

## Original Article

# Early ambulation and good outcomes after using combined nail plate construct for fixation of distal femoral fractures: a retrospective series of 14 cases

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Received November 6, 2022; Accepted July 5, 2023; Epub August 15, 2023; Published August 30, 2023

**Abstract:** Background: Combined nail/plate technique is a relatively novel method for surgically managing distal femur fractures. It was supposed to allow for early weight bearing and achieve adequate fixation that allow for good bone healing. This study aims to describe our single institution experience of treating distal femur fractures using the combined nail/plate technique. Methodology: This is a retrospective study of 14 cases who had AO/OTA fractures 33A\_C that were managed with this technique. Patients mean age was 67.6 years and all of them had either obvious osteopenia/osteoporosis or comminuted fractures. Results: With early postoperative weight bearing, after a mean follow up of 13.2 months, all the patients were able to return to preinjury activity level. None of the cases were revised for union related problems. Adequate bone healing was noticed after a mean of 16.8 weeks postoperatively. At the final follow up, the mean Oxford knee score was 42 (range 34-46). Conclusion: The combined nail/plate technique provides adequate fixation method that allows for early weight bearing and good functional outcomes. More studies, ideally comparative are needed to properly assess the cost benefit of this technique compared to other techniques.

**Keywords:** Combined, fixation, distal femur, fracture, osteoporosis, nail, plate

## Introduction

Distal femoral fractures represent about 6% of all femoral fractures and have a steadily increasing incidence due to growth of elderly population [1, 2]. With a bimodal distribution [2], these fractures occur in elderly osteoporotic patients after low energy falls and in young adults after high energy trauma. Clinical picture typically comprises pain, swelling, knee effusion and varus or valgus deformity along with loss of weight bearing. With an incidence of open wounds occurring in 5-10% of supracondylar fracture cases and vascular injury risk reaching 15% in association with significant fracture displacement [1-4], as well as the prolonged immobilization time, these fractures have high morbidity and mortality that are comparable with proximal femur fractures [5]. Surgical treatment of these fractures should enable early postoperative mobilisation, thereby reducing immobility-related morbidity and mortality [5-8].

While conservative treatment may be utilized in low demand patients who are unfit for surgery, distal femur fractures have been classically managed surgically with either anatomical locked plates or distal femoral nails and both techniques have close outcomes [9]. Many factors or risk features do exist and contribute for difficulty in achieving a stable fixation construct and hence may lead to delayed mobilization and poor results with either fixation techniques [10-12]. These factors include the presence of osteoporosis, thin femoral cortices, wide intramedullary canal, comminuted fracture articular cartilage comminution [13].

The concept of combination of distal femoral nail and minimally invasive plating for distal femur fractures has been recently developed as a viable option [14, 15] to achieve a mechanically stable construct that allow for early weight bearing and with reported overall favourable outcomes compared to single plating [15]. By means of paucity of studies that report the out-

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comes of this technique [14-16], the aim of this study is to report our single institution results, particularly regarding early mobilization and time for radiological union.

### Materials and methods

#### *Study design*

This is a retrospective study of 14 patients who had ORIF surgery for distal femur fractures using combined nail/plate technique. Institutional review board approval was obtained before commencing the study and reviewing the available patients' outcomes. Inclusion criteria for the study were patients above 50 years old who had received combined nail plate fixation for a distal femur fracture. Exclusion criteria were incompleteness of 6 months follow up, and cases with open fractures.

#### *Patients' demographics*

Between January 2020 and January 2022, the cases who received a nail-plate composite fixation at Ain Shams University Hospitals has been retrospectively reviewed. A total of 15 cases could be initially retrieved and had their clinical and radiographic data assessed; Of them 14 cases met the inclusion criteria and included in this study while one case was excluded due to incomplete follow up data. Decision was to do this combined ORIF technique in cases who has either fracture comminution, obvious radiological osteopenia, history of osteoporosis and in any case with age above 70 years.

