The stability of intertrochanteric fractures

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ABSTRACT

The stability of intertrochanteric fractures is primarily dependant on the attainment of firm contact between the medial cortices of the two major fragments. In addition, the placement of the internal fixation device (regardless of the type used) also is of importance in relation to its placement in reference to the femoral neck. Furthermore, the angle of inclination of the fracture plays a major role, since a fracture of a high very vertical angle may more easily collapse under vertical forces.

Keywords
fractures, intertrochanteric fractures, stability, nailing

INTRODUCTION

The intertrochanteric fracture continues to be one of great importance, not only because of its frequent occurrence, but also because despite great progress made from the use of intramedullary fixation, complications still develop.[1] It is likely that with additional experience and technical improvements, intramedullary nailing will gain additional acceptance. In this brief article a few relatively controversial technical points related to stabilization are discussed.

FIXATION OF INTERTROCHANTERIC FRACTURES

It is usually believed that when a nail-plate is used, the nail should be located in the center of the head to achieve the best fixation.[2–5] However, there are far more important factors than the location of the nail in the femoral head. Because the density of the femoral head is uniform throughout, it should not matter where the tip end of the nail is when dealing with intertrochanteric fractures (Figure 1). However, when operating on femoral neck fractures using multiple pins for fixation, their peripheral location is more desirable because rotational stability is further enhanced.

In addition to vertical forces on the fractured fragments, external rotation forces are important, especially at heel strike. If the nail is close to the posterior cortex, powerful external rotational forces encourage the nail to migrate anteriorly without bony opposition. On the other hand, if the nail is in contact with the anterior cortex of the neck, the external rotation forces tending to displace it anteriorly cannot succeed because the nail has no place to move. Since the femur has a few degrees of anteversion, the nail that enters the neck parallel to the floor ends up in the center of the head. The conclusion to be drawn is that it is not the placement of the nail in the center of the head that matters most, but its contact with the anterior cortex of the femoral neck (Figure 2).[6,7]

Although the placement of the nail in regards to the cortices of the femoral neck is important, the stability of the nailed fracture is primarily dependent on achieving anatomical contact between the medial/anterior cortices of the two major fragments. This applies to fractures treated with a single nail-plate and those treated with an interlocking intramedullary nail (Figures 3 and 4). Under weight bearing or even from the forces necessary to carry out activities of daily living, e.g. lifting the leg, collapse of the fragments may occur (Figure 3).[6,7]

We have conducted studies with the use of electromyography demonstrating that during the painful postoperative stages, strong forces attempt to produce a varus deformity. This observation shows that the main force comes from the adductor musculature and not from the abductors, which is the popular belief, usually explained by the alleged unopposed pull of the gluteus medius on the greater trochanter (Figure 5).

We conducted additional laboratory studies that clearly proved that with reapproximation of the medial/anterior

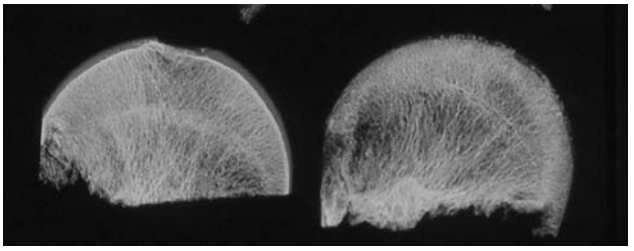

FIGURE 1. Radiographs of sections of two femoral heads illustrating their uniform density. The one on the left is from an acute fracture, and the one on the right from an arthritic hip.

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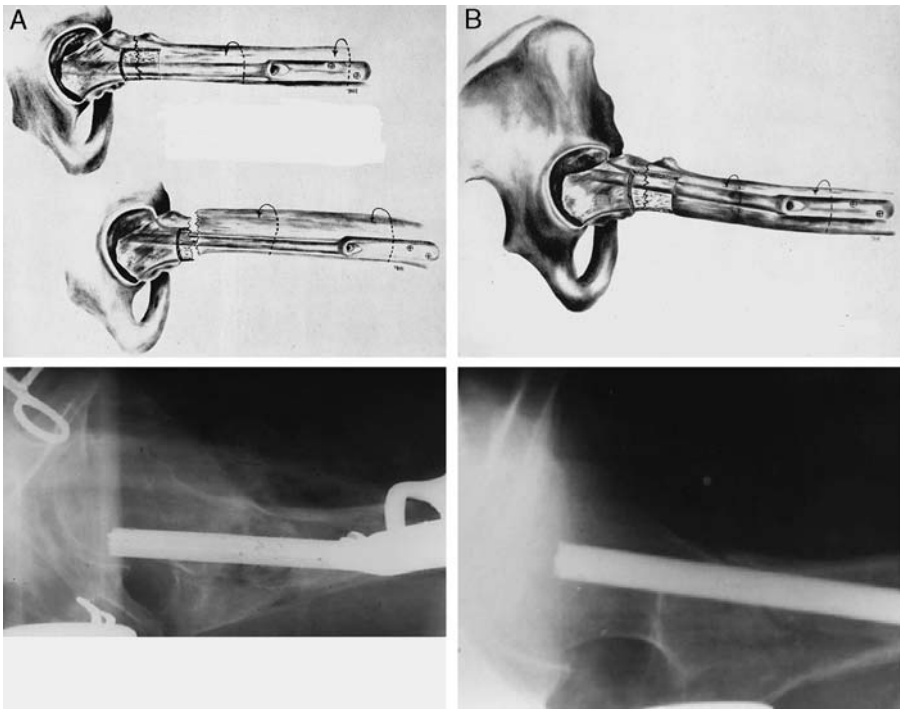

