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SYMPOSIUM: FEMUR FRACTURES: CONTEMPORARY TREATMENT APPROACHES

Ipsilateral Proximal Femur and Shaft Fractures Treated With Hip Screws and a Reamed Retrograde Intramedullary Nail

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Abstract

Background Although not common, proximal femoral fractures associated with ipsilateral shaft fractures present a difficult management problem. A variety of surgical options have been employed with varying results.

Questions/purposes We investigated the use of hip screws and a reamed retrograde intramedullary (IM) nail for the treatment of this combined fracture pattern in terms of postoperative alignment (malunion), nonunion, and complications.

Methods Between May 2002 and October 2011, a total of 95 proximal femoral fractures with associated shaft fractures were treated at three participating Level 1 trauma centers; all were treated with hip screw fixation (cannulated screws or sliding hip screws) and retrograde reamed IM nails. The medical records of these patients were reviewed retrospectively for alignment, malunion, nonunion, and complications. Followup was available on 92 of 95 (97%) of the patients treated with hip screws and a retrograde nail. Forty were treated with a sliding hip screw, and 52 were treated with cannulated screws.

Results There were five proximal malunions in this series (5%). The union rate was 98% (90 of 92) for the femoral neck fractures and 91.3% (84 of 92) for the femoral shaft fractures after the initial surgery. There were two nonunions of comminuted femoral neck fractures after cannulated screw fixation. There was no difference in femoral neck union or alignment when comparing cannulated screws to a sliding hip screw. Four open comminuted femoral shaft fractures went on to nonunion and required secondary surgery to obtain union, and one patient developed symptomatic avascular necrosis.

Conclusions The treatment of ipsilateral proximal femoral neck and shaft fractures with hip screw fixation and a reamed retrograde nail demonstrated a high likelihood of union for the femoral neck fractures and a low risk of malunion. Comminution and initial displacement of the

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proximal femoral fracture may still lead to a small incidence of malunion or nonunion, and open comminuted femoral shaft fractures still may progress to nonunion despite appropriate surgical management.

Level of Evidence Level IV, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

Introduction

Studies have shown that 2.5% to 6% of femoral shaft fractures will have an associated ipsilateral femoral neck fracture [15, 19]. Although this entity is not common, it presents a diagnostic and therapeutic challenge for orthopaedic surgeons. Initially, antegrade intramedullary (IM) nails were employed with screws around the nail to fix the femoral neck fracture [4, 18, 20]. Although this provided adequate treatment for the femoral shaft fracture, the femoral neck fixation with this approach offered was tenuous. The advent of cephalomedullary nails for the treatment of proximal femur fractures was seen as an improvement for the treatment of ipsilateral femoral neck and shaft fractures; however, results have varied, with some series reporting good results and others reporting a concerning frequency of varus malunions [2, 6, 9–12, 16, 21]. In the mid-1990s, retrograde femoral IM nailing saw wider use and larger comparative reports demonstrating good union and alignment rates in the treatment of femoral shaft fractures. The success of this device led to the use of independent screw fixation of femoral neck fractures and retrograde IM nailing of the ipsilateral femoral shaft fracture [3, 8, 13, 14, 17]. In theory, these two implants allowed the individualized treatment of each fracture. There have been several published reports on the use of screw fixation for the hip fracture and retrograde nailing of the ipsilateral femoral shaft fracture; however, these have all been with a small number of patients and usually a single institution, making it difficult to draw conclusions [3, 8, 13, 14, 17].

We conducted a retrospective review of proximal femoral fractures associated with ipsilateral shaft fractures treated at three Level 1 trauma centers; specifically, we evaluated the use of hip screws and a reamed retrograde IM nail for the treatment of this combined fracture in terms of postoperative alignment (frequency of malunion), nonunion, and complications.

Patients and Methods

Study Design and Patients

We reviewed a consecutive series of patients treated for the diagnosis of proximal femoral fracture with associated ipsilateral femoral shaft fracture between May 2002 and October 2011 at three Level 1 trauma centers (Cooper University Hospital, Camden, NJ, USA; Boston University Medical Center, Boston, MA, USA; and St Louis University Hospital, St Louis, MO, USA) with two separate implants used for this combined fracture pattern. Institutional review board approval was obtained from all institutions. All fractures were treated with a sliding hip screw, 95° hip screw and plate, or cannulated screws proximally and a reamed retrograde IM nailing for the femoral shaft fracture. At Cooper University Hospital, all of the combined fractures were treated with a sliding hip screw and reamed retrograde IM nailing. At Boston University Medical Center, all patients were treated with cannulated screws for their proximal fracture, while at St Louis University Hospital, vertical femoral neck fractures, basicervical fractures, and intertrochanteric fractures were treated with a sliding hip screw and all other femoral neck fractures with cannulated screws. All on-call orthopaedic surgeons, including some who were fellowship-trained trauma surgeons, treated these fractures.

