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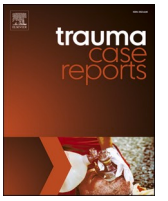

Case Report

Trifocal femur fracture with intracapsular femoral neck, open diaphyseal, and distal complete articular fractures

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ABSTRACT

We describe a trifocal femur injury with intracapsular femoral neck fracture, diaphyseal fracture with bone loss, and distal complete articular (AO/OTA C type) fracture, an injury rarely described in the literature. Surgical management utilized a not-yet-reported implant combination: screw-side plate device for the intracapsular femoral neck, retrograde nail for the diaphysis, and lag screws plus mini fragment buttress plating for the distal fracture. The patient had uneventful fracture union with no changes in alignment. Given the rarity and complexity of this injury, there is little consensus on surgical technique and implant choice. This case demonstrates a modernized approach that may be useful for surgeons who encounter similar fracture patterns in their practice.

Introduction

Noncontiguous ipsilateral femur fractures involving the proximal femur, diaphysis, and distal femur are generally associated with high-energy trauma and are sparsely described in the literature. Intracapsular femoral neck and distal complete intraarticular fractures (AO/OTA type 33-C) [1] complicate management and are even more infrequently described. Given the rarity and complexity of these injuries, there is no consensus regarding their optimal surgical management.

This case report presents a high-energy, open, trifocal femur fracture (intracapsular femoral neck, diaphyseal femur with bone loss, and complete articular distal femur) treated with a sliding hip screw-style femoral neck system (Synthes), retrograde nail for the comminuted diaphysis with bone loss, and lag screws with fragment-specific unicortical buttress plating of the medial and lateral columns for the distal intraarticular fracture. This combination of implants, not yet reported in the literature, allowed for anatomic reduction of the proximal and distal periarticular fractures while facilitating optimal treatment of the diaphyseal injury with medullary nailing.

Case report

The patient is an otherwise healthy 32-year-old male who was the restrained driver in a high-speed rollover motor vehicle accident. On examination, he had pelvic tenderness and a gross deformity of the left thigh with a 30x12cm open wound, exposed diaphyseal

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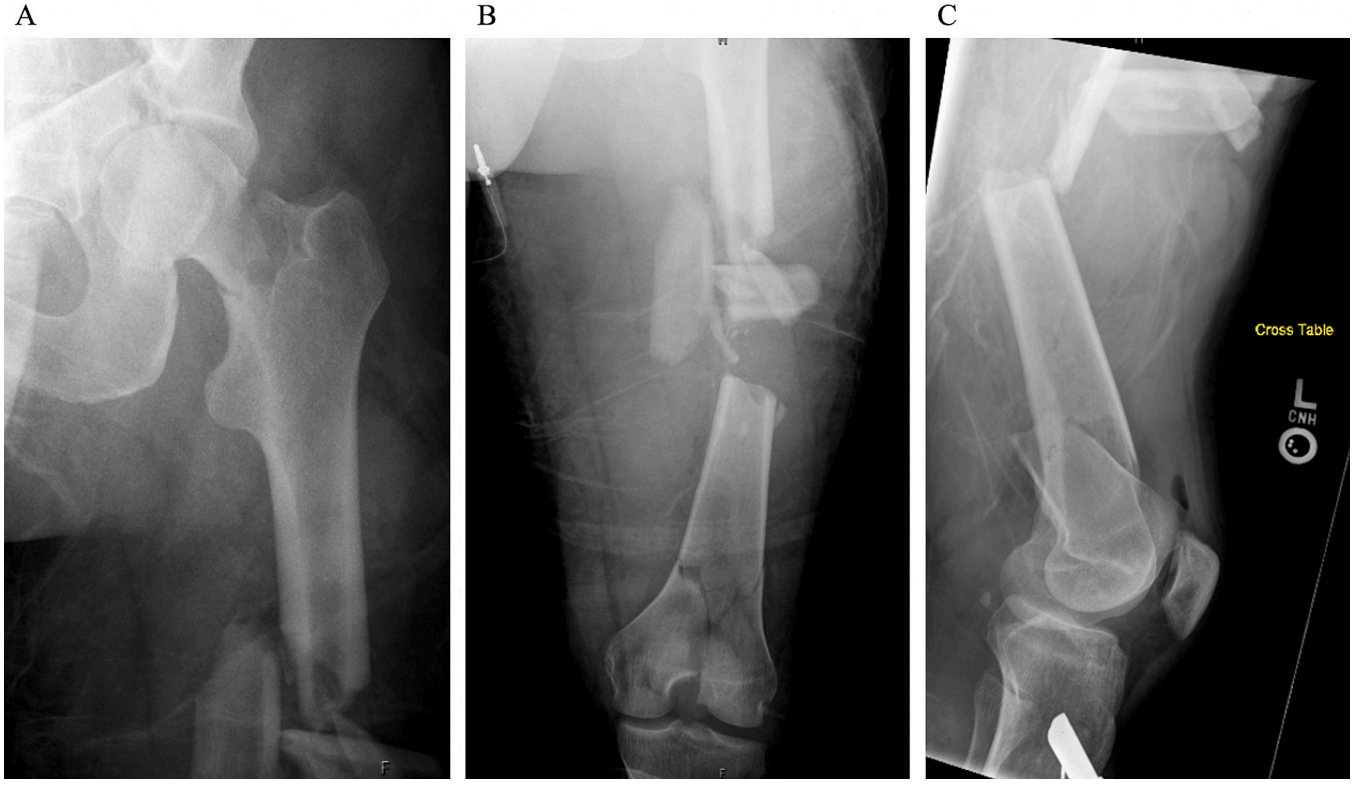