FIGURE 2. (A) The external rotation forces, which take place primarily at heel strike, tend to displace the nail anteriorly without opposition from the anterior cortex. (B) The placement of the nail close to the anterior cortex of the femur at the neck cannot migrate anteriorly because the cortex prevents further movement. Because of the normal anteversion of the femoral neck, a nail that enters the femur parallel to the ground ends up in the center of the head. (Reproduced with permission from: Sarmiento A. *J Bone Joint Surg.* 1963; 45A:706).

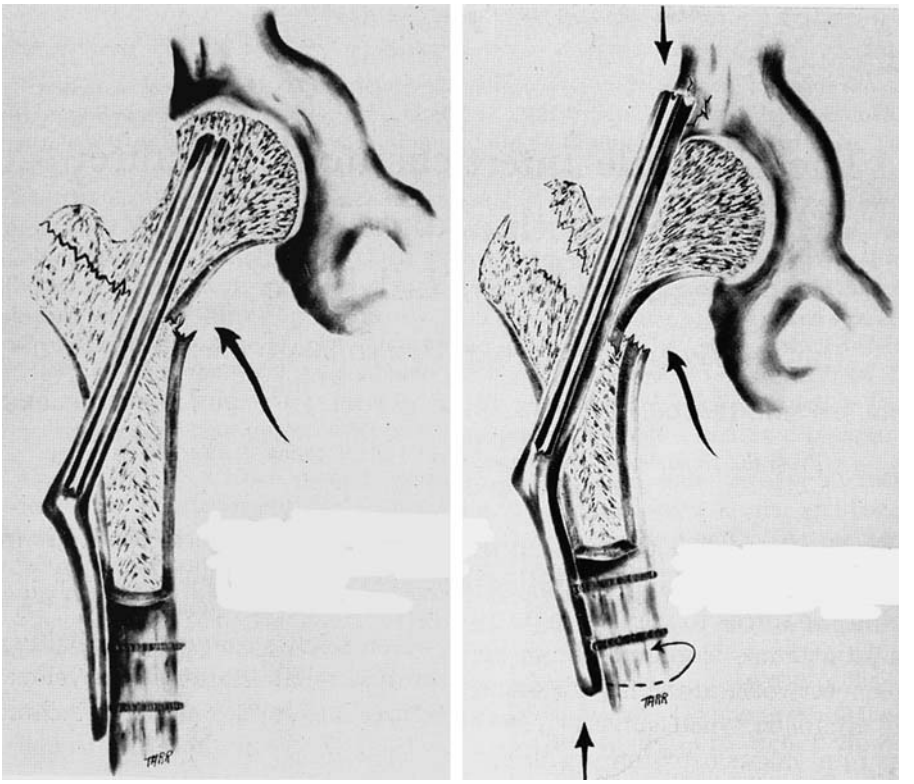

FIGURE 3. Illustration of the manner in which lack of medial/anterior contact between the two major fragments easily results in collapse of the fracture. (Reproduced with permission from: Sarmiento A. *J Bone Joint Surg.* 1970; 52A:1309).

FIGURE 4. Collapse of the intertrochanteric fracture treated with an interlocking nail can also take place when reduction of the medial cortex is not accomplished.

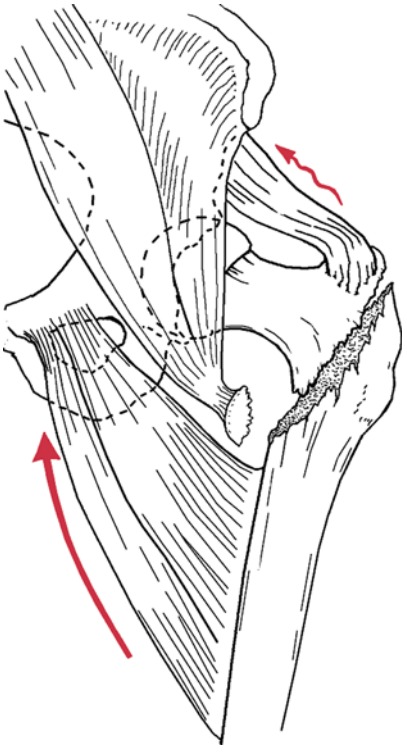

FIGURE 5. Illustration indicating that during the painful preoperative and postoperative stage, the abductor mechanism is in a relaxed condition, while the adductors are spastic.