Of the 95 patients identified, three were lost to followup, leaving 92 patients available for analysis. At Cooper University Hospital, there were 26 ipsilateral proximal femur and shaft fractures (two lost to followup) of the 813 femoral fractures treated over the 10-year period (3.2%). There were 21 combined fractures (one lost to followup) of 579 femoral shaft fractures (3.6%) at Boston University Medical Center and 48 combined fractures of 1250 femoral fractures (3.8%) at St Louis University Hospital. There were 22 females and 70 males; 39 were left femoral fractures and 53 were right. The mean age was 33.1 years (range, 17–83 years). Followup ranged from 16 weeks to 72 months (mean, 23.92 months). The proximal fractures (OTA 31A, B) included one subtrochanteric, 23 intertrochanteric, 53 basicervical, 13 transcervical, and two subcapital. Twenty-eight patients had isolated femur fractures and 64 patients had other associated injuries, including one ipsilateral knee dislocation and three closed and one open ipsilateral patella fractures. There were 28 comminuted (OTA 32C) fractures, 27 with a butterfly fragment (OTA 32B); 36 transverse (OTA 32A) fractures; and one distal 1/3 (OTA 33A) fracture.

Ten femoral neck fractures had vertical (Pauwels Type III) angulation, of which seven were displaced. Twenty-six of the 92 proximal femur fractures (39%) were displaced on the initial plain radiographs (Table 1). The proximal fracture was treated with a 95° screw-plate (n = 2), sliding hip screw implants (n = 38), and cannulated screws (n = 52), as the implant choice was both fracture and surgeon dependent. All of the nondisplaced fractures were fixed in situ. Of the 26 displaced proximal femur fractures, 13 had an open reduction before screw placement after an initial unsuccessful attempt at closed reduction. Nineteen

Table 1. Categorization of displaced and nondisplaced proximal femoral fractures with treatment

Variable	Number of fractures	
	Displaced	Nondisplaced
Total	26	66
Sliding hip screw	12	28
Cannulated screws	14	38
Pauwels Type III	7	3
Basicervical/intertrochanteric	15	52
Transcervical/subcapital/subtrochanteric	4	11

shaft fractures were open and were treated with irrigation and débridement of the open fracture before employment of a reamed retrograde IM nail. Reaming of the IM canal was performed before insertion of all retrograde IM nails. Four polytraumatized patients and one with a Grade IIIB open fracture had open reduction and internal fixation of their hip fractures with external fixation of the femoral shaft fracture, followed later by retrograde IM nailing.

Plain radiography and/or CT scan identified 86 proximal femur fractures before going to the operating room (Fig. 1). Three patients had the femoral neck fracture identified in the operating room during retrograde nailing, one patient had a femoral neck fracture identified in the postanesthesia care unit after retrograde nailing, and one morbidly obese patient had a basicervical fracture identified in the trauma intensive care unit after retrograde IM nailing. One patient demonstrated a displaced femoral neck fracture under fluoroscopy in the operating room while undergoing antegrade IM nailing and was converted to screws plus a retrograde IM nail.

Surgical Technique

All patients were placed supine on a radiolucent operating room table with a small bolster under the ipsilateral torso. This bump was not positioned under the trochanter as this may inhibit hip fracture reduction and may also make rotational assessment of the femoral shaft fracture more difficult. The femoral neck fracture was always provisionally or definitively fixed first. Nondisplaced proximal femoral neck fractures were fixed in situ. Displaced fractures had an initial attempt at a closed reduction, and if unsuccessful, then an open reduction was utilized to allow direct visualization and palpation of the reduction before fixation. Both Smith-Petersen and Watson-Jones approaches were used per surgeon discretion; by definition, these patients had capsulotomies. Traction and internal rotation were applied to the middle floating shaft fragment utilizing a 5-mm Schanz pin for manipulation and reduction of the femoral neck. Once the

alignment was obtained, either a sliding hip screw or multiple cannulated screws were inserted. When using a sliding hip screw, the lowest angle that yielded an acceptable reduction (135° or 140°) was used to leave sufficient room for the retrograde IM nail to have maximum purchase in the proximal fragment. A single unicortical or intracortical screw was often inserted into the side plate to hold the sliding hip screw in place while the retrograde IM nail was inserted. When utilizing cannulated screws, a similar approach was employed, keeping the insertion site close to the vastus lateralis ridge and the screws in a more varus trajectory.

