



IBTN-USA

*“In vitro Comparison of Head-Neck Taper Junction
vs. Bone-Stem Interface Fretting Corrosion in a Total
Hip Arthroplasty Model”*

Maria João Runa¹

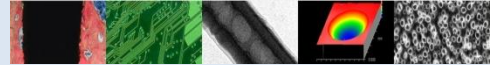
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2/21/14

Motivation



Fretting

Corrosion



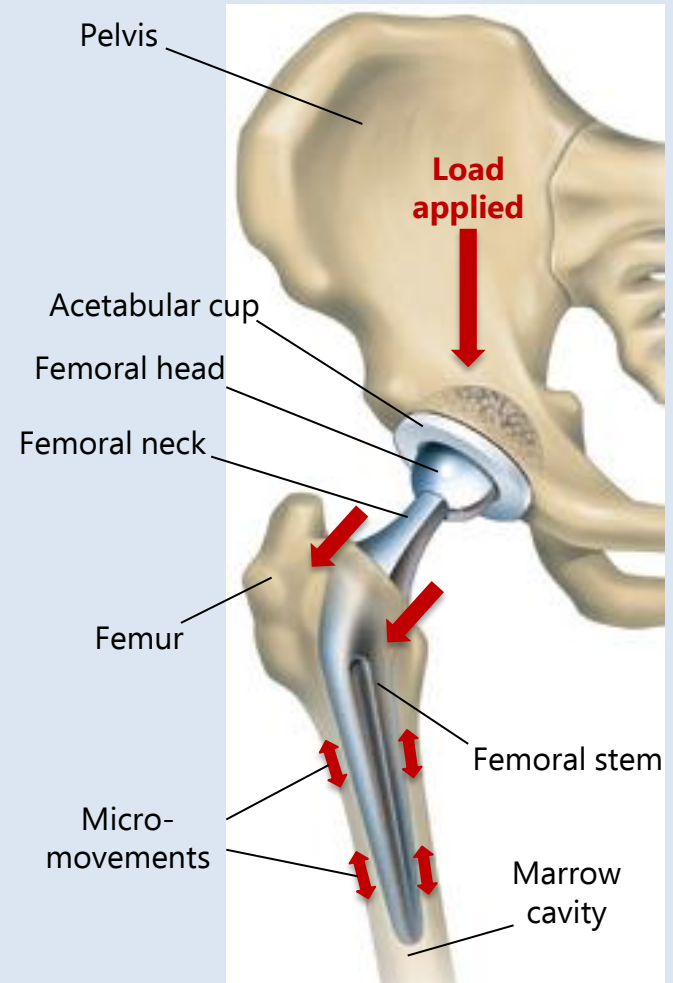
Cyclic loading
Small amplitude
movements (1-100 μ m)

Synovial fluid

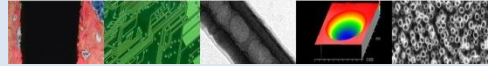


DEGRADATION of the
material

- Release of metal ions and wear debris
- Inflammation
- Osteolysis
- Crack initiation
- Loosening of the implant