Mean age was 67.6 years old (range 55-83). Patients were 6 males and 8 females, and 9 cases had the right side involved. Indications were native distal femoral fractures in all patients. According to AO/OTA classification, most of the patients had either 33A1 or 33C2 fractures (4 cases each). Preoperative comorbidities were noticed in six patients (3 smokers, 2 dementia, 1 hemiparesis). Regarding preoperative weight bearing level, eleven patients had a history of independent weight bearing, with or without assisting devices as crutches or walkers, and one had minimal assisted weight bearing at home.

#### *Surgical technique*

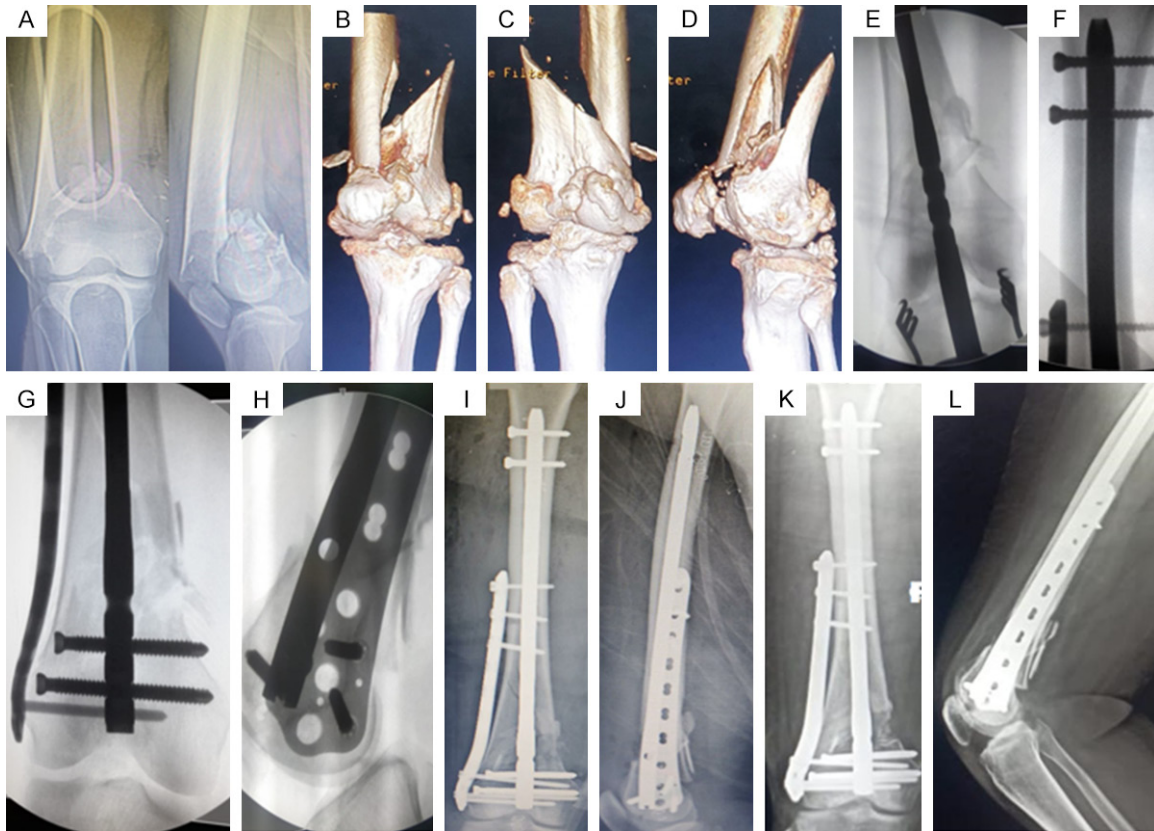
Surgery has been performed while the patient is supine. In all cases, and under image intensi-