The knee was then placed over a triangle or bolster at approximately 45° of knee flexion to allow for safe passage of the reamers and insertion of the retrograde IM nail through the appropriate starting point. The retrograde IM nail was inserted as proximal as possible, at times abutting the proximal screws in the femoral neck. When a sliding hip screw was used, the previously placed unicortical proximal screw was replaced with a screw through the side plate either anterior or more commonly posterior to the IM nail after the proximal locking screw was placed in the IM nail.

Outcomes

Outcome measures evaluated included immediate postoperative alignment and alignment at the time of union, malunion, nonunion, and surgical complications and their management including any secondary procedures. All radiographs were measured by the three senior authors (RFO, PT, JTW) for proximal femoral and shaft alignment using hand-held goniometers or angle determination was performed on a digital radiographic system. All fractures at union were compared to the fracture alignment immediately postoperatively and the contralateral proximal femur was used for a reference as well.

Statistical Analysis

A chi-square test was used to analyze the differences between the sliding hip screw and cannulated screw groups for complications of displaced proximal fractures. We performed the statistical analyses using GraphPad Prism® (GraphPad Software, Inc, San Diego, CA, USA).

Results

Malunion

There were five malunions of the proximal femoral fractures (5%), four treated with a sliding hip screw and one

Fig. 1A–B (A) A radiograph shows a segmental femur fracture in a 70-year-old man. (B) A CT scan shows a nondisplaced basicervical femoral neck fracture (arrow).
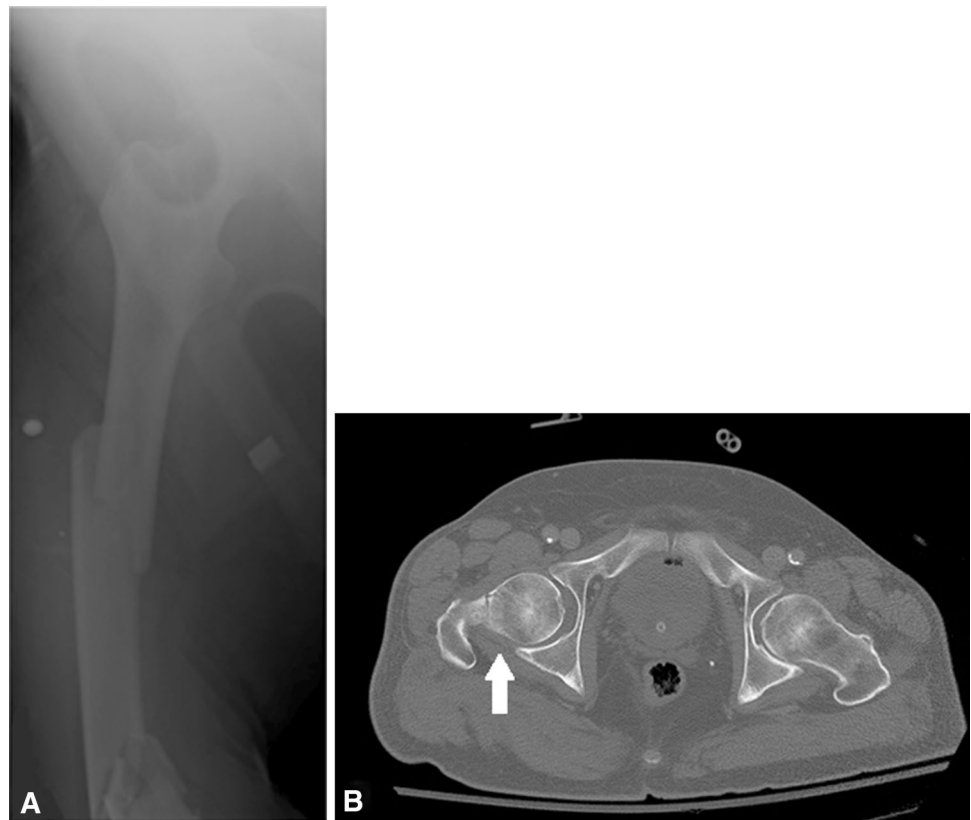
with cannulated screws, and one of the femoral shaft. One patient with a Grade IIIA shaft fracture was treated with an undersized retrograde IM nail and healed in 5° of varus. One patient treated for an ipsilateral subtrochanteric fracture with a 95° screw-plate implant was stabilized and healed in 5° of varus. One femoral neck treated with a sliding hip screw with a two-hole plate drifted into 5° of varus and healed. Two comminuted vertical femoral neck fractures treated with a sliding hip screw shortened with ambulation (Fig. 2), as did one treated with three cannulated screws. Analysis of the initial fixation demonstrated accurate reduction and appropriate hardware placement with subsequent collapse of the fractures due to comminution.

