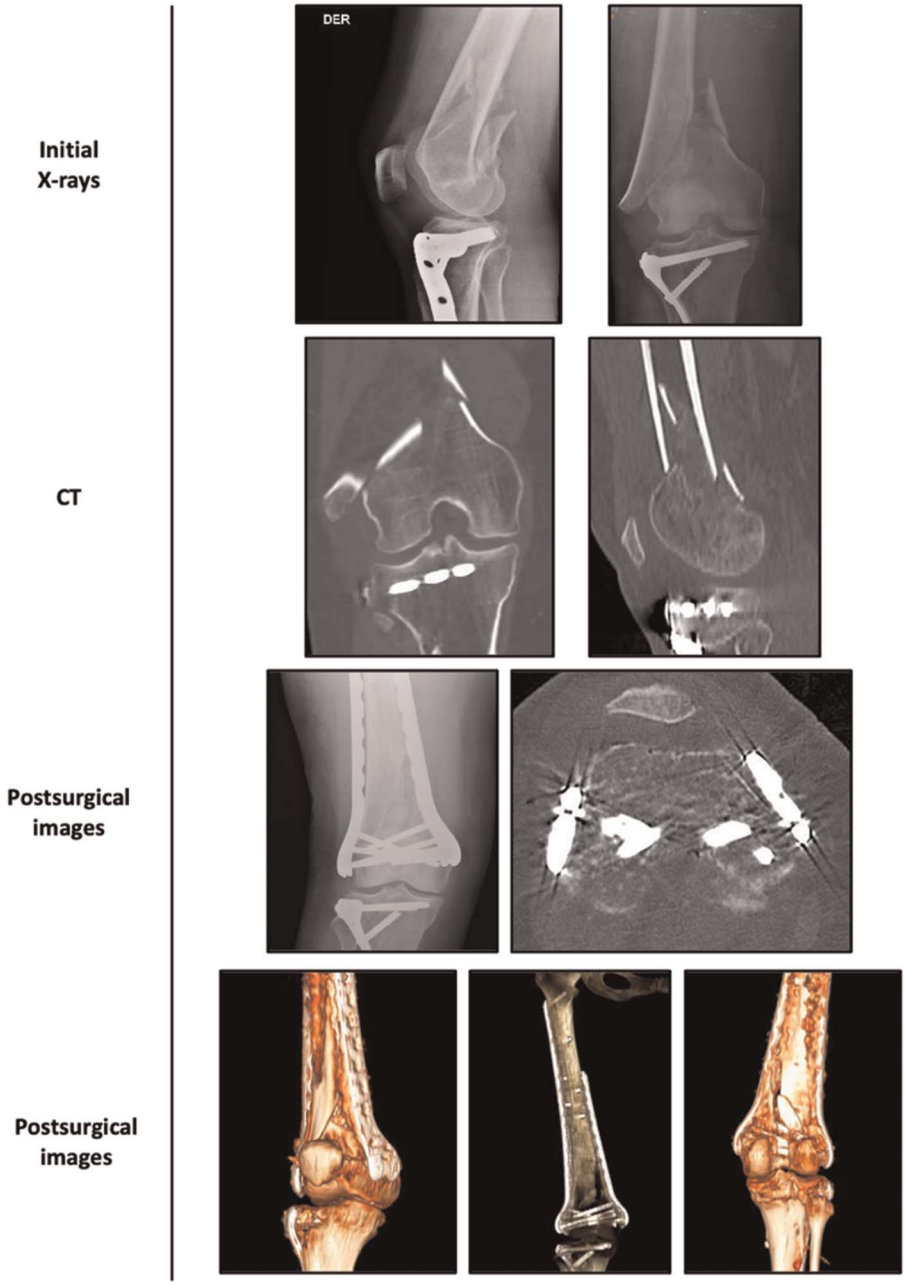

Figure 4. Case 2: Initial radiographs showed a very distal fracture without intact extension of metaphyseal bone on lateral side. CT images demonstrated distal compromise and metaphyseal comminution. Postsurgical images displayed lateral and medial distal plates adapting to medial distal femur. Postsurgical images with 3D CT reconstruction demonstrated adequate adaptation of the plate to the medial anatomy of the distal femur. CT, computed tomography.

hesitancy toward medial fixation, primarily due to unfamiliarity with the approach and concerns about potential vascular complications in the femur and limb. However, numerous studies have shown that medial fixation only increases the risk of complications by an additional 4% compared with submuscular lateral fixation alone. In addition, there is a safety margin of approximately 16 cm proximal to the adductor tubercle, within which the risk of injury to the femoral artery and its branches is minimal.[21,24,25] It is important to clarify that the minimally invasive technique is just one option and, in cases of unfamiliarity or increased risk of vascular injury, an open technique as described by Checroun et al or by Tosun could be used if open approach is chosen.[26,27]

The strengths of this technique lie in the utilization of a robust 4.5-mm locked plate capable of immediate postoperative support, which anatomically conforms to the distal and medial femur as demonstrated in the postoperative CT scans. The minimally invasive approach could minimize disruption of vascularity, and the same instruments and plates used for the lateral side are used for the medial side, obviating the need for additional materials.