fier, either a single lateral para-patellar incision is used to insert the nail and slide the plate on the lateral femoral condyle from the same incision, or a classic double (one midline knee and one lateral) incisions were used. In cases who had articular fractures, the lateral parapatellar incision is widened, and patella was medially retracted to reduce the intercondylar fracture and fix it preliminary with K wires, which were placed anterior from the nail trajectory. The nail is inserted as usual, with care taken to ream very gently and use a nail with a diameter less than the most fitting reamer. This is done to allow for a room for the plate screws. Reduction was either done closed or using the lateral parapatellar approach to manipulate the fracture without violating the fracture hematoma and periosteum. The nail distal screws were either inserted from lateral or medial side (for example, if the medial femoral condyle was split). Proximal nail locking was performed using either a target device or a freehand technique under C-arm guidance. After finishing the nail insertion and putting the proximal and distal locking screws, a distal femur locked plate or locked broad DCP were slid and fixed with at least three screws proximal and two screws distal to the fracture site in a minimally invasive technique. All the patients received the nail plate combination, and none of them had linked fixation. The mean plate length was thirteen holes. The implants used were either all titanium or stainless.

#### *Postoperative management and outcomes' evaluation*

In all cases, a U-shaped walker was used for 2 weeks followed by crutches until full radiological union is noticed. Follow up is done at 2 weeks postoperative then scheduled monthly to the 6<sup>th</sup> month, then scheduled biannually. At each visit, a plain X ray is obtained to detect bone union. Bone union is deduced when cortical gaps were filled in at least three out of four bone cortices and no tenderness over the fracture site with palpation, as well as painless independent weight bearing. Patient ability to bear weight was assessed clinically after full radiological union. Knee active flexion range was assessed clinically using goniometer at each visit. The Oxford knee score has been utilized to assess the functional outcomes at the last follow up visit.

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**Figure 1.** ORIF using nail-plate construct in a 74-year-old female utilizing a distal femur locked plate. A-D. Preoperative AP and lateral radiographs and CT scan of 74 years old female with AO/OTA 33C2 (metaphyseal comminution and fissure extending intraarticular) with obvious fracture comminution. E-H. Intraoperative radiographs highlighting surgical steps. I, J. Immediate postoperative radiographs after fixation with retrograde nail and locked short distal femur plate. K, L. Twelve weeks postoperative X ray with showing stable construct and callus formation. The patient is fully weight bearing from day 1 postoperative.

### Results

#### *Perioperative outcomes*

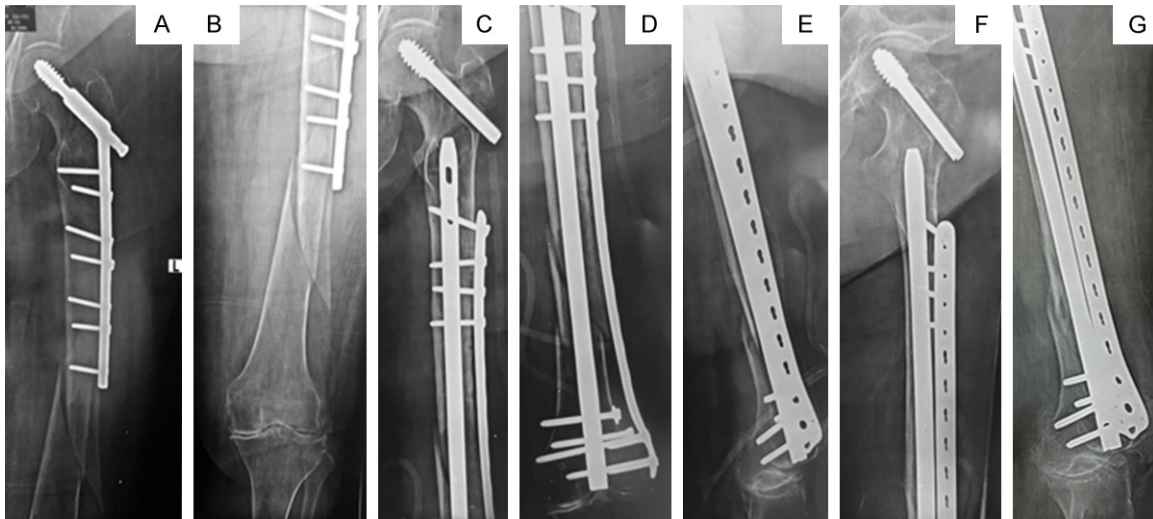
The mean duration of surgery was 124 minutes (range 80-260). None of the patients required intraoperative or postoperative blood transfusion. Postoperatively, active knee range of motion and muscle strengthening exercises were started at the same day of surgery. Weight bearing was started at day 2 or 3 postoperatively in the form of full weight bearing as tolerated in 10 patients and partial toe touch WB in 2 cases who had significantly comminuted fractures.