Fig. 1. Trifocal femur fracture including displaced transcervical femoral neck fracture (A), comminuted, open diaphyseal fracture (B), and complete articular distal femur fracture (B-C).

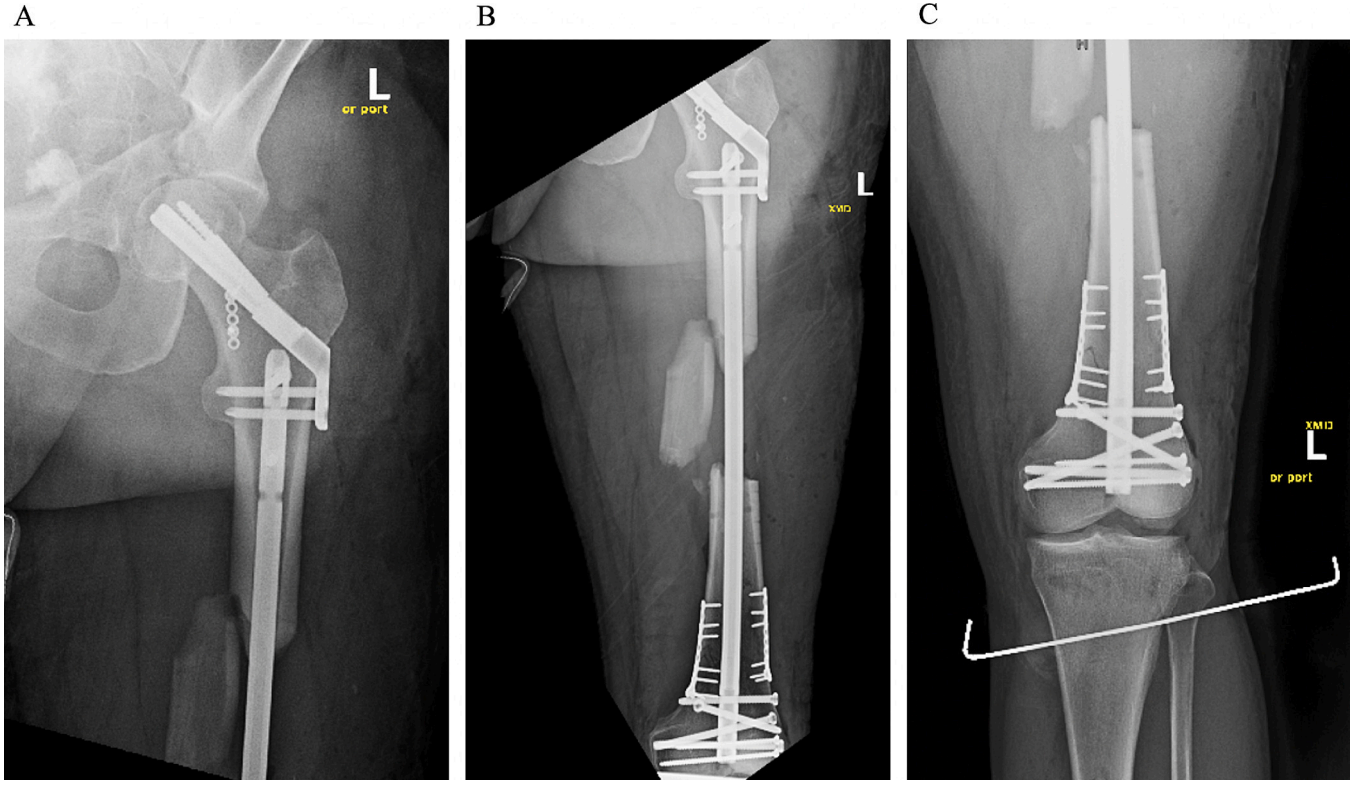

Fig. 2. Post-operative images demonstrating the use of a sliding femoral neck system for the proximal femur (A), retrograde nail for the diaphysis (B), and lag screws plus mini-plating for the distal intraarticular fracture (C).