Nonunion

Four open comminuted femoral shaft fractures went onto nonunion, two healing after retrograde exchange nailing and the other two after plating (Fig. 3). One of these patients with a Grade IIIA open femur fracture healed but subsequently developed osteomyelitis and required nail removal and antibiotic beads for treatment of the infection. Three patients had successful dynamization for a closed femoral shaft fracture delayed union. One delayed union failed dynamization and had all hardware removed from the femur and a subsequent exchange reamed IM nailing

led to fracture union. Two comminuted femoral neck fractures treated with three cannulated screws went onto nonunion and healed after valgus osteotomy. We found no differences in malunions and nonunions of displaced proximal fractures treated with a sliding hip screw (four of 12) versus cannulated screws (three of 14) (p = 0.49).

Complications

One patient with a BMI of more than 40 had thigh pain, no broken hardware, and a lucency that was called a delayed union and was successfully treated with autogenous bone graft. Two patients were nailed 1 cm short. An asymptomatic delayed union of a nondisplaced femoral neck fracture showed radiographic signs of union at 14 months in one patient (Fig. 4).

There were no cases of hardware failure. A 22-year-old patient with a displaced transcervical femoral neck fracture had an open reduction and fixation with cannulated screws and went on to heal the neck fracture in excellent position but developed avascular necrosis at 4 years and had a hip arthroplasty at 5 years after injury. Ten patients had knee pain (seven required screw removal), two had hip pain, three had symptoms referable to chondromalacia patella, and one had hip and knee pain. One patient had bilateral deep venous thrombosis and two patients developed knee
