From Loosening to Lasting: Bioactive Solutions for Hip Implants

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Background

- Aseptic loosening is a leading cause of failure in total hip arthroplasty (THA), accounting for approximately 58.3% of revision surgeries [1].
- Wear particles lead to inflammatory responses, causing loosening and instability

Design

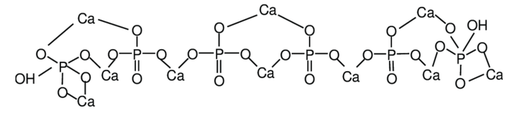
- Wider stem and neck to evenly distribute mechanical loads across femur prosthetic features. [2]
- Grooves along the femoral stem increase contact area between bone and implant, increasing effectiveness of osseointegration [3].

Material

- New implant made of carbon fiber-reinforced polymer composites (CRPC).
- Unlike metal implants, CFRPCs are resistant to corrosion and do not release ions or particles that would further osteolysis [4].

Bioactive Coating

- Coating femoral stem with hydroxyapatite (HA) would enhance bone growth.
- HA promotes greater bone-implant bonding, facilitating stronger integration [5].



Patient Profile

Name: Ke Huy-Quan **Weight:** 111 kg
Age: 51 **Sex:** M

- Overweight; sedentary lifestyle
- Severe pain in hip joint
- Notable reduction in bone density at femur
- Diagnosed with aseptic loosening

A B

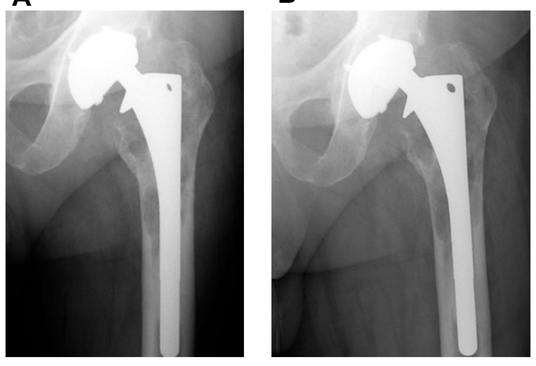


Figure 1: X-ray radiographs of patient's left hip **A)** 5 years, and **B)** 7 years after hip replacement.

Aims

- Develop a novel solution for aseptic loosening due to osteolysis for patient.
- Should provide relief to pain by not causing further osteolysis and properly supporting weight.

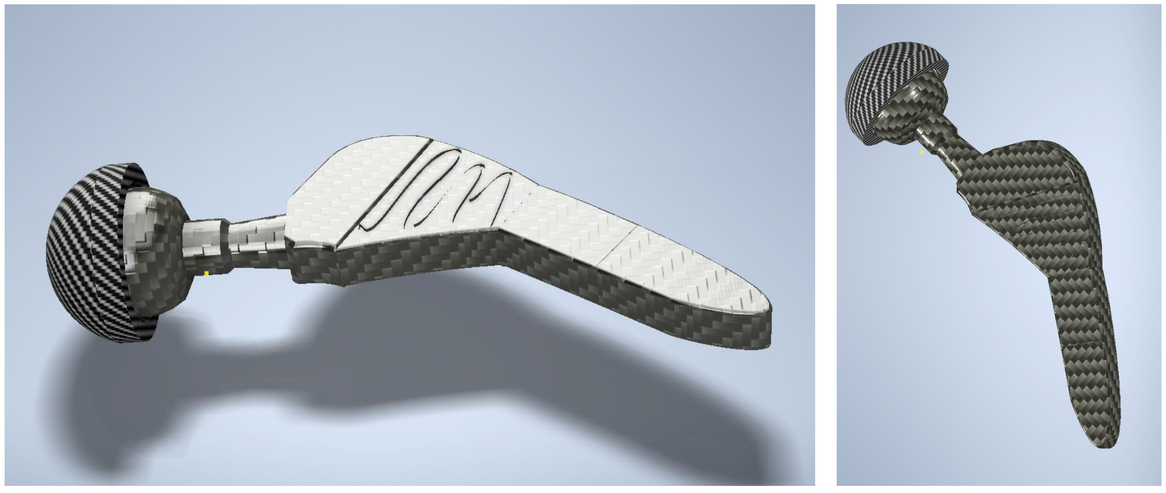


Figure 2: CAD Model of new hip implant design.

Strength Testing

- Ultimate tensile strength (UTS) modelled maximum strength bone could withstand until fracture.
- Resultant stress measured stress experienced by bone under a certain applied load.
- UTS intersects with resultant stress at ~28 years, indicating estimated time after surgery to reach fracture.

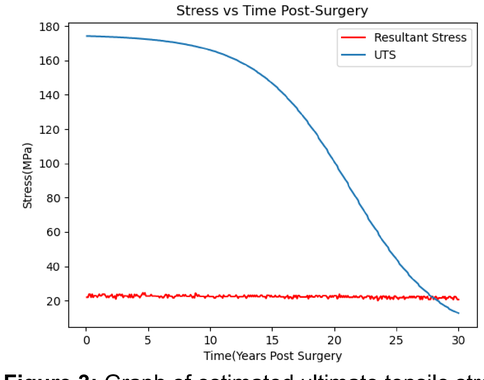


Figure 3: Graph of estimated ultimate tensile strength (UTS) over time.

Surgical Fixation

- Femoral canal reamed to prepare cavity for implant, remaining fragments from previous implant removed
- Implant carefully press-fitted prepared femoral canal

Limitations

- Reduction in stress by most deteriorated part of femur could lead to slowing of bone growth in that region
- CRPCs are expensive materials to procure

References

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