#### *Clinical outcomes*

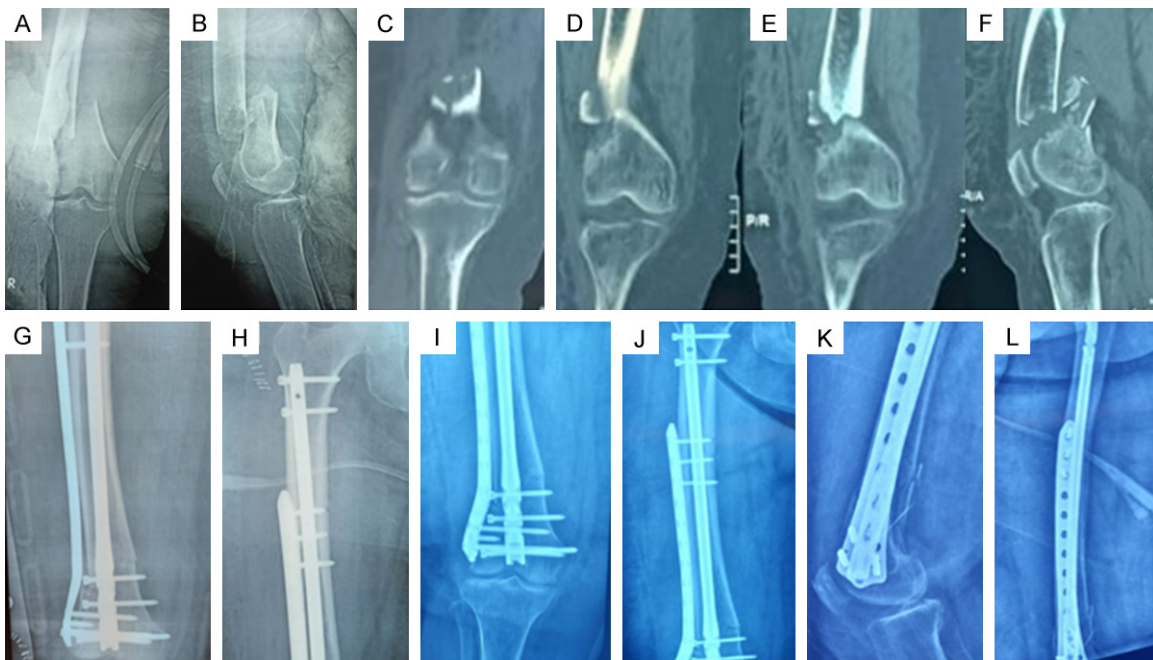
After a mean follow up of 13.2 months (range 9.6-25.3 months), all the patients were able to independently bear weight and no patients

needed a revision surgery for refracture, hardware failure or non/malunion (**Figures 1-3**). Superficial wound dehiscence has occurred in 1 case and was managed with antibiotics and daily dressing. One patient had symptomatic prominent hardware related to the distal screws on the medial side of the knee and was scheduled for screw removal. The mean knee flexion range calculated at time of bony union is 110 degrees (range 70-140). Four patients had a knee flexion of less than 90 degrees at 6 months due to non-compliance with the ROM exercises and were instructed for follow up along with physiotherapy. Of them, 3 patients achieved flexion past 100 degrees, while one patient had knee flexion of 70 degrees and was scheduled for manipulation under anaesthesia. The Oxford knee score [17] has been used to calculate the clinical outcomes. In the last follow up, the mean Oxford knee score was 42