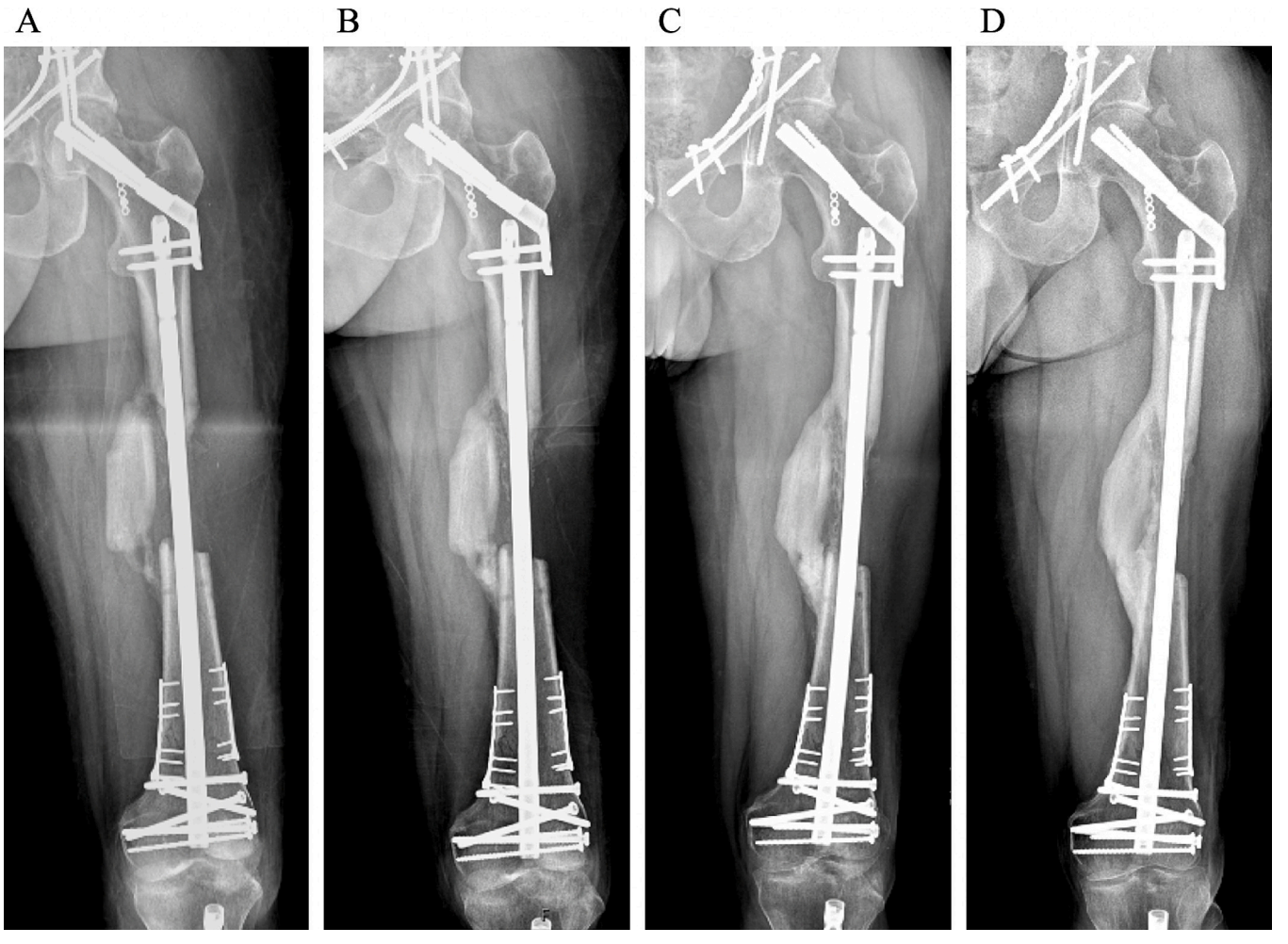

Fig. 3. Interval fracture healing shown on anteroposterior x-rays taken at 2 months post-op (A), 3 months post-op (B), 6 months post-op (C), and 13 months post-op (D) clinic visits. X-ray at 13 months (D) demonstrated intact hardware and well-healed femoral neck, diaphyseal, and distal femur fractures.

