Introduction

- Hip fracture risk during a fall can be modulated through impact dynamics and/or underlying femur morphology [1]
- Risk assessment efforts have focused on the latter
- An approach sensitive to both skin-surface impact dynamics as well as underlying femur morphology could provide additional insight into the mechanical nature of clinical risk factors

Purpose: Evaluate the influence of fall simulation paradigm (FSP), sex, and trochanteric soft tissue thickness (TSTT) on femoral neck stresses and fracture index (FRI)

- Insights gained through coupling of experimental data and tissue-level models could inform the development of protective devices and increase the accuracy of clinical screening tools

Methods

- 33 young adults (16 male) were stratified into TSTT groups via ultrasound imaging (Figure 1)
- A series of FSP and dual-energy x-ray imaging (DXA) were utilized to enable estimation of femoral neck stresses and FRI

Fall Simulations:
Participants completed a series of FSP (Figure 3), encompassing the variability of falls observed in older adults. Kinematics and kinetics of the impacting (left) thigh were collected. At the instant of peak force, the net impact vector orientation, anatomical point of application, and local force magnitude over the greater trochanter (circular r = 5 cm) were extracted.

Modelling: Participants underwent left hip DXA imaging. Participant specific beam models were generated through extraction of femur morphology [2] and application of experimental loading conditions. Femoral neck stresses at the superior-lateral (SL) and inferior-medial (IM) cortices, as well as a cross-sectional FRI were calculated for each experimental fall simulation (Figure 4).

Discussion

- FSP, sex and TSTT had independent effects on metrics of impact severity and femur strength
- Towards mirroring contributing factors, hip fracture risk analyses should consider both impact dynamics and underlying femur morphology
- The current results support epidemiological findings suggesting TSTT is a protective factor against hip fracture; however, sex differences in fracture risk are likely driven by age related changes in femur morphology not included in this analysis
- Based on the apparent importance to fracture risk, future work should aim to quantify the translation of skin surface pressure distributions to impact energy delivered to the proximal femur
- The framework developed in this study could be utilized in the design of impact mitigating protective devices

References