Efficacy of Prophylactic Augmentation with an Intramedullary Nail for Hip Fracture Prevention in a Sideways Fall Scenario

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The objective of this study was to assess the effect of prophylactic implantation of an intramedullary nail on fracture outcome in a sideways fall from standing impact.

Geriatric hip fracture presents a tremendous burden on society with almost 1.6 million incidents annually worldwide[1] and high morbidity and mortality rates. The immediate strengthening of a vulnerable femur to protect against hip fracture (called prophylactic augmentation) has been investigated in multiple biomechanical studies and demonstrated as plausible in some clinical trials; however, its use is not yet widespread in the clinical community. In this study, we aimed to assess the affect of prophylactic augmentation with a commercial fracture fixation system in a realistic sideways fall impact, an injury scenario known to cause geriatric hip fracture[2].

Six fresh-frozen human cadaveric hip joint pairs (whole pelvises from S1 to the mid-shaft femur; 3M:3F, average age 76.2±7.4 years and BMI of 19.9±6.2) were obtained for this study. Each specimen was dissected down to the bone (preserving joint capsules and pelvis ligaments), mounted in a fall alignment per previously described methods[3], and scanned with a clinical computed tomography (CT) scanner. In the *ex vivo* augmented group, an orthopedic surgeon (PG) implanted an intramedullary nailing system (Gamma3, Stryker Inc., Kalamazoo, MI) in the intact femur on the impacting side of each specimen. Each specimen was encased in a surrogate soft tissue material in a subject-specific shape and subjected to a fall impact at 3.1 m/s onto a force plate. After testing, specimens were inspected for fracture after removal of the soft tissue surrogate. For the control group, CT scans of the native specimens (taken before augmentation) were used to build matching finite element models (FEMs) of the specimens per a previously validated method[4]. Explicit FEM simulations were run using LS-DYNA software and bone fracture was determined to have occurred when bone element strains exceeded pre-determined tension and compression thresholds.

To assess augmentation efficacy, post-fall fracture outcome was compared in terms of severity between the augmented *ex vivo* group and the control FEM group.

No signs of fracture in the femur on the impacting side (indicating hip fracture) were found in the augmented group. However, two augmented specimens showed fractures on the impacting side of the pelvis at the ramus and pubic root. For the control group, FEMs indicated femoral neck fractures in two specimens and pelvis fractures in the rest. On a per-specimen basis, fracture status remained unchanged or lowered in severity when the augmentation was introduced.

These results suggest that prophylactic augmentation with an intramedullary nail may prevent hip fracture, but would not have any influence on reducing the likelihood of pelvis fracture. Nevertheless, pelvic fractures may be a more preferable clinical outcome compared to hip fractures, due to a reduced need for surgical intervention[5]. This work provides a robust biomechanical evaluation of prophylactic augmentation of the femur with an orthopedic implant already familiar to trauma surgeons, which may broaden the options currently considered for the clinical prevention of hip fracture.

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