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**Figure 2.** ORIF with a nail-plate construct after fracture distal to previous fixation. A, B. Preoperative AP and lateral radiographs of 69 years old female with AO/OTA 33A with obvious femora cortical thinning and clear history of osteoporosis and history of ORIF for intertrochanteric fracture 4 years earlier. C-E. Immediate postoperative radiographs after fixation with retrograde nail and locked distal femur plate. The DHS side plate was removed during surgery. F, G. Four weeks postoperative X ray with showing stable construct and callus formation. The patient is fully weight bearing from day 1 postoperative.



**Figure 3.** ORIF using nail plate construct utilizing a locked distal femur plate. A, B. Preoperative AP and lateral radiographs of 71 years old female with AO/OTA 33A with obvious femora cortical thinning. C-F. Preoperative CT scan showing metaphyseal comminution and intact articular surface. G, H. Immediate postoperative plain radiographs. I-L. Six weeks postoperative X ray with showing stable construct and callus formation. The patient is fully weight bearing from day 3 postoperative.

(range 34-46). Two cases had limb shortening of less than 2 cm that was attributed to fracture collapse and were managed with shoe raise.

### *Radiological outcomes*

In all cases, progressive filling of the fracture gaps was seen in serial x-rays. The mean time

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till full radiological union was 16.8 weeks (range 6-28 weeks). None of the cases developed delayed or non-union nor required additional intervention to achieve bone healing.

### Discussion

This is a retrospective case series studying the early results of nail plate combination in distal femoral fractures. After a mean follow up of 13.2 months, all the cases had achieved full weight bearing and fracture healing. Knee ROM and weight bearing were started as early as the second postoperative day and none of the cases required a revision fixation surgery.

Distal femoral fractures can be quite challenging, especially in presence of marked comminution or osteoporosis. The goal of surgery is to achieve rigid fixation and allow for early weight bearing. Since these fractures occur commonly in elderly patients, delay of weight bearing can lead to detrimental outcomes [18]. Early weight bearing has been proved to achieve better overall results with significant reduction of morbidity and mortality, both in young and elderly patients [7].

Distal femoral fractures have been surgically managed traditionally using either a single plate or retrograde nail. With single plating, many surgeons are cautious with the early weight bearing [19, 20]. Again, non-union and hardware failure remain significantly common complications following single plate fixation with an incidence reaching 28% [12, 16, 20-22]. On the other hand, since distal femoral nailing has a limited ability of fixation in comminuted articular fractures, along with comparable union rates to single plating [23], it has been used in selected indications such as distal diaphyseal and purely metaphyseal fractures.

To allow for early weight bearing and possibly enhanced bone healing in non-united or revision cases, combined nail plate fixation was suggested [24]. Since then, it has gained more popularity in acute native or periprosthetic distal femur fracture cases [14, 16, 25-27] with improved outcomes than using a single fixation implant technique, both clinically [16] and biomechanically [29, 30]. This combined technique allows for utilization of two fixation concepts and aims at allowing early weight bearing

in elderly, osteoporotic patients and in younger patients with high energy trauma or severe comminution.

Like the results of Liporace et al. [14], Garala et al. [16] and Kanabur et al. [28], all the fourteen cases in our series were able to independently bear weight and no patients needed a revision surgery for refracture, hardware failure or non/malunion. Although linking of constructs was advised by most authors in previous studies [14, 16, 28], we thought it would add to operative time and we didn't use linking. This did not seem to affect the outcomes since all of our cases had stable constructs. With this technique, even if delayed radiological union is noticed in absence of significant fracture gap or pain, full weight bearing can be allowed safely, giving enough time for bone healing in such elderly patients. The only complications related to hardware in our series were related to prominent screw tip at the medial distal femur and this could be easily avoided if taken into consideration during surgery.