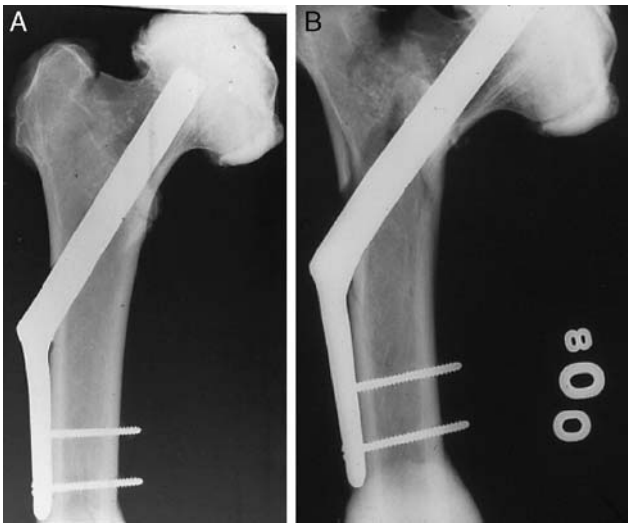

FIGURE 6. Cadaver bone with an artificially produced high intertrochanteric fracture nailed with a 150° angle nail. Collapse of the fracture occurred when 800 pounds of vertical load was applied, a load several times greater than the intrinsic strength of the nail.

cortex at the fracture site, major vertical forces well beyond the intrinsic strength of the nail, do not cause migration of the nail or collapse of the fragments (Figure 6).[6,7]

If the angle of inclination of the fracture is too vertical, the shearing stresses at the fracture site prevent maintenance of the reduction under weight bearing conditions. Such a fracture may be stabilized by a valgus osteotomy that changes its vertical inclination into a more transverse one and a resulting stable contact between the medial cortices of the two major fragments (Figures 7–9).[8]

CONCLUSION

The treatment of intertrochanteric fractures has undergone favorable evolution as a result of the success with intramedullary nailing. However, this procedure is not applicable to all such fractures, and the same basic pathophysiological and mechanical principles that govern the traditional nail-plate fixation equally apply to the intramedullary nailing technique. This brief article identifies what may be crucial precepts that determine the stability of intertrochanteric fractures and provide guidance regarding technical details that assist in decreasing postoperative complications. Restoration of contact between the medial/anterior cortices of the two major fractures is essential and so is consideration of the importance of the angle of inclination of the fracture, since a vertical one, regardless of its treatment, places the mechanical fixation in jeopardy. The anterior placement of the nail in the femoral neck, not in the femoral head, is important for the reduction of the harmful effects that external rotation forces have on displacing the nail anteriorly and in that manner causing the loss of the essential reduction of the anterior/medial cortex.

