

Treatment of Comminuted Subtrochanteric Femoral Fractures in a Young Population with a Reconstruction Nail

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The authors report their experience using the Russell-Taylor reconstruction intramedullary interlocking nail in five comminuted subtrochanteric fractures in young paratroopers. The retrospective case series presented demonstrates the usefulness of this device for a challenging problem. Follow-up averaged 22 months and clinical results were good in that all soldiers could return to parachuting. The authors discuss surgical techniques and review the literature. The authors recommend consideration of the reconstruction nail use for this clinical problem.

Introduction

Subtrochanteric femur fractures are among the most challenging fractures the orthopedic surgeon treats.¹ The tremendous compressive and tensile forces in the subtrochanteric region (Fig. 1) can place extreme forces on implants designed to treat these fractures.² Sliding hip screws, dynamic condylar screws, side plate devices, 95° condylar plates, the gamma nails, blade plates, and flexible intramedullary devices have all been utilized to stabilize these injuries.³⁻⁸ Zickel introduced his intramedullary nail and reported on the success of its use.⁹ However, there have been subsequent reports on complications and problems with the use of the Zickel nail.^{1,8} Such complications include fracture upon implant removal.⁸

In general, intramedullary nails have revolutionized the treatment of femur fractures.¹⁰ The development of interlocking screws expanded the indications for the use of the intramedullary nail to include comminuted femoral shaft fractures and simple subtrochanteric fractures. In 1987, the second generation of interlocking nails was introduced.¹¹ The reconstruction, or "RECON," nail designed by Russell and Taylor, is reinforced proximally for greater strength and allows for fixation screws to be placed into the head and neck of the femur. This broadens the indications to include complex proximal femoral fractures, impending pathologic fractures of the proximal femur, and ipsilateral shaft and neck fractures.¹²⁻¹⁵ The strength of the implant is also enhanced by a closed-section design and increased wall thickness. Additionally, 6.5-mm distal interlocking screws may be used with this nail.

At Fort Bragg, North Carolina, subtrochanteric fractures are an occasional injury associated with airborne operations (Fig. 2). The Russell-Taylor reconstruction nail has become a standard treatment device for many of these fractures. The purpose of this study was to evaluate the use of the reconstruction nail in treating comminuted subtrochanteric femur fractures.

Methods

We retrospectively reviewed the subtrochanteric femur fractures from April 1989 to April 1990 that were treated with the Russell-Taylor reconstruction nail (Fig. 3). Five patients were identified. All were male active duty paratroopers who sustained their injuries during parachute landings. The average patient age was 32. All fractures were comminuted in the subtrochanteric region, with intertrochanteric extension at least through the lesser trochanter. Therefore, all fractures were unstable and were classified as type C in the AO system or as Seinsheimer types III A, IV, or V.⁶ During this 1-year period, the reconstruction nail was also used to treat two ipsilateral femoral neck and shaft fractures that are not included in this study. Treatment consisted of placing the injured extremity in balanced skeletal traction with a proximal tibial traction pin prior to performing the operation. The operation consisted of closed reduction followed by reamed intramedullary nailing with the reconstruction nail (Fig. 4). One patient required open reduction to obtain proper fracture alignment for nail insertion. All operations were performed within 3 days of injury. The supine and lateral decubitus positions were used in two and three cases, respectively. All nails were proximally interlocked with two screws into the head and neck. Four of five nails were distally interlocked. Weight bearing as tolerated began on the first postoperative day, except in two patients with large segmental fracture components, who were restricted to touch-down weight bearing for 6 weeks.

Follow-up examinations and radiographic evaluation were conducted at an average of 22 months after surgery (Fig. 5).

Results

The average operative time was 171 minutes and the average blood loss was 620 ml (Table I). For each individual surgeon, both variables decreased with the experience. The surgical support team also became more familiar with the implant.

All fractures in this series healed without evidence of hardware failure. Union occurred within 3 months. After fracture healing, the hardware was removed in five patients, and three of the five have resumed airborne operations. Hardware removal was offered to symptomatic patients 1 year after insertion. The other two patients have no pain or activity limitation, but have chosen not to resume airborne operations. There was one transient peroneal nerve palsy that resolved by postoperative day 3. There were no other complications (limb length discrepancy, malrotation of the limb, etc.) after the primary or secondary procedures. The hospital stay averaged 1 week. Patients routinely complained of pain secondary to the prominence of the proximal nail and the heads of the proximal interlocking screws.

The investigation was performed at the Orthopedic Service, Womack Army Medical Center, Fort Bragg, NC.

