**Introduction:** External fixation has been described as a viable treatment option for elderly osteoporotic trochanteric fracture patients (1). This treatment is not without advantages. It is minimally invasive, operative time is short, blood loss minimal and hospital stay brief. In addition, it is possible to adjust loading mode during treatment. In a recent comparative study of external fixation vs. sliding hip screw, better clinical results were reported with external fixation (2). However, the potential for pin loosening and infection limits its application. To improve pin osteointegration and fixation strength, hydroxyapatite-coated pins have been developed (3,4). In a clinical study of osteoporotic wrist fracture patients, hydroxyapatite-coated pins were better fixed than similar standard pins (5). In the present study, we addressed whether or not similar improvement in fixation strength could be achieved in a highly loaded weight-bearing situation such as osteoporotic trochanteric fractures.

**Methods:** Ten consecutive osteoporotic patients with trochanteric fracture were selected. Inclusion criteria were: female, age =65 years; AO type A1 or A2 hip fracture; bone mineral density (BMD) at the contralateral hip lower than -2.5 T score. Patients were treated with a pertrochanteric fixator and four hydroxyapatite-coated tapered pins. Pins were numbered 1 through 4, from proximal to distal. Two pins were inserted into the femoral head (positions #1 and #2) and two into the proximal femoral shaft (positions #3 and #4). Weight-bearing was as tolerated. All fixators were removed three months after surgery. Pin insertion torque was measured intraoperatively, and pin extraction torque at fixator removal. All pins were removed in outpatient facilities without general or local anesthesia. Pin track infection was evaluated according to Checketts and Otterburn. Femoral neck shaft angle was measured postoperatively and at 6 months. Following removal, one pin from each patient was selected at random for SEM and histologic analysis.

**Essential Results:** Average patient age was 82±7 years. Average BMD was 53±27. There were five A1 fractures and five A2 fractures. All fractures healed and no fixation failed. Femoral neck shaft angle was 130±3 postoperatively and 129±3 at 6 months. Harris Hip Score at 6 months was 54±17. Mean final pin insertion torque was 1967±1254 Nmm, mean pin extraction torque was 2770±1710 Nmm (p=0.001). Mean final insertion torque and mean final extraction torque were 1024±452 Nmm and 1250±923 Nmm respectively, for pin position #1; 1023±153 Nmm and 1712±1049 Nmm for pin position #2; 2655±1103 Nmm and 3917±613 Nmm for pin position #3; 3148±946 Nmm and 4266±1311 Nmm for pin position #4. Pin insertion and extraction torque was lower for pin positions #1 and #2, compared with pin positions #3 and #4 (p<0.0005). No pin track infection occurred. Microscopic analysis of the extracted pins showed no exposure of the metallic substrate and bone fragments attached to the coating (Fig. 1).

**Discussion:** The increasing number of patients with osteoporosis and the problems associated with fracture fixation in mechanically weak bone necessitates the development of innovative fixation methods. This is the first quantitative weight-bearing clinical study showing that hydroxyapatite-coated pins are well-fixed in osteoporotic trochanteric fractures, a major achievement in osteoporotic bone fixation. Pin insertion torque was shown to relate to pin position. The lowest pin insertion torque was found in proximally inserted pins and #2. These pins were implanted into the cancellous bone of the femoral head, where bone density is lower than in the femoral shaft. This finding confirms that pin insertion torque is influenced by bone density. Adequate fixation in osteoporotic bone is a challenge, especially in weight-bearing situations. Progressive deterioration of fixation strength is inevitable in osteoporotic bone fixed with standard pins and screws. This deterioration can result in lag screw cut-out, a severe complication of hip fracture fixation. In contrast, our study shows that hydroxyapatite-coated pins improve bone/pin fixation over time, as shown by an average pin extraction torque greater than the corresponding insertion torque (p=0.001). Pin extraction torque was lowest for pin positions #1 and #2, most likely due to the lower bone density of the femoral head. However, even in positions #1 and #2, overall fixation was adequate and no failure occurred. Fixation was strong enough to prevent pin cut-out and fracture redisplacement. Reduction was maintained over time, as there were no significant differences between the postoperative femoral neck shaft angle and the femoral neck shaft angle at 6 months. This is a positive finding, because failure to restore normal hip anatomy often occurs in elderly trochanteric fracture patients. Previous studies in normal bone showed that the increased fixation strength of hydroxyapatite-coated tapered pins corresponded to bone/pin contact, without fibrous tissue interposition (3). The biomechanical results of the current study indicate that pin osteointegration was achieved. This is confirmed by microscopic evidence of bone fragments attached to the screws. In conclusion, this is the first weight-bearing study offering quantitative clinical proof of the superior fixation ability of hydroxyapatite-coated pins in osteoporotic bone. Optimal fixation was achieved and there was no infection of the pin tracks. We recommend external fixation with hydroxyapatite-coated pins for osteoporotic trochanteric fractures. Furthermore, our findings can be applied to other fixation augmentation treatments in osteoporotic bone.

**References**

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