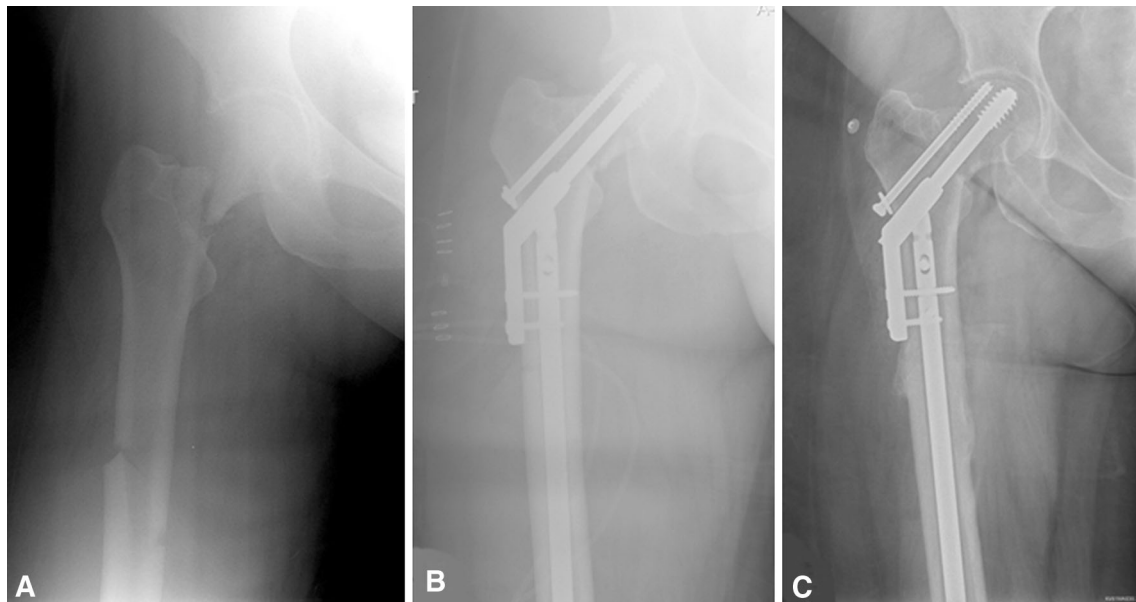
Fig. 2A–C (**A**) An initial radiograph shows a comminuted vertical basicervical femoral neck fracture with an associated ipsilateral shaft fracture in a 42-year-old woman. (**B**) A radiograph shows the fracture 1 month after an open reduction and fixation of the femoral neck fracture. (**C**) A 7-month radiograph demonstrates that there is subsequent shortening of the femoral neck on the sliding hip screw due to comminution.
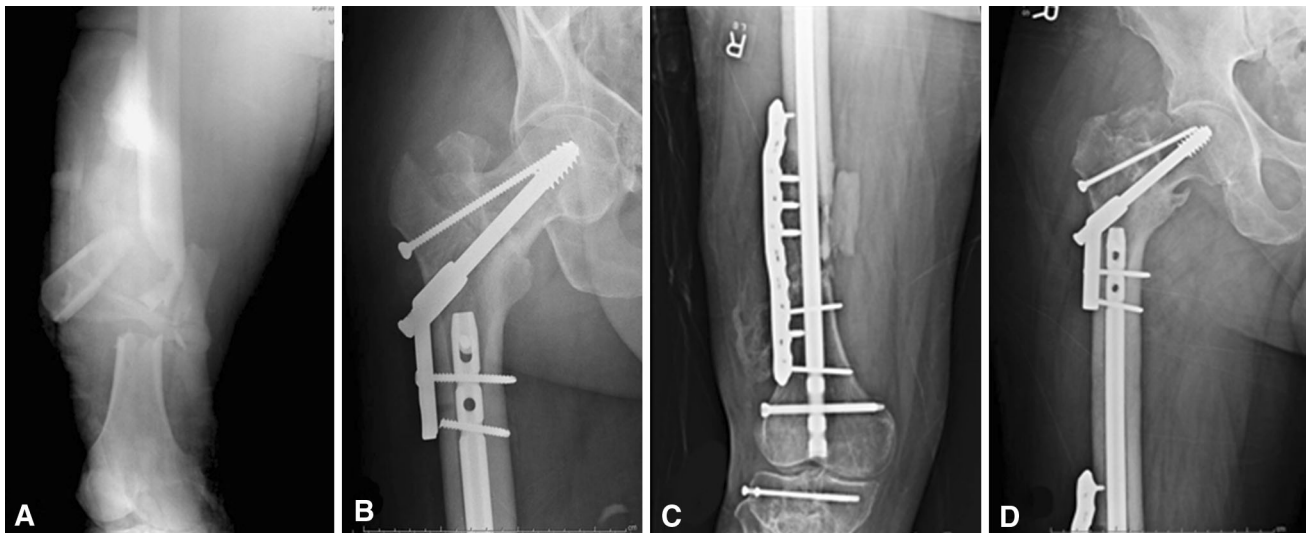
Fig. 3A–D (**A**) A radiograph shows a displaced intertrochanteric hip fracture and a segmental Grade IIIB open femur fracture in a 30-year-old man. (**B**) At 3 months, the hip fracture has drifted into 5° of varus with slight compression of the lag screw in the barrel. The femoral shaft fracture showed no signs of union, and bone graft and plating were performed around the IM nail. Radiographs taken at 7 months postoperatively show final union of (**C**) the femoral shaft and (**D**) the hip fracture.

flexion contractures of 5°. One patient developed a pulmonary embolism and septicemia and another had abdominal compartment syndrome and acute renal failure.

Discussion

Although not common, ipsilateral femoral neck and shaft fractures present a difficult management problem. This consecutive series of 92 ipsilateral proximal femoral and associated shaft fractures treated with lag screw fixation of the proximal femoral fracture and reamed retrograde IM nailing of the femoral shaft demonstrates that, although malunions are uncommon, they do occur, and union is likely and occurs in the large majority of fractures thus treated, but the severity of these injuries can result in complications even when managed appropriately.

