Characterizing the stiffness change of the proximal femur between quasi-static and dynamic loading in a fall configuration

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Introduction

\begin{itemize}
  \item Detect – Prevent – Treat
  \item Detection is key to prevention
  \item \textit{aBMD} predicts <30\% of fractures [1].
  \item New imaging may change that – we need to be prepared!
  \item Understand mechanism
  \item Current lab models are quasi-static.
  \item Clinical fractures are dynamic.
\end{itemize}

Objective

To determine if loading behaviour of the proximal femur is different under quasi-static loading and simulated fall conditions.

Methods

\begin{itemize}
  \item 17 fresh frozen femurs \textit{DXA} scanned.
  \item Tested at 0.5 mm/s in a materials testing machine to 50\% \textit{DXA} predicted failure.
  \item Tested in a fall simulator with impact at 3 m/s [2].
  \item Fall simulator body representation:
    \begin{itemize}
      \item Body mass – 32 kg [3]
      \item Soft tissue – 18 mm foam [3]
      \item Pelvis – 50 N/mm spring [3]
      \item Pelvis & femur inertia compensation [4]
    \end{itemize}
\end{itemize}

Results

\begin{itemize}
  \item Higher \textit{DXA} femurs became stiffer when tested in the fall simulator ($p = 0.015$).
  \item Stronger femurs became stiffer when tested in the fall simulator ($p < 0.001$).
  \item Energy absorption to fracture was not different when grouped by relative stiffness ($p = 0.16$).
\end{itemize}

Conclusion

Proximal femur loading mechanics are affected by the testing method in a significant way. Intrinsic properties (e.g. \textit{DXA}) play a part in determining how the bone will react to different loading scenarios.

References