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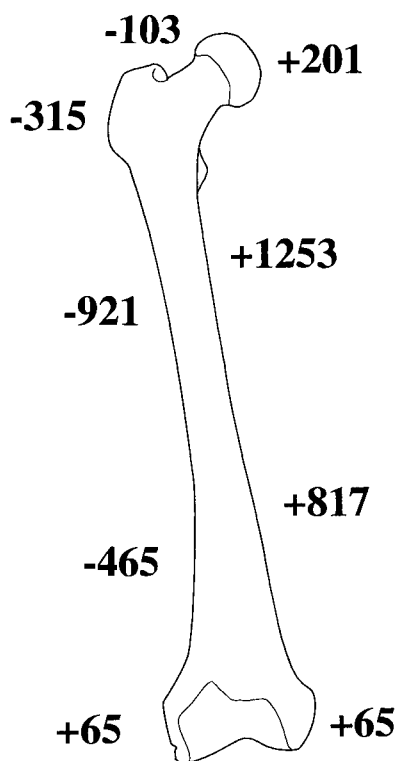


Fig. 1. Compressive and tension forces (in pounds) in the femoral cortex (re-drawn from Koch).



Fig. 2. Mechanism of injury.

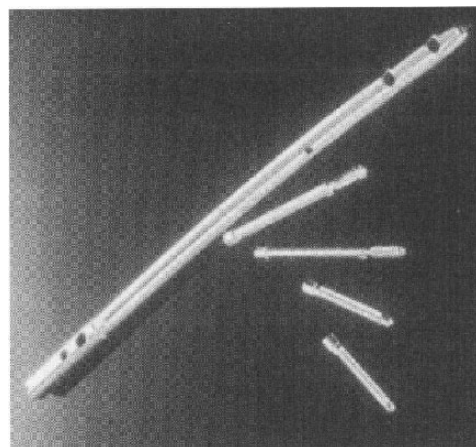


Fig. 3. The Russell-Taylor reconstruction nail system.

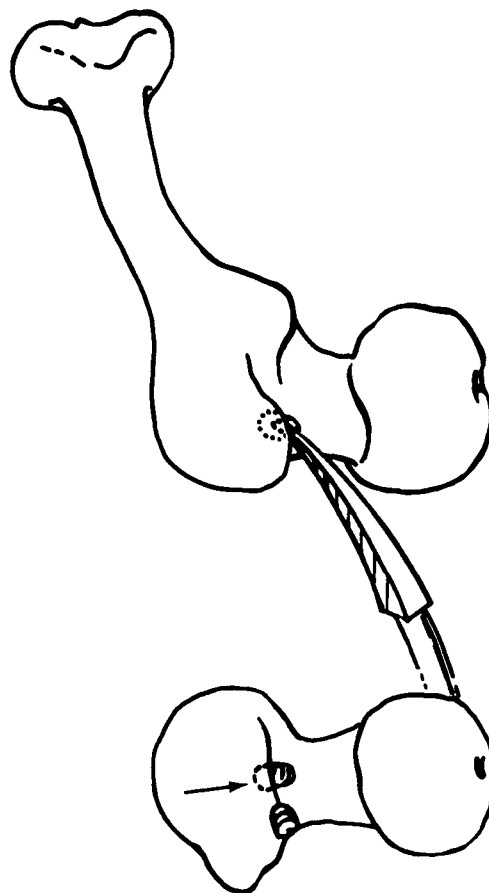


Fig. 4. Placing starting point.

Discussion

As stated earlier, with experience, operative time and blood loss decreased. Several technical factors were identified as important steps in obtaining reduction and proper nail insertion. First, the insertion hole should be at a point in the middle of the anterior-posterior axis of the femur, just medial to the greater trochanter. This is not in the piriformis fossa, as has been taught by some, but just anterior to the piriformis fossa. This permits improved placement of the nail into the femoral neck.

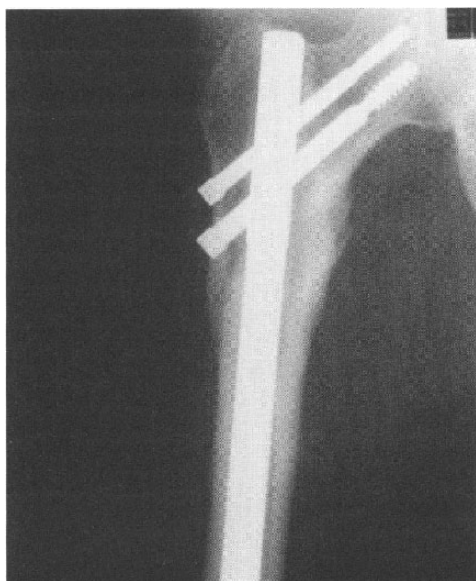


Fig. 5. Postoperative radiograph.