Fig. 4A–D (**A**) A radiograph shows a femoral shaft fracture in a 25-year-old woman. (**B**) A radiograph shows a minimally displaced basicervical femoral neck fracture. (**C**) A radiograph shows the appearance of the femoral neck fracture at 7 months. (**D**) Radiographic union of the femoral neck fracture at 14 months after injury is shown.
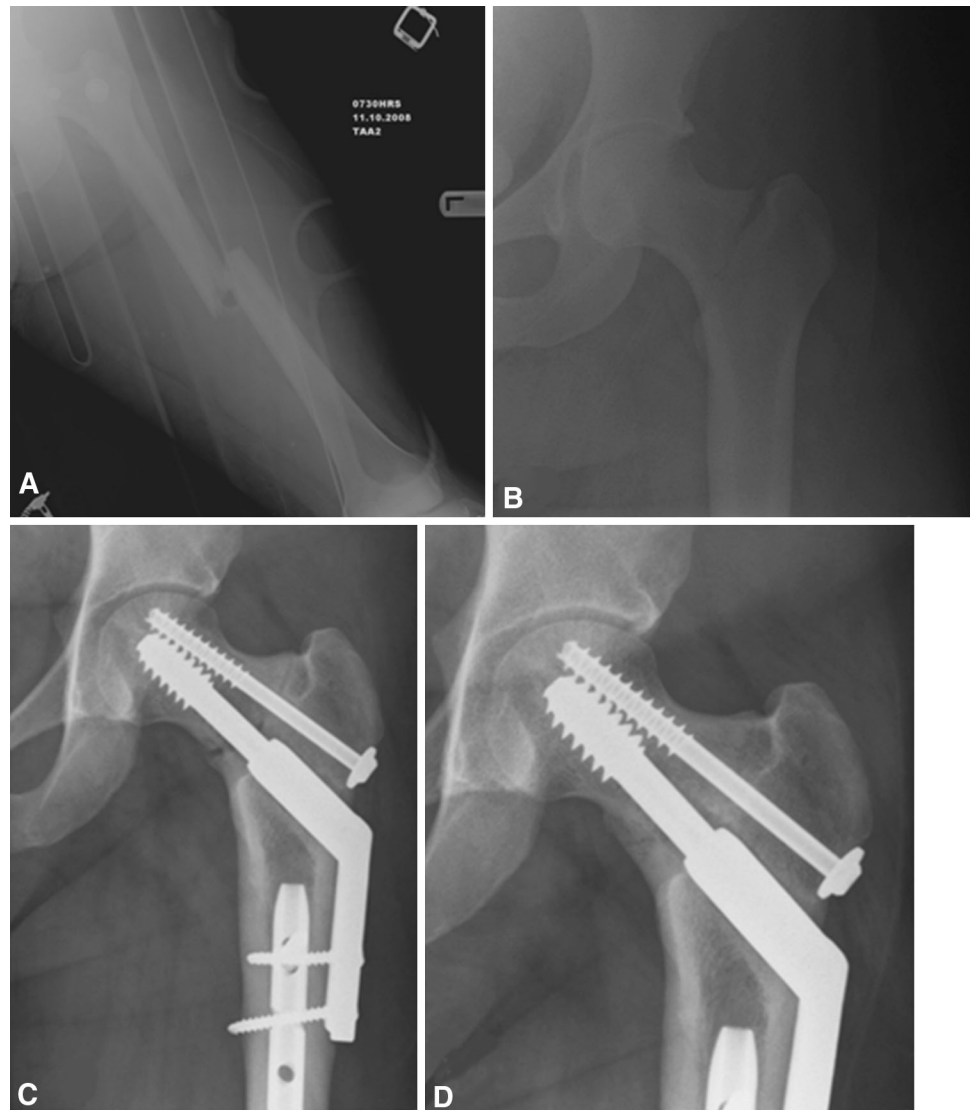
This study has the limitations of all retrospective case series in that we relied on existing radiographs and charts for our data and analysis. All three trauma centers provided a consecutive series of proximal femoral fractures representing all patients treated for the diagnosis of ipsilateral femoral shaft fracture during the period in question, without exclusion, and the only patients whose data were not included in the analysis were those patients lost to followup. There was no exact treatment protocol for this combined fracture pattern, but with different institutions, surgeons, and fracture patterns, an algorithm was followed by all involved that was a current state-of-the-art approach that was reproducible, and hopefully this study can provide a framework for subsequent care in other hospitals. The shorter followup of 16 weeks in some patients was chosen to assess union, alignment, and complications only and was appropriate in these few cases. There was no comparison group for our patients because at none of these institutions were cephalomedullary implants used for any of these fractures during this time period.

