Hip fractures in geriatric patients are associated with mortality rates of 20-30% at one year. Many more patients experience significant loss of function and independence (1). The number of hip fractures worldwide was estimated at 1.7 million (1990) and is expected to rise to 6.3 million by 2050 (2).

Preventing Hip Fractures
One of the strongest predictors of hip fracture is a prior hip fracture. This is particularly true if a preventative osteoporosis intervention is not pursued after the patient’s first fracture. The risk of a second fracture in the patient’s uninjured hip remains high even if appropriate treatment for osteoporosis is initiated, due to the lag between initiation and actual fracture risk attenuation. The current primary standard of care for preventive intervention is medical management to reduce the rate of progressive osteoporosis. Common fracture prevention modalities include the use of bisphosphonates, vitamin D, calcium supplementation, and fracture precautions. However, bone sparing medical protocols such as the use of bisphosphonates do not guarantee bone density restoration and have recently become associated with increased risk of atypical fracture patterns, particularly around the subtrochanteric area of the femur (3). Other options for osteoporosis management such as the use of PTH agonists for bone restoration also carry potential risks (4). Non-medical preventative measures include fall prevention techniques, use of cushioning pads and reorganization of living space.

Prophylactic Interventions
These limitations of medical management for fracture prevention have promoted interest in interventional procedures to reduce hip fracture risk. Prophylactic fixation of fractures with traditional fracture repair instrumentation has been suggested, but is not cost-effective and carries significant surgical risk (5). There is recent interest in developing cost-effective interventional techniques to augment the mechanical properties of the proximal femur. Following the successful experience with vertebroplasty, various minimally invasive femoroplasty techniques involving introduction of fillers such as polymethylmethacrylate (PMMA), elastomeric polymers or calcium phosphate products into the osteoporotic proximal femur have been described (6,7), but are not routinely performed in patients.

Currently, there is no standard of care for femoroplasty procedures in the United States. While in vitro biomechanical results with femoroplasty have demonstrated increased peak loads and yields to fracture, they do not correlate with fracture prevention, and few studies have simulated fall stresses (8). Results in general have been disappointing, and none of the methods have been recommended for patient use in the US or Europe.

Anistropy Restoring Femoroplasty (ARF)
In collaboration with Dr. Ara Nazarian at the Center for Advanced Orthopedic Science at the BIDMC, we are exploring the
concept of Anisotropy Restoring Femoroplasty as a minimally invasive interventional option for hip fracture prevention. We have developed a technique and device that partially restores the material anisotropy of the proximal femur with a polymeric or Ca-phosphate filler. This composite structure, consisting of metallic elements embedded in an isotropic filler, restores both shear and axial energy dissipation potential to the proximal femur beyond what is possible with isotropic filling of the proximal femur. The technique allows for minimally invasive insertion of an antegrade ARF device from the greater trochanter combined with retrograde ARF device from the lesser trochanter, both interlinked within a Ca-phosphate (Ca-P) filled proximal femur, each inserted through separate 5 mm drill holes (Figure 1).

We are presently testing a prototype device in a pig femur model (Figure 1) that has optimistic early results when compared with isotropic femoroplasty alone. Insertion of our ARF prototype device with calcium phosphate in a de-trabeculated pig femur is isotropic femoroplasty alone. Insertion of our ARF prototype device with calcium phosphate in a de-trabeculated pig femur is inserted through separate 5 mm drill holes (Figure 1).

Summary
We envision ARF could be indicated for patients at high risk for hip fractures or as a procedure performed during the same surgical session on the intact contralateral side of a patient presenting for ORIF of a hip fracture.

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References