TABLE I
PATIENT DATA AND RESULTS

Patient	Age (years)	Operation Time (minutes)	Blood Loss (ml)	Follow-Up (months)	Duty Status
1	29	287	350	15	Airborne
2	32	106	450	55	Full duty
3	28	152	750	14	Airborne
4	38	205	900	15	Full duty
5	32	107	650	12	Airborne

Second, the intramedullary canal of the femoral shaft needs to be reamed to a diameter at least 1 to 1.5 mm greater than the nail diameter and to a minimum of 15.5 mm. In the proximal segment, 17-mm reaming compensates for the larger proximal nail diameter. Additional over-reaming can be helpful to allow the nail to rotate to achieve the proper anteversion for placement of the guide wires for the femoral head screws.

Third, although patients complained of irritation due to the prominence of the proximal nail, we found that for insertion of the two screws into the femoral head, the nail must not be fully impacted; seating the nail approximately 1 cm short of flush allowed for optimal position of the two femoral neck screws. Nail prominence and pain were indications for implant removal.

Definitive statements about the use of the reconstruction nail, however, cannot be made due to the small sample size of this series. Direct comparison of this device with other devices cannot be made. In our review of the literature, we found several references to the Russell-Taylor reconstruction nail. Some deal with subtrochanteric fractures in one way or another.^{8,11,14,16-23} Others deal with pathologic, shaft, or ipsilateral neck and shaft fractures.^{13,15,24-27}

Since initiating this study, several other reports on the use of the reconstruction nail have been published. In a study similar to ours, carried out in a civilian population at Stanford, seven subtrochanteric femur fractures united after treatment with the

reconstruction nail.²¹ If the lesser trochanter is contiguous with the proximal fragment, a standard intramedullary device can be used.

A series of 36 patients treated with the reconstruction nail was reviewed by Hoover et al. in Houston. Twenty of the fractures in their series were classified as intertrochanteric with shaft extension. All of their fractures healed with good functional results.¹⁸ Preoperative radiographs (Fig. 6) should be scrutinized for fracture configuration, e.g. if the greater trochanter is fractured, then this implant may displace the fragment.

Biomechanical studies showed that nail strengths are comparable between the Grosse-Kempf, AO, and reconstruction nails except that the reconstruction nail was significantly more resistant to torsional loading.^{20,28} A second biomechanical study showed that the unslotted reconstruction nail-fracture construct was approximately 15% weaker under axial compression and 300% stronger in torsion than the slotted Grosse-Kempf nail; this difference in compression was attributed to greater load sharing by the bone.²⁹ Cold work expansion processing has improved fatigue life at the screw holes.³⁰

The clinical studies generally report favorable results when the device is used appropriately. Indications include acute or impending pathologic subtrochanteric fractures, comminuted proximal femoral fractures (especially if the lesser trochanter is involved), ipsilateral femoral neck and shaft fractures, and femoral shaft fractures.

Coleman et al. identified some technical aspects that when followed can make using the reconstruction nail easier.¹⁷ They noted that Steinmann pin placement in the greater trochanter was one useful technique for stabilizing the proximal fragment and avoiding varus positioning of the hip. They also recommend placing the lower screw hole just above the inferior aspect of the neck.

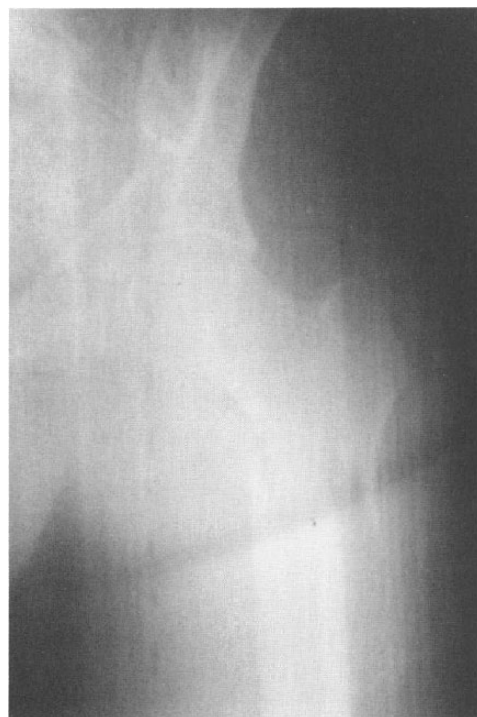


Fig. 6. Injury radiograph.

Based on our study and our literature review, we feel that some positive features of reconstruction nail use include its torsional rigidity from the slotted proximal interlocking screws, the relatively short operative time, the small amount of blood loss, and the relatively easy insertion.^{19,24,29} Potentially negative features of reconstruction nail use include the surgical learning curve, slight limb lengthening or shortening, chondrolysis risk, avascular necrosis risk, and implant prominence.¹⁸

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