The main drawback identified is the higher cost compared with using a standard 4.5-mm LCP plate or 3.5-mm locking systems, such as some other options described in the literature. Further comparative and cost-effectiveness studies are needed to address this issue, as well as to evaluate the comparison with other plates and techniques.

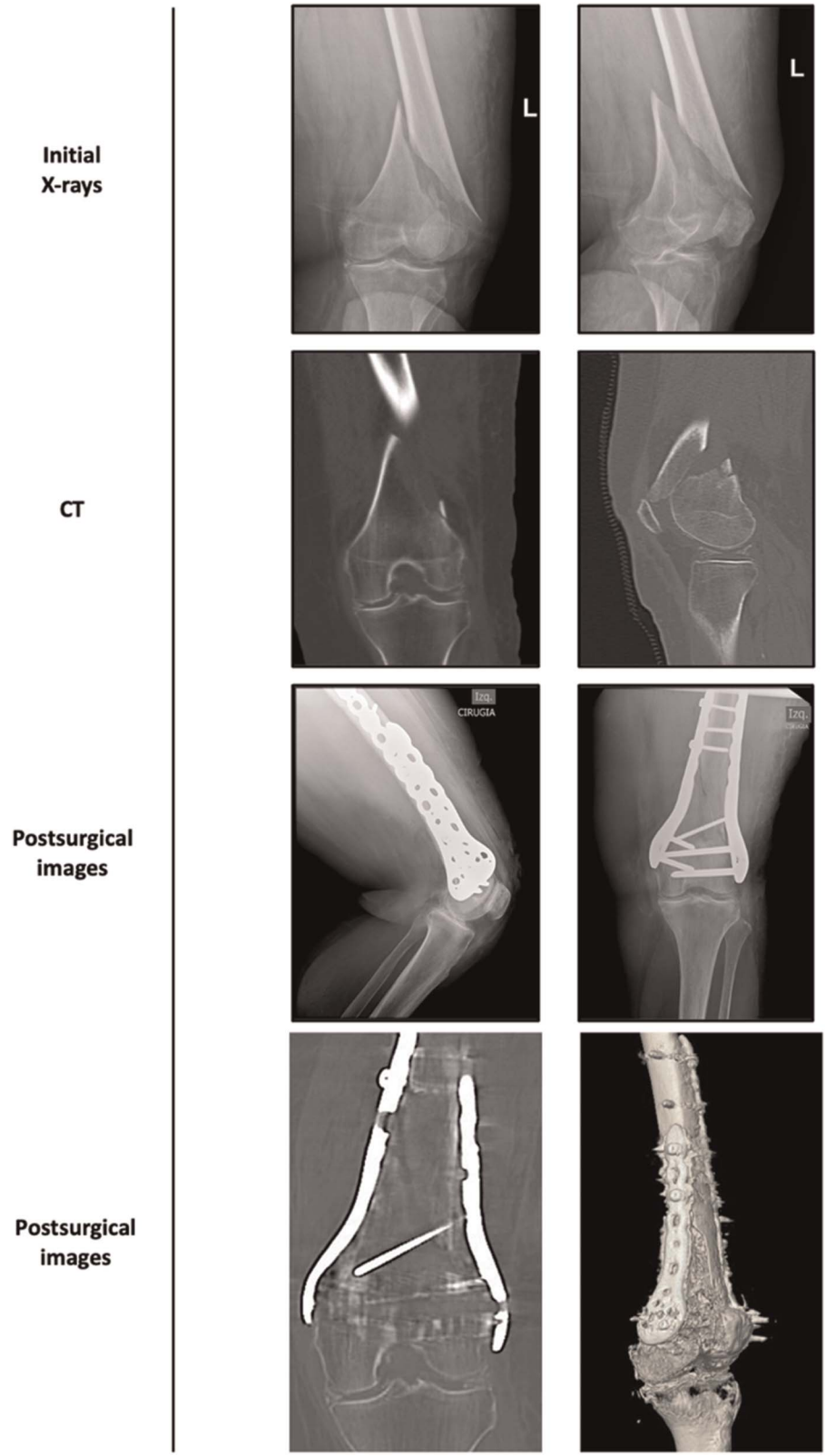

Figure 5. Case 3: Initial radiographs showed a very distal fracture without intact extension of metaphyseal bone on lateral side. CT images demonstrated distal compromise on the lateral side with no intact metaphysis on that side. Postsurgical images displayed lateral and medial distal plates adapting to medial distal femur. Postsurgical images with 3D CT reconstruction demonstrated adequate adaptation of the plate to the medial anatomy of the distal femur. CT, computed tomography.

5. Conclusions

The distal lateral femoral locking plate system conforms anatomically to the distal medial and diaphyseal surfaces of the femur, making it valuable in the arsenal of treatment options for fractures requiring medial augmentation. It offers the possibility of using a robust system and the use of a single system for medial and lateral fixation in these fractures. However, comparative studies with other systems are needed to evaluate its mechanical superiority and cost-effectiveness.