This study has several limitations, being retrospective, non-comparable study. Ideally, a prospective controlled randomised study would be ideal to assess the efficacy of this technique and comparing it with a single fixation technique, or more recently double plating technique for distal femur. Another limitation is the small number of cases, but when comparing this cohort to the few published studies, the cases numbers are comparable. Another limitation was the use of different implants from different providers in all cases, however this didn't result in a change of outcomes.

### Conclusion

Combined nail plate fixation technique in distal femoral fractures can be a viable option for ORIF in elderly patients with osteoporosis and when significant bone comminution is present. It allows for early weight bearing, restoration of the knee range of motion and successful bone healing. More studies are needed to compare this technique with a single implant fixation or double plating techniques.

### Disclosure of conflict of interest

None.

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### References

- [1] Khan AM, Tang QO and Spicer D. The epidemiology of adult distal femoral shaft fractures in a central London major trauma centre over five years. *Open Orthop J* 2017; 11: 1277-1291.
- [2] Della Rocca GJ, Leung KS and Pape HC. Periprosthetic fractures: epidemiology and future projections. *J Orthop Trauma* 2011; 25 Suppl 2: S66-S70.
- [3] DiChristina DG, Riemer BL, Butterfield SL, Burke CJ 3rd, Herron MK and Phillips DJ. Femur fractures with femoral or popliteal artery injuries in blunt trauma. *J Orthop Trauma* 1994; 8: 494-503.
- [4] Loosen A, Fritz Y and Dietrich M. Surgical treatment of distal femur fractures in geriatric patients. *Geriatr Orthop Surg Rehabil* 2019; 10: 2151459319860723.
- [5] Perez JV, Warwick DJ, Case CP and Bannister GC. Death after proximal femoral fracture—an autopsy study. *Injury* 1995; 26: 237-240.
- [6] Hamlet WP, Lieberman JR, Freedman EL, Dorey FJ, Fletcher A and Johnson EE. Influence of health status and the timing of surgery on mortality in hip fracture patients. *Am J Orthop (Belle Mead NJ)* 1997; 26: 621-627.
- [7] Siu AL, Penrod JD, Boockvar KS, Koval K, Strauss E and Morrison RS. Early ambulation after hip fracture: effects on function and mortality. *Arch Intern Med* 2006; 166: 766-771.
- [8] Silva TJ, Jerussalmy CS, Farfel JM, Curiati JA and Jacob-Filho W. Predictors of in-hospital mortality among older patients. *Clinics (Sao Paulo)* 2009; 64: 613-618.
- [9] Jankowski JM, Szukics PF, Shah JK, Keller DM, Pires RE, Liporace FA and Yoon RS. Comparing intramedullary nailing versus locked plating in the treatment of native distal femur fractures: is one superior to the other? *Indian J Orthop* 2021; 55: 646-654.
- [10] Campbell ST, Lim PK, Kantor AH, Gausden EB, Goodnough LH, Park AY, Bishop JA, Achor TS, Scolaro JA and Gardner MJ. Complication rates after lateral plate fixation of periprosthetic distal femur fractures: a multicenter study. *Injury* 2020; 51: 1858-1862.
- [11] Henderson CE, Kuhl LL, Fitzpatrick DC and Marsh JL. Locking plates for distal femur fractures: is there a problem with fracture healing? *J Orthop Trauma* 2011; 25 Suppl 1: S8-14.
- [12] Pfeufer D, Zeller A, Mehaffey S, Böcker W, Kammerlander C and Neuerburg C. Weight-bearing restrictions reduce postoperative mobility in elderly hip fracture patients. *Arch Orthop Trauma Surg* 2019; 139: 1253-1259.
- [13] Du YR, Ma JX, Wang S, Sun L, Wang Y, Lu B, Bai HH, Hu YC and Ma XL. Comparison of less invasive stabilization system plate and retrograde intramedullary nail in the fixation of femoral supracondylar fractures in the elderly: a biomechanical study. *Orthop Surg* 2019; 11: 311-317.
- [14] Liporace FA and Yoon RS. Nail plate combination technique for native and periprosthetic distal femur fractures. *J Orthop Trauma* 2019; 33: e64-e68.
- [15] Attum B, Douleh D, Whiting PS, White-Dzuro GA, Dodd AC, Shen MS, Mir HR, Obremsky WT and Sethi MK. Outcomes of distal femur non-unions treated with a combined nail/plate construct and autogenous bone grafting. *J Orthop Trauma* 2017; 31: e301-e304.
- [16] Garala K, Ramoutar D, Li J, Syed F, Arastu M, Ward J and Patil S. Distal femoral fractures: a comparison between single lateral plate fixation and a combined femoral nail and plate fixation. *Injury* 2022; 53: 634-639.
- [17] Dawson J, Fitzpatrick R, Murray D and Carr A. Questionnaire on the perceptions of patients about total knee replacement. *J Bone Joint Surg Br* 1998; 80: 63-9.
- [18] BOA BOAST - The care of the older or frail orthopaedic trauma patient. 2020.
- [19] Trompeter A. A call to arms: it's time to bear weight! *Bone Joint J* 2020; 102-B: 403-406.
- [20] Ricci WM, Streubel PN, Morshed S, Collinge CA, Nork SE and Gardner MJ. Risk factors for failure of locked plate fixation of distal femur fractures: an analysis of 335 cases. *J Orthop Trauma* 2014; 28: 83-9.
- [21] Tank JC, Schneider PS, Davis E, Galpin M, Prasarn ML, Choo AM, Munz JW, Achor TS, Kellam JF and Gary JL. Early mechanical failures of the synthes variable angle locking distal femur plate. *J Orthop Trauma* 2016; 30: e7-e11.
- [22] Campbell ST, Lim PK, Kantor AH, Gausden EB, Goodnough LH, Park AY, Bishop JA, Achor TS, Scolaro JA and Gardner MJ. Complication rates after lateral plate fixation of periprosthetic distal femur fractures: a multicenter study. *Injury* 2020; 51: 1858-62.
- [23] Jankowski JM, Szukics PF, Shah JK, Keller DM, Pires RE, Liporace FA and Yoon RS. Comparing intramedullary nailing versus locked plating in the treatment of native distal femur fractures: is one superior to the other? *Indian J Orthop* 2021; 55: 646-654.
- [24] Hussain MS, Dailey SK and Avilucea FR. Stable fixation and immediate weight-bearing after