The morphology of the proximal femoral fracture, despite appropriate reduction and fixation, led to five femoral neck malunions, demonstrating that, although most of these fractures are nondisplaced (61% in this series, 66 patients), those that are displaced can demonstrate instability. Cannulated screw fixation of comminuted femoral neck fractures was associated with the two nonunions we observed, but the numbers are too small to draw conclusions. We noted no difference in the nonunion and malunion rates when comparing the sliding hip screw and cannulated screw groups. Of our 92 fractures, only 26 had a displaced proximal femur fracture, with 12 being treated with a sliding hip screw and 14 by cannulated screws. The paucity of nonunions most likely is secondary to the fact that the majority of our proximal fractures were nondisplaced and, for the majority of these combined fractures,

the kinetic energy is imparted to the femoral shaft. The absence of postoperative displacement in our series may just be a reflection of our lack of displaced fractures and our finding that the proximal lag screw fixation type did not matter for nondisplaced fractures. Despite many authors supporting a single cephalomedullary IM nail, most had at least one varus malunion or nonunion when using this single implant to treat both fractures [2, 6, 8–10, 12, 16, 21]. In a retrospective study, patients receiving a cephalomedullary IM nail had one femoral neck and two femoral shaft malreductions (33%) compared to no malreductions at either fracture site when screws or a sliding hip screw was used proximally and a retrograde IM nail distally [3].

Two series have demonstrated a lower diaphyseal union rate with unreamed or small-diameter retrograde femoral IM nails [13, 17]. All of our retrograde femoral nails were placed after reaming. The one malunion was secondary to an undersized IM nail, again stressing the importance of using an appropriate canal-sized implant. Four open comminuted fractures progressed to nonunion, two healing after exchange nailing and two with plating, reinforcing that the severity and morphology of the femoral shaft fracture are the major determinants of progression to union. A recent meta-analysis showed strong evidence suggesting that reamed IM nails had a higher union rate than unreamed IM nails, again confirmed by our recent investigation [5]. Most recently, a multicenter retrospective review of 76 high-energy ipsilateral femoral neck and shaft fractures treated by a variety of surgeons with fixation determined by surgeon discretion found complications in patients treated with proximal cannulated screws and a retrograde IM nail [7]. In the group where the femoral neck fracture was identified early, 33 were treated with cannulated screws and 16 with a sliding hip screw with a secondary retrograde IM nail. Of their 11 nonunion or malunions of the femoral neck, six were treated with cannulated screws. The authors were not able to do any further analysis due to the retrospective nature of the review. Five of their original 91 femoral shaft fractures went onto nonunion, three in open fractures and three with small-diameter retrograde IM nails. The significance of our use of reamed IM retrograde nails is demonstrated by a low nonunion rate of only 5.4%. In our series, the only two nonunions were after cannulated screw fixation of displaced femoral neck fractures, but we were unable to determine whether the type of fixation was of clinical significance and predisposed the fracture to this complication.

Our series had five proximal malunions, one fixed in varus and four that drifted into varus. The use of an appropriate implant for the proximal femur fracture does not preclude the possibility of varus angulation, but our results are better than those in the literature when a single cephalomedullary implant was employed. Watson and

Moed [17] reviewed their complications in 13 patients who had surgical treatment of an ipsilateral femoral neck and shaft fractures. When assessing their femoral neck non-unions, 75% developed after the use of a reconstruction IM nail. They further found that an open fracture, unreamed small-diameter IM nail, and delay to weightbearing were factors contributing to poor results for the femoral shaft fractures. They concluded that lag screw fixation of the femoral neck and retrograde reamed IM nailing of the femoral shaft fracture were associated with the fewest complications. Kang et al. [11] used these second-generation IM nails to treat four ipsilateral femoral neck and shaft fractures but had a 75% complication rate and stated that this implant is not a good choice for this combined fracture pattern. Conclusions from a larger series from the same institution stated: "fixation schemes that rely on one device for both fractures seem to compromise the treatment of one or both fractures in some way" [1, 11, 19]. Eleven patients treated with a reconstruction nail had multiple associated fracture-healing complications, intraoperative technique issues, and prolonged surgical times of 180 minutes, and the authors concluded that the use of this IM nail for this fracture pattern was "demanding" and that technical errors with this implant will lead to fracture complications [6].

The treatment of ipsilateral proximal femoral fractures with hip screw fixation and a reamed retrograde IM nail demonstrated good clinical results and a 91.3% initial union rate for the shaft and 97.8% union for the femoral neck fractures with five malunions. There was no difference in femoral neck union or alignment when comparing cannulated screws to a sliding hip screw, although the numbers were small. We recommend the use of compression screw fixation for the treatment of the proximal femur fracture and reamed retrograde IM nailing for the associated ipsilateral femoral shaft fracture. Comminution and initial displacement of the proximal femoral fracture may still lead to a small incidence of malunion or nonunion, and open comminuted femoral shaft fractures still may progress to nonunion despite appropriate surgical management.

