Efficacy of Injectable Calcium Composite Bone Substitute Augmentation for Osteoporotic Intertrochanteric Fractures: A Prospective Case-Control Study

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INTRODUCTION: Femoral intertrochanteric fractures (ITFs) in older adults are associated with a substantial risk of mechanical failure after fixation, which can lead to persistent pain, delayed mobilization, and increased mortality. Injectable calcium composite bone substitute (ICCBS) augmentation has been proposed as a strategy to enhance construct stability and promote bone healing, but clinical evidence remains limited. The purpose of this study was to evaluate the efficacy of ICCBS in the man-agement of osteoporotic ITFs.

METHODS: We conducted a multicenter prospective case-control study of patients undergoing surgical fixation for osteoporotic ITFs using proximal femoral nails. Patients who consented to augmentation received ICCBS(n=59), while the control group underwent standard fixation alone(n=64). Demographic and injury related variables were documented, and outcome data were prospectively collected. The primary outcome was time to radiographic bone union, while secondary outcomes included functional recovery (pain and ambulatory status) and complications, including fixation failure.

RESULTS SECTION: The mean time to radiographic bone union did not differ significantly between groups ($p = 0.324$). However, patients receiving ICCBS augmen-tation reported significantly lower postoperative pain scores between 2 and 8 weeks and demonstrated reduced lag screw sliding and varus collapse at the time of bone union. There were no significant differences in complication rates, fixation failure or ambulatory status at last follow up between the two groups.

DISCUSSION: In a prospective multicenter CMN-only cohort, $CaSO_4$/CaP augmentation yielded less sliding/varus and better early pain/ambulation, with similar union times. This supports a front-loaded, interface-stabilizing effect of an osteoconductive, void filling graft that reduces micromotion and facilitates early mobilization. Although non-random allocation and center effects remain, ICCBS looks like a pragmatic adjunct to enhance early recovery without added safety concerns; larger randomized or center stratified evaluations are needed.

SIGNIFICANCE/CLINICAL RELEVANCE: (1-2 sentences): Augmentation improved early pain, ambulation and construct stability without increasing complications, directly supporting mobilization under CMN fixation for osteoporotic intertrochanteric fractures. Greatest clinical value is expected in unstable patterns, residual metaphyseal voids or poor bone quality, where early interface stabilization can enable early recovery.

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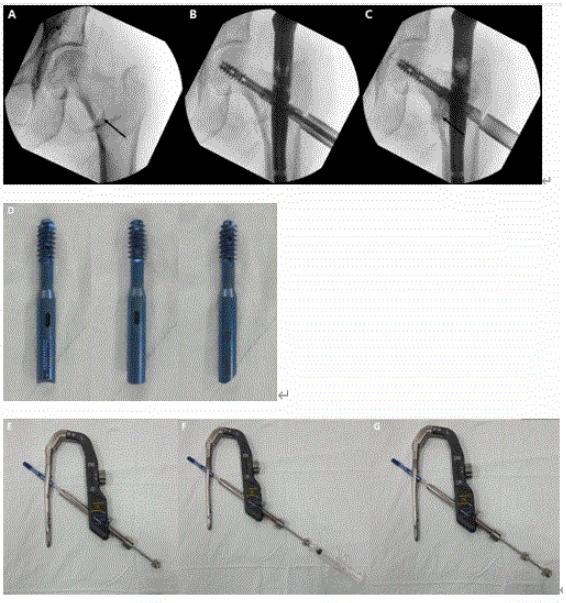

Fig1. Intraoperative technique and instruments for ICCBS augmentation during cephalo medullary nailing of intertrochanteric fractures.
(A) Pre-injection anteroposterior fluoroscopy after reduction, showing the femoral head neck region; a metaphyseal void along the intended head-element track is indicated (arrow). (B) Final position of the cephalomedullary lag screw within the femoral head under fluoroscopic guidance. (C) Delivery cannula docked to the lateral sleeve and injection of the calcium-based composite through the fenestrated head element; radiopaque fill within the head–neck trabecular bone is seen (arrow). (D) Fenestrated lag screws with circumferential ports that permit ICCBS delivery. (E) head element seated; (F) syringe connected to the injection port and material delivered under fluoroscopic control; (G) final construct after completion of augmentation.

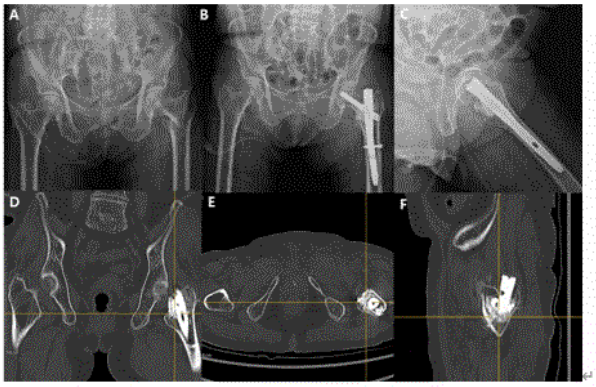

Fig.3 Pre- and post-operative imaging demonstrating cephalomedullary nailing with injectable calcium-based augmentation.
(A) Preoperative anteroposterior (AP) pelvis radiograph showing an intertrochanteric fracture of the left femur. (B) Immediate postoperative AP pelvis view after cephalomedullary nailing. (C) Lateral postoperative view of the proximal femur; radiopaque material is visible along the head–neck track, consistent with ICCBS delivery via the fenestrated head element. (D–F) Multiplanar postoperative CT reconstructions—(D) coronal, (E) axial, and (F) sagittal planes—confirm circumferential, cloud-like distribution of the augmentation around the head element within the femoral head/neck, without intra-articular or extraosseous leakage. (AP, anteroposterior; CT, computed tomography.)