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- combined retrograde intramedullary nailing and open reduction internal fixation of non-comminuted distal interprosthetic femur fractures. *J Orthop Trauma* 2018; 32: e237-e240.
- [25] Spitler CA, Bergin PF, Russell GV and Graves ML. Endosteal substitution with an intramedullary rod in fractures of the femur. *J Orthop Trauma* 2018; 32 Suppl 1: S25-S29.
- [26] Liporace FA, Aneja A, Carroll EA and Yoon RS. Maintaining the neutral axis in the treatment of distal femur fractures via dual plate or nail plate combination technique: when and how? *J Orthop Trauma* 2021; 35 Suppl 5: S38-S40.
- [27] Liporace FA, Menken LG and Yoon RS. Complex distal femur fracture: a new and novel technique to maximize fixation and promote early weight-bearing-a case report. *J Orthop Trauma* 2021; 35: e1-e4.
- [28] Kanabur P, Sandilands SM, Whitmer KK, Owen TM, Coniglione FM and Shuler TE. Nail and locking plate for periprosthetic fractures. *J Orthop Trauma* 2017; 31: e425-e431.
- [29] Chen SH, Tai CL, Yu TC, Wang CW, Lin CW, Chen CY and Liu KC. Modified fixations for distal femur fractures following total knee arthroplasty: a biomechanical and clinical relevance study. *Knee Surg Sports Traumatol Arthrosc* 2016; 24: 3262-3271.
- [30] Başcı O, Karakaşlı A, Kumtepe E, Güran O and Havitçioğlu H. Combination of anatomical locking plate and retrograde intramedullary nail in distal femoral fractures: comparison of mechanical stability. *Eklemler Hastalıkları Cerrahisi* 2015; 26: 21-26.