References

1. Alho A. Concurrent ipsilateral fractures of the hip and shaft of the femur: a systematic review of 722 cases. *Ann Chir Gynaecol.* 1997;86:326–336.
2. Bali K, Gahlot N, Aggarwal S, Goni V. Cephalomedullary fixation for femoral neck/intertrochanteric and ipsilateral shaft fractures: surgical tips and pitfalls. *Chin J Traumatol.* 2013;16:40–45.
3. Bedi A, Karunakar MA, Caron T, Sanders RW, Haidukewych GJ. Accuracy of reduction of ipsilateral femoral neck and shaft fractures—an analysis of various internal fixation strategies. *J Orthop Trauma.* 2009;23:249–253.
4. Bennett FS, Zinar DM, Kilgus DJ. Ipsilateral hip and femoral shaft fractures. *Clin Orthop Relat Res.* 1993;296:168–177.

5. Bhandari M. Ipsilateral femoral neck and shaft fractures. *J Orthop Trauma.* 2003;17;138–140.

6. Bose WJ, Corces A, Anderson LD. A preliminary experience with the Russell-Taylor reconstruction nail for complex femoral fractures. *J Trauma.* 1992;32:71–76.

7. Cannada LK, Viehe T, Cates CA, Norris RJ, Zura RD, Dedmond B, Obremskey W, Bosse MJ; Southeastern Fracture Consortium. A retrospective review of high-energy femoral neck-shaft fractures. *J Orthop Trauma.* 2009;23:254–260.

8. Gary JL, Taksali S, Reinert CM, Starr AJ. Ipsilateral femoral shaft and neck fractures: are cephalomedullary nails appropriate? *J Surg Orthop Adv.* 2011;20:122–125.

9. Hossam ElShafie M, Adel Morsey H, Emad Eid Y. Ipsilateral fracture of the femoral neck and shaft, treatment by reconstruction interlocking nail. *Arch Orthop Trauma Surg.* 2001;121:71–74.

10. Jain P, Maini L, Mishra P, Upadhyay A, Agarwal A. Cephalomedullary interlocked nail for ipsilateral hip and femoral shaft fractures. *Injury.* 2004;35:1031–1038.

11. Kang S, McAndrew MP, Johnson KD. The reconstruction locked nail for complex fractures of the proximal femur. *J Orthop Trauma.* 1995;9:453–463.

12. Koldenhoven GA, Burke JS, Pierron R. Ipsilateral femoral neck and shaft fractures. *South Med J.* 1997;90:288–293.

13. Oh CW, Oh JK, Park BC, Jeon IH, Kyung HS, Kim SY, Park IH, Sohn OJ, Min WK. Retrograde nailing with subsequent screw fixation for ipsilateral femoral shaft and neck fractures. *Arch Orthop Trauma Surg.* 2006;126:448–453.

14. Ostrum R, Poka A. Ipsilateral femoral hip and shaft fractures: a management protocol. *Am J Orthop.* 1999;28(1 suppl):4–11.

15. Peljovich AE, Patterson BM. Ipsilateral femoral neck and shaft fractures. *J Am Acad Orthop Surg.* 1998;6:106–113.

16. Randelli P, Landi S, Fanton F, Hoover GK, Morandi M. Treatment of ipsilateral femoral neck and shaft fractures with the Russell-Taylor reconstructive nail. *Orthopedics.* 1999;22:673–676.

17. Watson JT, Moed BR. Ipsilateral femoral neck and shaft fractures: complications and their treatment. *Clin Orthop Relat Res.* 2002;399:78–86.

18. Wiss DA, Sima W, Brien WW. Ipsilateral fractures of the femoral neck and shaft. *J Orthop Trauma.* 1992;6:159–166.

19. Wolinsky PR, Johnson KD. Ipsilateral femoral neck and shaft fractures. *Clin Orthop Relat Res.* 1995;318:81–90.

20. Wu CC, Shih CH. Ipsilateral femoral neck and shaft fractures: retrospective study of 33 cases. *Acta Orthop Scand.* 1991;62:346–351.

21. Wu LD, Wu QH, Yan SG, Pan ZJ. Treatment of ipsilateral hip and femoral shaft fractures with reconstructive intramedullary interlocking nail. *Chin J Traumatol.* 2004;7:7–12.