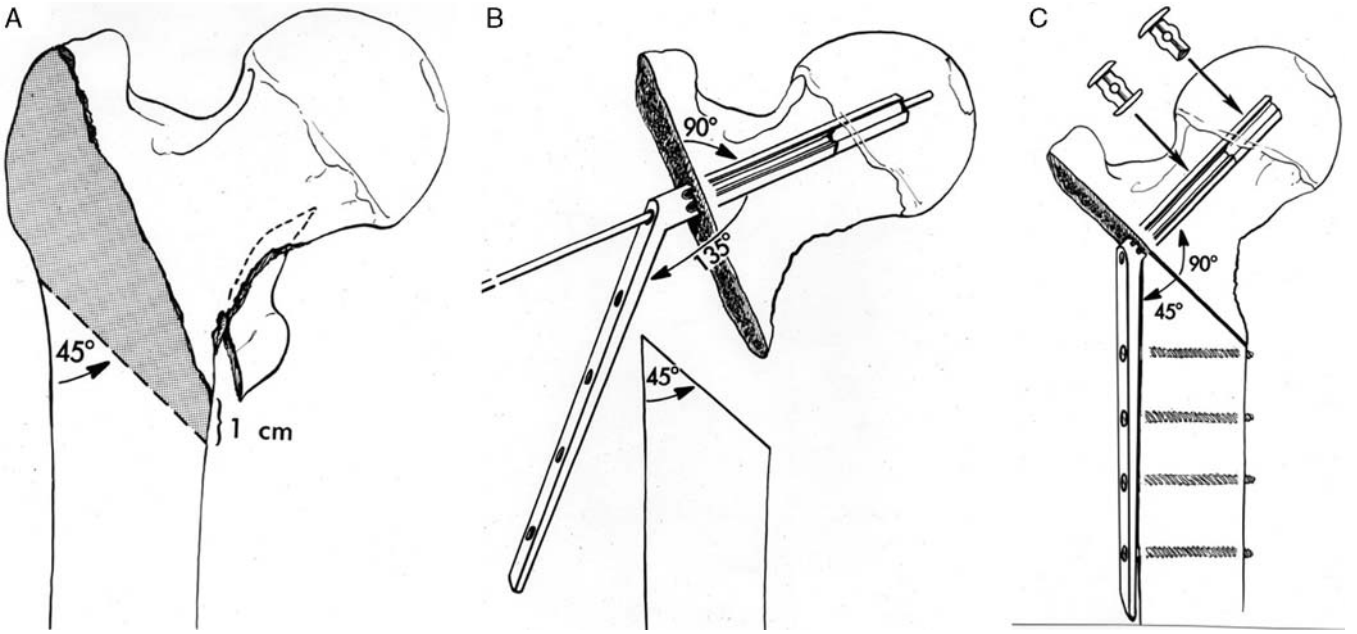

FIGURE 7. Schematic drawings of the valgus osteotomy that reduces the angle of inclination of the fracture and makes possible the approximation of the medial cortices of the two major fragments. (Reproduced with permission from: Sarmiento A. Valgus osteotomy technique for unstable intertrochanteric fractures, In: Amstutz HC, editor. The Hip, Proceedings of the third open scientific meeting of the Hip Society, St. Louis, CV Mosby; 1975).

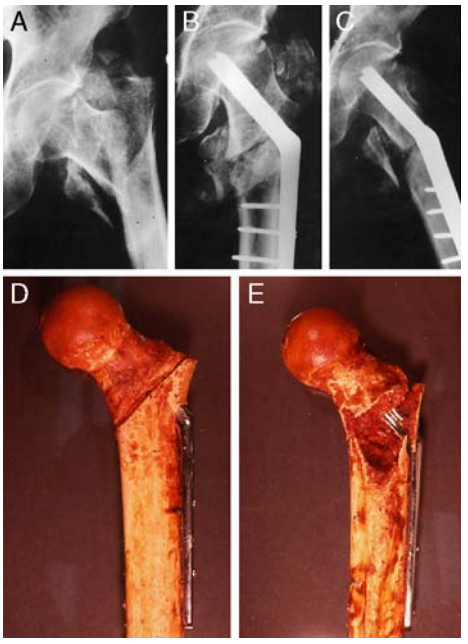

FIGURE 8. (A) Radiograph of vertical, comminuted intertrochanteric fracture. (B) Radiograph obtained in surgery after completion of a valgus osteotomy that reduced the angle of inclination of the fracture and restored contact of the anterior and medial cortices of the two major fragments. (C) Lateral radiograph of the proximal femur. Notice the free posterior fragment. (D) After the patient expired 24 hours after nailing procedure, the specimen showed the more horizontal direction of the fracture and the contact between the medial and anterior cortices. (E) The posterior surface of the femur showed the defect produced by the free posterior fragment. (A, B, D and E reproduced with permission from: Sarmiento A. Valgus osteotomy technique for unstable intertrochanteric fractures, In: Amstutz HC, editor. The Hip, Proceedings of the third open scientific meeting of the Hip Society, St. Louis, CV Mosby, 1975).

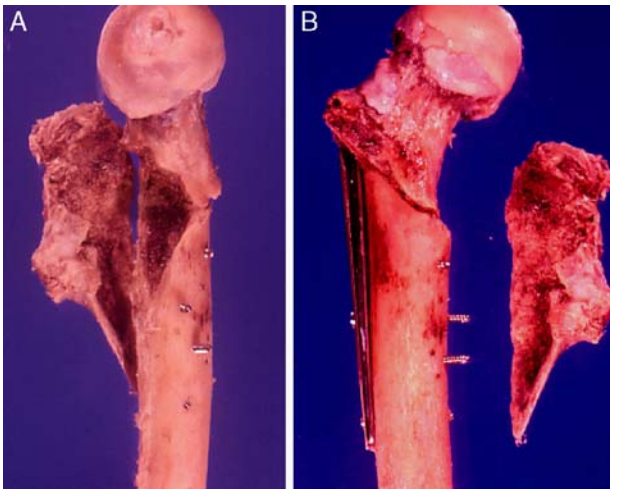

FIGURE 9. Specimen recovered in an autopsy study of the femur of a patient who expired a few days after the valgus osteotomy procedure. Notice the bone contact of the medial/anterior cortex and the large defect posteriorly, which is probably of minor importance.

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