Background

- Household falls are a common accidental injury mechanism as well as a common falsely reported cause in cases of abuse.
- In non-ambulatory children, femur fractures are more likely to be due to abuse.
- Clinicians must be able to delineate between abuse and accidental injuries.
- Currently little biomechanical evidence to distinguish accidental and non-accidental injuries.

Methods

- A post-mortem diagnostic CT scan of 11-month old child was used to derive a 10-node tetrahedron femur model meshed in 3-matic (Materialise, Ann Arbor MI). (341736)
  - Applied a linear material model
  - Analyzed in ANSYS Workbench (ANSYS Inc., USA) (Figure 2) using applied femur loads and constraints representing those in ATD fall experiments.
  - Subset of trials run. Recorded outcomes for each trial: Maximum principal stress and strain
  - ANOVA of factors (impact surface and fall dynamics, Table 1) for each fall type on peak stress and strain (α = 0.05)

Results

**Bed Fall**

- Difference in peak stress and strain:
  - Fall Dynamic (A): Lower leg impacting first is greater than upper leg impacting first (p-value ≤ 0.026)
  - No difference due to impact surface
- Peak FE predicted outcomes for trials exceeding fracture thresholds associated with peak bending moments (14-22Nm) and compression

**Feet-First Fall**

- Difference in peak stress and strain for:
  - Fall Height: Greater for 119cm height
  - No trials exceeded any fracture threshold
- Peak FE predicted outcomes associated with peak torsional or bending loads

Conclusions

- Increased femur fracture potential represented by increased peak FE predicted outcomes are associated with:
  - Lower leg impacting first in bed falls
  - Falls from greater heights in feet-first falls
  - 50% of evaluated bed falls had a potential for fracture
- No evaluated feet-first falls had a potential for fracture

Future Work:

- Addressing limitations of FE model and analysis
- Improving understanding of representative dynamics of children falling through observation or more detailed clinical case histories
- Expansion of model and analysis to other healthy, one year old subjects

Clinical Relevance:

- Bed falls may generate loads associated with femur fracture potential
- Results indicate importance of detailing fall dynamics in histories when attempting to delineate between accidental and abusive diaepiphysial femur fractures

**Limitations**

- Material application: linear model and no consideration of effect of strain rate
- Lack of studies defining pediatric mechanical properties, especially applied to FE models
- Stress-based thresholds are usually defined by density relationships
- Elements exceeding thresholds are in higher density regions
- Lower resolution CT scan used to derive model
  - Can result in higher peak strains on surface of model due to partial volume effects