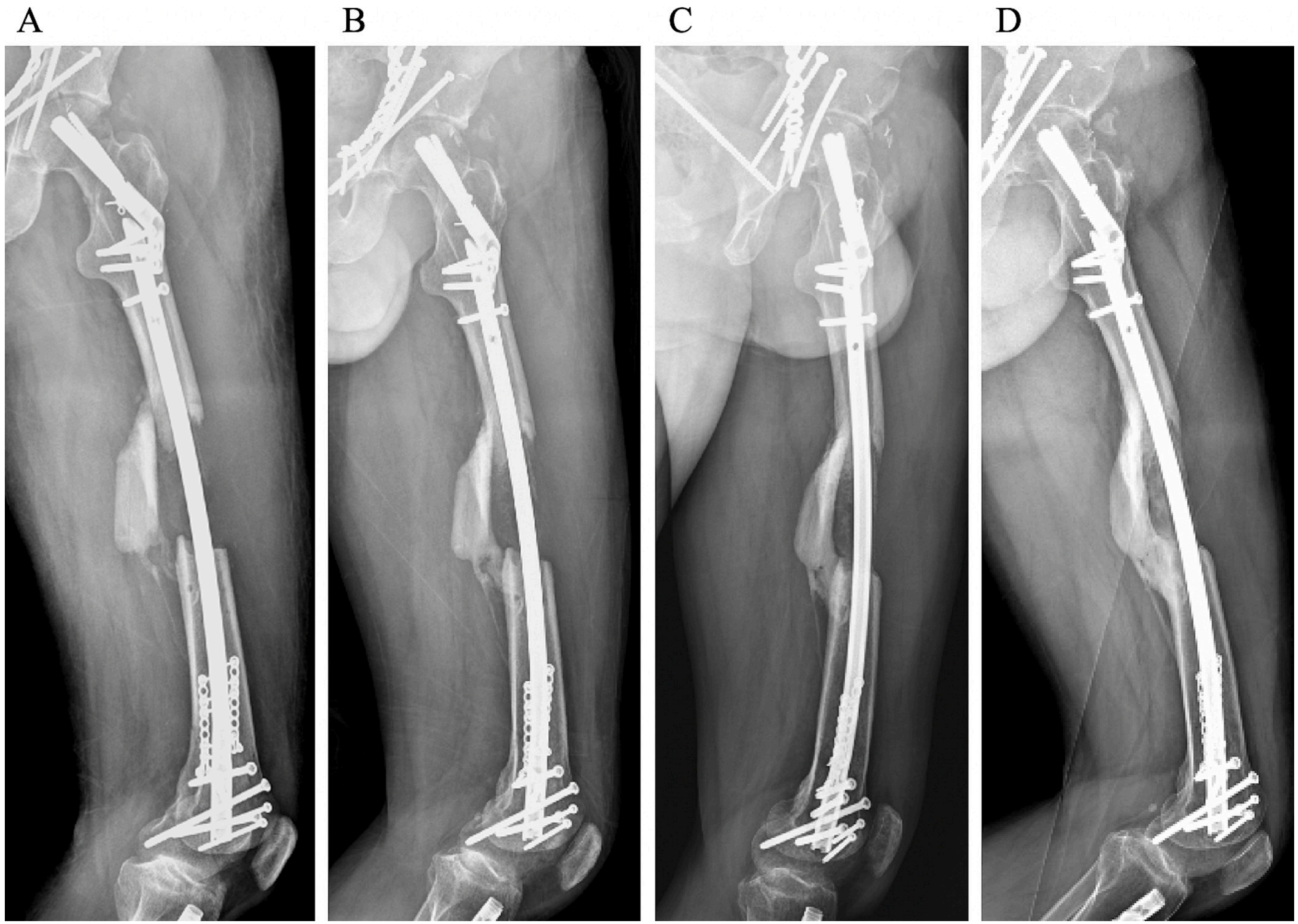

Fig. 4. Interval fracture healing shown on lateral x-rays taken at 2 months post-op (A), 3 months post-op (B), 6 months post-op (C), and 13 months post-op (D) clinic visits. X-ray at 13 months (D) demonstrated intact hardware and well-healed femoral neck, diaphyseal, and distal femur fractures.

femur, and intact pulses. Workup revealed several other fractures involving the right pelvic ring, left acetabulum, left tibia shaft, left third/fifth metatarsals, ribs, and sternum. His left trifocal femur fracture (Fig. 1) was characterized as a displaced, obliquely-oriented transcervical femoral neck fracture (AO/OTA 31-B2), a comminuted, open midshaft fracture (AO/OTA 32-C3) with loss of the lateral hemicortex, and an intercondylar distal femur fracture with complete articular involvement, with relatively simple metaphyseal fracture apices medially and laterally (AO/OTA 33-C1.1).

The left leg was initially temporized with skeletal traction and he was taken for urgent surgery for the open femur fracture. In the operating room, the patient was positioned supine on a flat top radiolucent table and a rotational profile of the contralateral limb was obtained using imaging. The 30x12cm anterolateral traumatic laceration was extended into a subvastus and lateral parapatellar approach distally and a Smith-Peterson approach proximally. A smaller direct lateral exposure was performed for the femoral neck implant application and a medial subvastus exposure was performed to access the medial metaphyseal apex of the distal fracture. A systematic debridement was performed, including removal of a large cortical portion of the lateral diaphysis that was completely stripped of soft tissues.

The distal C type fracture was addressed first. Through the medial subvastus exposure, the medial condyle was reduced, wired, and fixed using a 2.4 reconstruction plate in anti-glide mode with unicortical 2.4 mm cortex screws. The lateral condyle was then reduced using the parapatellar exposure and fixed using a second 2.4 plate in antiglide mode. The articular surface was lagged by technique using 3.5 mm cortex screws. Next, standard retrograde nailing was performed for the diaphyseal fracture, using fine wire traction to control the axial parameters while the coronal and sagittal reduction was controlled directly through the open wound. We took care to leave enough room proximally for femoral neck implant placement.