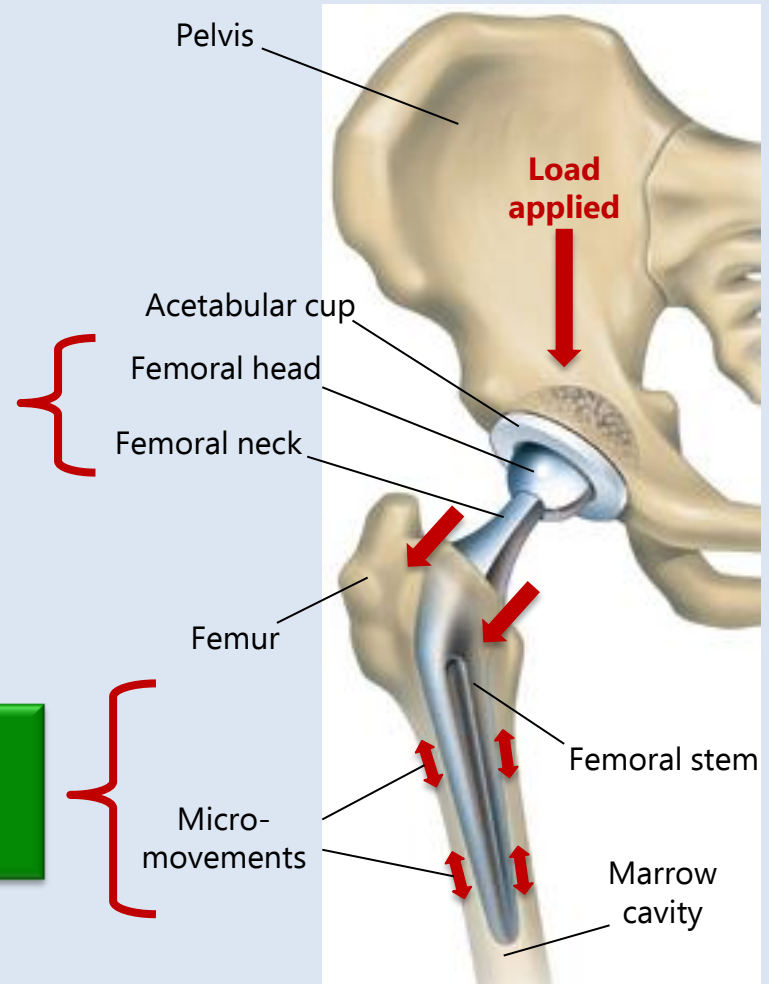


Motivation



Modular
Junctions
(Head-Neck
interface)

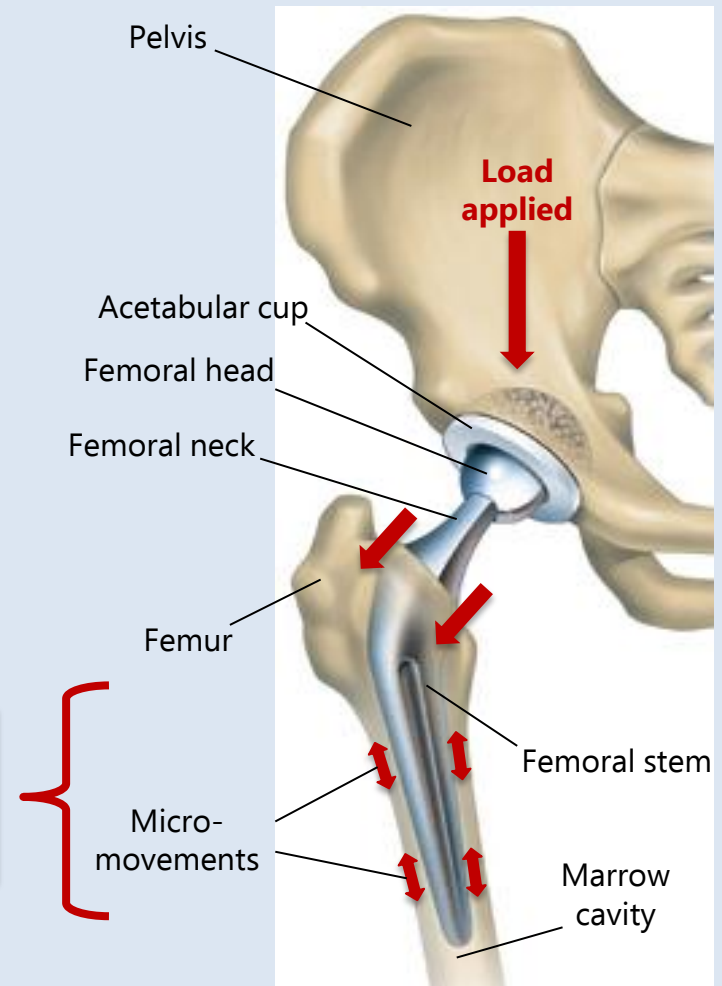
Bone-Stem
interface



Motivation

Hypothesis: The amount of fretting-corrosion that occurs at the Bone-Stem interface is greater than at the Head-Neck taper junction*.

Goal: Measure the **OCP voltage drops** associated with low and high loads at the bone-stem (Ti6Al4V alloy) interface.