References

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury*. 2006;37:691–697.
2. Elsoe R, Ceccotti AA, Larsen P. Population-based epidemiology and incidence of distal femur fractures. *Int Orthop*. 2018;42:191–196.
3. Von Rehlingen-Prinz F, Eggeling L, Dehoust J, et al. Current standard of care for distal femur fractures in Germany and Switzerland. *Injury*. 2023; 54:110936.
4. Canton G, Giraldi G, Dussi M, et al. Osteoporotic distal femur fractures in the elderly: peculiarities and treatment strategies. *Acta Bio Medica Atenei Parm*. 2019;90:25–32.
5. Moloney GB, Pan T, Van Eck CF, et al. Geriatric distal femur fracture: are we underestimating the rate of local and systemic complications? *Injury*. 2016;47:1732–1736.
6. Striano BM, Grisdela PT, Shapira S, et al. Early weight bearing after distal femur fracture fixation. *Geriatr Orthop Surg Rehabil*. 2022;13: 215145932110701.
7. Beeres FJP, Emmink BL, Lanter K, et al. Minimally invasive double-plating osteosynthesis of the distal femur. *Oper Orthop Traumatol*. 2020;32: 545–558.
8. Ebraheim NA, Liu J, Hashmi SZ, et al. High complication rate in Locking Plate fixation of lower periprosthetic distal femur fractures in patients with total knee arthroplasties. *J Arthroplasty*. 2012;27:809–813.
9. Bologna MG, Claudio MG, Shields KJ, et al. Dual plate fixation results in improved union rates in comminuted distal femur fractures compared to single plate fixation. *J Orthop*. 2020;18:76–79.
10. Sanders R, Swiontkowski M, Rosen H, et al. Double-plating of comminuted, unstable fractures of the distal part of the femur. *J Bone Joint Surg*. 1991;73:341–346.
11. Park KH, Oh CW, Park IH, et al. Additional fixation of medial plate over the unstable lateral locked plating of distal femur fractures: a biomechanical study. *Injury*. 2019;50:1593–1598.
12. Liu JF, Zhou ZF, Hou XD, et al. Hybrid locked medial plating in dual plate fixation optimizes the healing of comminuted distal femur fractures: a retrospective cohort study. *Injury*. 2021;52:1614–1620.
13. Jang SA, Byun YS, Han IH, et al. Medial plating of distal femoral fracture with locking compression plate-proximal lateral tibia: cases' report. *J Korean Fract Soc*. 2016;29:206.
14. Hohenberger GM, Schwarz AM, Grechenig P, et al. Medial minimally invasive helical plate osteosynthesis of the distal femur—a new technique. *Injury*. 2021;52:S27–S31.
15. Pires RE, Yoon RS, Liporace FA, et al. Expanding the horizons of clinical applications of proximal humerus locking plates in the lower extremities: a technical note. *Chin J Traumatol*. 2020;23:331–335.
16. Poelmann J, Kloen P. Modified use of the proximal humeral internal locking system (PHILOS) plate for distal femoral nonunions. *Eur J Orthop Surg Traumatol*. 2022;33:425–433.
17. Henry GoodnoughL, Salazar BP, Chen MJ, et al. Supplemental medial small fragment fixation adds stability to distal femur fixation: a biomechanical study. *Injury*. 2021;52:1670–1672.
18. Chen SR, Shaikh H, Turvey BR, et al. Technical trick: supplemental medial column screw fixation of distal femur fractures treated with a laterally based locked plate. *J Orthop Trauma*. 2023;37:e175–e180.
19. Riley DS, Barber MS, Kienle GS, et al. CARE guidelines for case reports: explanation and elaboration document. *J Clin Epidemiol*. 2017;89: 218–235.
20. Nayagam S, Davis B, Thevendran G, et al. Medial submuscular plating of the femur in a series of paediatric patients: a useful alternative to standard lateral techniques. *Bone Joint J*. 2014;96-B:137–142.
21. Jiamton C, Apivatthakakul T. The safety and feasibility of minimally invasive plate osteosynthesis (MIPO) on the medial side of the femur: a cadaveric injection study. *Injury*. 2015;46:2170–2176.
22. O'Driscoll SW. Optimizing stability in distal humeral fracture fixation. *J Shoulder Elbow Surg*. 2005;14:S186–S194.
23. Tripathy SK, Mishra NP, Varghese P, et al. Dual-plating in distal femur fracture: a systematic review and limited meta-analysis. *Indian J Orthop*. 2022;56:183–207.
24. Rollick NC, Gadinsky NE, Klinger CE, et al. The effects of dual plating on the vascularity of the distal femur. *Bone Joint J*. 2020;102-B: 530–538.
25. Kim JJ, Oh HK, Bae JY, et al. Radiological assessment of the safe zone for medial minimally invasive plate osteosynthesis in the distal femur with computed tomography angiography. *Injury*. 2014;45: 1964–1969.
26. Checroun AJ, Mekhail AO, Ebraheim NA, et al. Extensile medial approach to the femur. *J Orthop Trauma*. 1996;10:481–486.
27. Tosun B. Medial approach for the treatment of femur fractures in association with vascular injury. *Injury*. 2020;51:1367–1372.