Lastly, the femoral neck was addressed. This is perhaps controversial, as traditional dogma states that the femoral neck should be prioritized. However, in this scenario we chose to create an intact distal segment first to better be able to manipulate the axial parameters of the neck reduction using fine wire traction, pulling through an intact segment. K-wires and the wire for the femoral neck system were pre-positioned in the lateral/distal segment. The anterior interval was then used to reduce the neck fracture through a capsulotomy. The K-wires were advanced and a 2.0 reconstruction plate with 2.0 mm cortex screws was used for provisional fixation. The femoral neck system was then placed, with the plate slightly posterior on the shaft and two bicortical locking screws placed behind the retrograde nail. This implant uses locking screws to attach the plate portion to the diaphysis, allowing 10° of freedom in the coronal plane to match a varus/valgus neck-shaft angle. In this case, this feature was helpful to navigate the implant above the previously placed retrograde nail. Finally, the wounds were closed and post-operative x-rays were obtained (Fig. 2).

Following surgical stabilization of his pelvic ring, acetabulum, and tibia fractures later during this hospitalization, the patient was discharged in stable condition on femur post-operative day #14. Minor wound dehiscence was noted on post-operative day #15, treated with debridement and closure in the operating room with subsequent uneventful wound healing. Patient was made non-weightbearing for twelve weeks per periarticular injury protocol. At his 13-month post-operative clinic visit, he was doing well with no complaints and had healed fractures on x-rays (Figs. 3–4).

Discussion

Trifocal femur fractures involving the proximal, diaphyseal, and distal femur are extremely rare. There have been only nine reported cases of a trifocal femur fracture with distal AO/OTA C type fracture [2–8], with only two including an intracapsular femoral neck fracture as well [2,3]. The case presented in our report is therefore the third published example of a trifocal femur fracture consisting of femoral neck, diaphyseal, and C type distal fractures.

Given the rarity of this injury, there is little consensus regarding surgical strategy and implant choice. The first reported case of this injury, published by Käch in 1993, described a basicervical fracture treated with lag screws, segmental mid-diaphyseal fracture treated with an antegrade locking nail, and C type distal femur fracture treated with a 95° blade plate, with no complications noted [3]. In 2011, Dousa et al. described a transcervical fracture treated with dynamic hip screw and mid-diaphyseal and C type distal fractures treated with a 95° condylar plate, with reoperation performed for diaphyseal malunion [4].

Here we describe treatment using screw-side plate device for the femoral neck fracture, retrograde nail for the comminuted diaphyseal fracture with bone loss, and lag screws with dual-column buttress plating for the distal complete articular fracture. This combination allows for prioritization of the two articular injuries with direct reductions and fragment-specific implants optimized for primary bone healing and optimal treatment of the femur shaft with medullary nailing. This represents the third instance of this combination of injuries to be represented in the literature, and the first since 2011 using modern implants. Previous dogma and reports have focused on prioritization of the proximal and distal fractures, sometimes at the expense of the femur shaft, with the premise that a shaft non- or malunion is more straightforward to treat than a problem with one of the end segments. While this is probably true for the surgeon, the patient may still experience significant morbidity from such an approach. Using modern implants, it is possible to fully optimize each component of the injury to provide the patient with the best chance to go on to uneventful union.

In conclusion, this case report describes a trifocal femur fracture with intracapsular femoral neck, diaphyseal, and distal complete articular fractures treated operatively with a combination of modern implants not yet described in the literature. This patient had a good clinical outcome and uneventful fracture union, with a construct optimized for each component of the injury. We anticipate this case may be valuable for the surgeon who encounters and is preparing to treat similar complex injuries.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing

interests:

Robinson and Fitzpatrick declare that they have no competing interests. Soles reports the following: Depuy, A Johnson & Johnson Company (Paid consultant), Orthopaedic Trauma Association (Board or committee member). Saiz reports the following: AAOS (Board or committee member), Orthopaedic Research Society (Board or committee member), Orthopaedic Trauma Association (Board or committee member). Lee reports the following: AO Foundation (Board or committee member), Globus Medical (IP royalties), Osteocentric (Stock or stock options), Osteocentric/SMV (Paid consultant), Synthes (Paid consultant, presenter, or speaker). Campbell reports the following: AAOS (Board or committee member), NSITE Medical INC. (Stock or stock options), Orthopaedic Trauma Association (Board or committee member), Synthes (Paid consultant, presenter, or speaker), Takeda Pharmaceuticals (Research support).

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