Experimental details

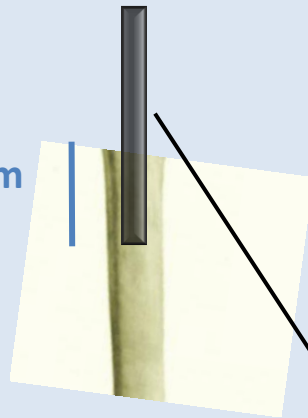
Bone-stem fretting systems:

Porcine femur bone

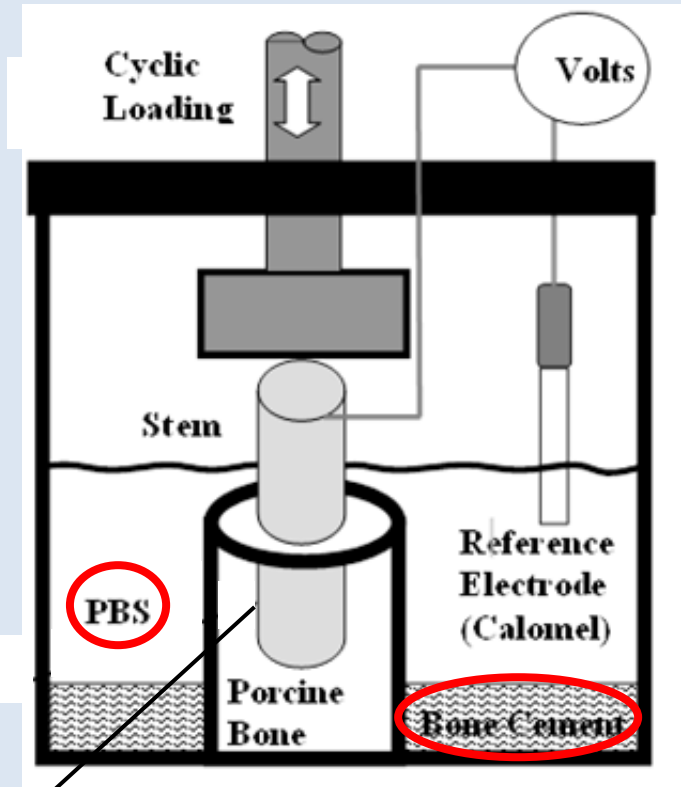


- Cut epiphysis
- Drill a hole in the marrow cavity ($\text{\O}:18.5 \text{ mm}$)

$\approx 2 \text{ cm}$



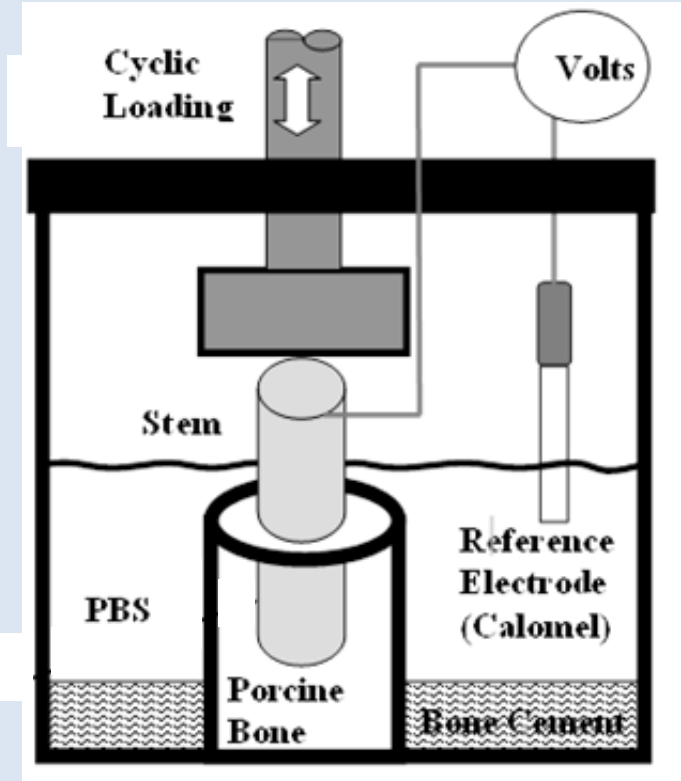
Ti6Al4V rod
 $\text{\O}:18.5 \text{ mm}$



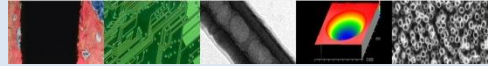
Experimental details

Bone-stem fretting systems:

- **Insertion test:**
 - Rate of 10mm/min up to 2cm press fit
 - 8800 Instron test frame
- **Cyclic loading test:**
 - **Stage (1):** low load (100N-500N)
 - **Stage (2):** higher loads (500-2000N)
- **Electrochemical measurements:**
 - Open circuit potential (OCP)
 - WE - Ti6Al4V rod
 - RE - SCE



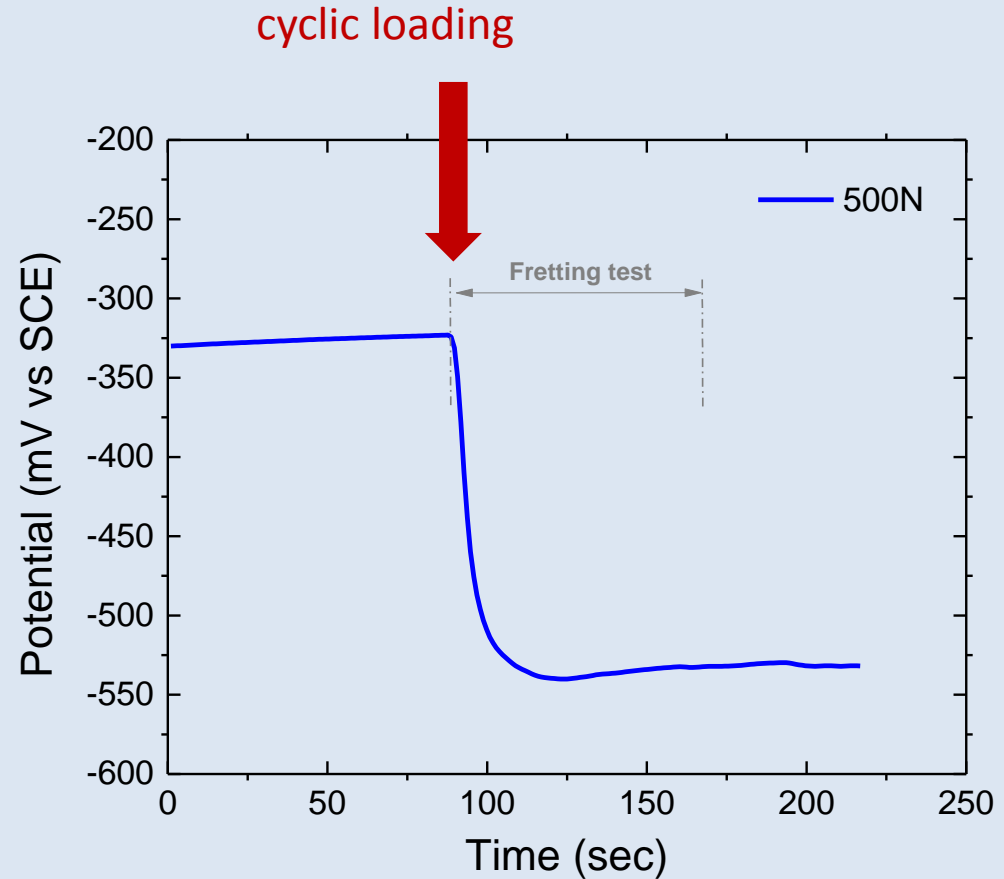
Results



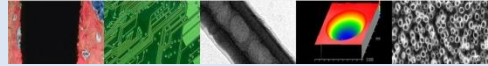
Evolution of potential:

Potential (voltage)
drop induces fretting
corrosion

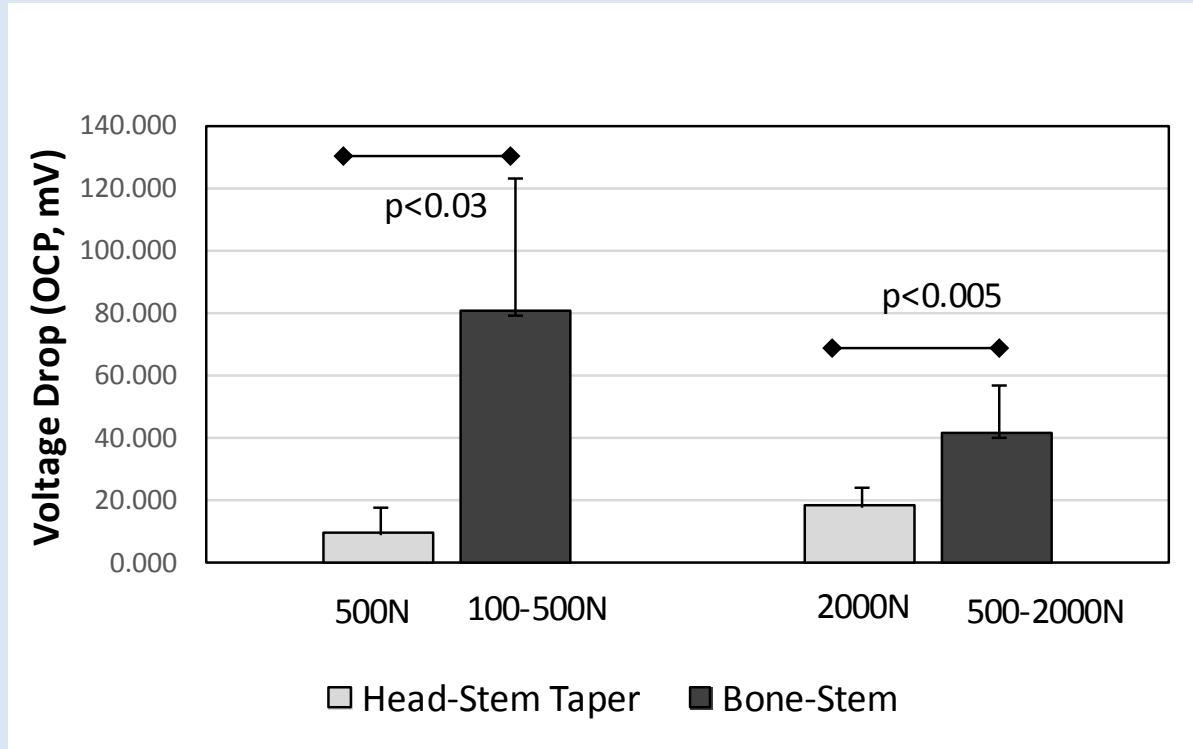
OCP drop
215mV



Results

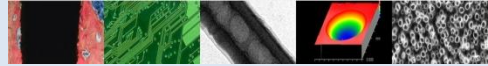


Potential drop: head-neck* vs. bone-stem



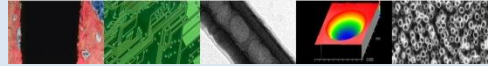
Fretting-corrosion at the **Bone-Stem interface** was significantly greater than at the Head-Neck taper junction.

Summary



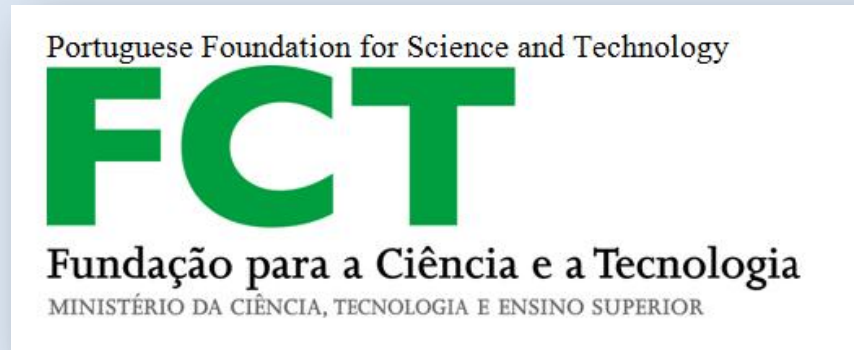
- **Hypothesis** supported.
- **Press-fit into femoral bone**: free potential behavior is strongly dependent on the unique morphology of the bulk bone and the unique contact areas of Ti6Al4V stem.
- Amount of fretting-corrosion at the bone-stem interface is higher than that previously reported for metal-on-metal taper junction [1].
- The identification of fretting-corrosion behavior at **two locations** of hip implants may indicate critical instability of the electrochemical system, where the **synergistic interaction** of fretting and corrosion may accelerate degradation mechanisms in some patients.

Future Work



- Fretting-corrosion in **sawbones** (polyurethane foam with properties similar to trabecular bone)
- Perform **EIS tests**
- Perform **potentiostatic tests** (applied potential)
- **Synergism** between corrosion and wear mechanisms.

Acknowledgements



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Questions?

