Design of Facet Joint Resurfacing Bearings for Tribological Testing Purposes

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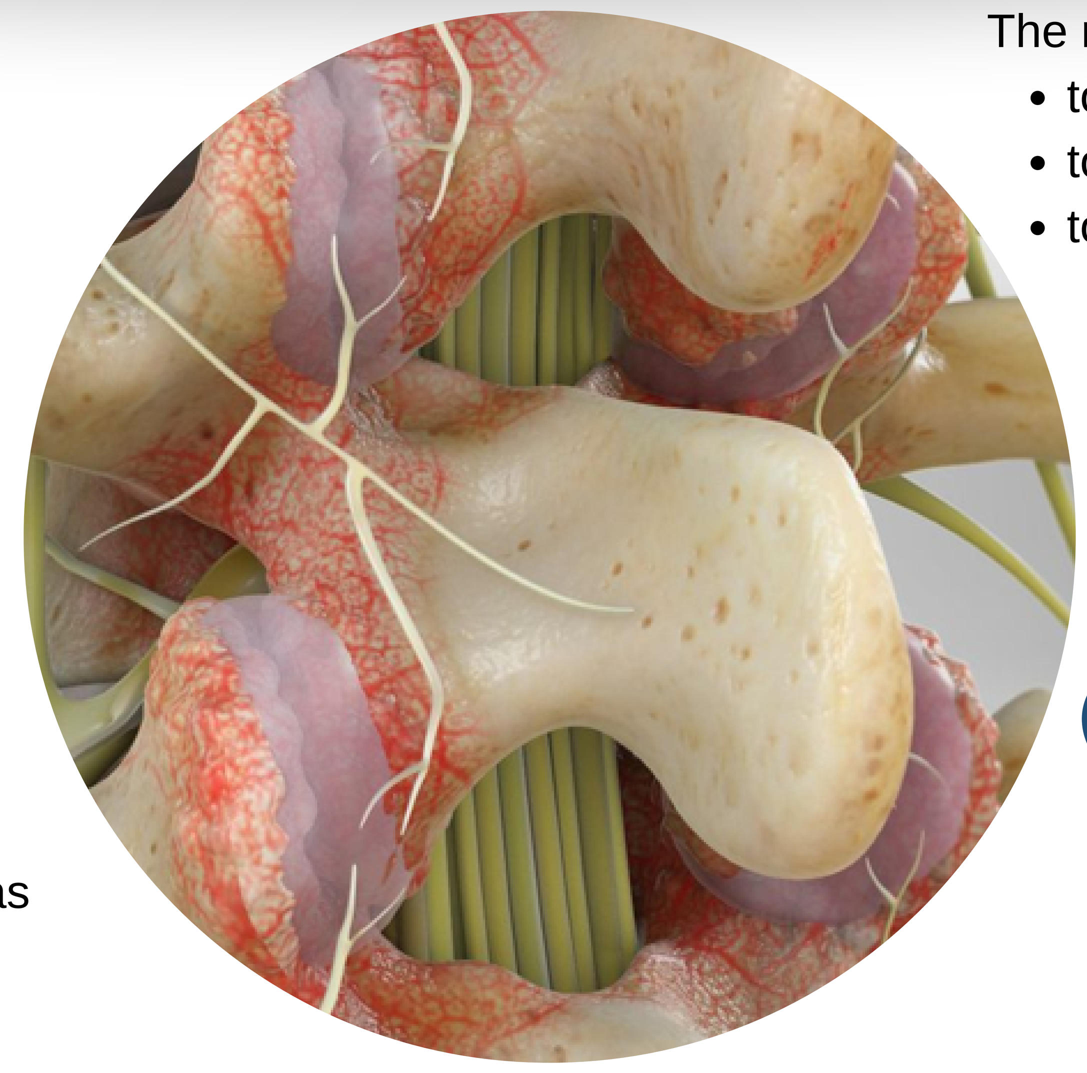
Introduction:

Up to 65% of individuals experience neck pain in their lifetime [1].

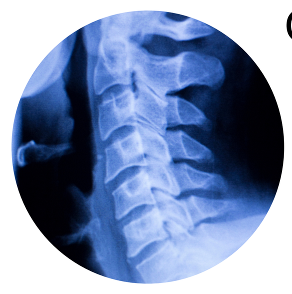
The facet joints play a pivotal role in back and neck pain, a condition that has been a leading cause of global disability since 1990 [2].

The global spinal implants & devices market size was valued at USD 12.4 billion in 2021 [3].



The main functions of the facet joints (FJs) when healthy:

- to provide support
- to sustain stability in the spine
- to limit end-range motion



Common facet-related problems:

- osteoarthritis
- spinal stenosis
- degenerative spondylolisthesis
- trauma

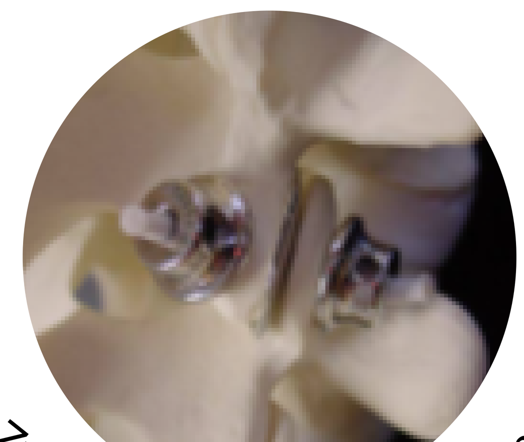
Outcome:

- Leg/back/neck pain
- Spinal instability
- Neurologic injury
- Further degeneration of the facet joint

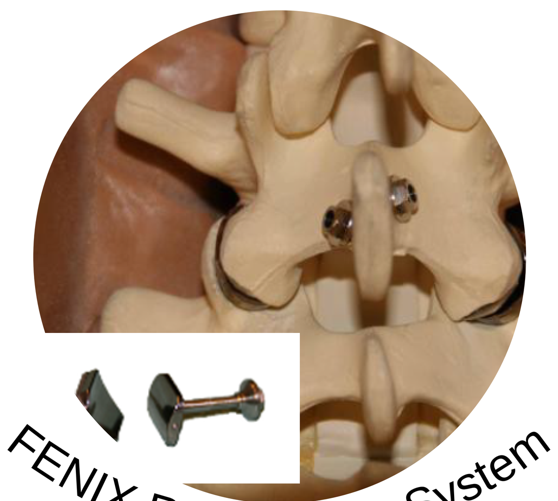
Gaps in the Literature:

- A facet resurfacing system design focusing on the cervical spine (neck)
- A standard guide describing a wear testing method for cervical facet joint replacement system
- Tribological testing rig design to assess tribological characteristics of the resurfacing bearings.

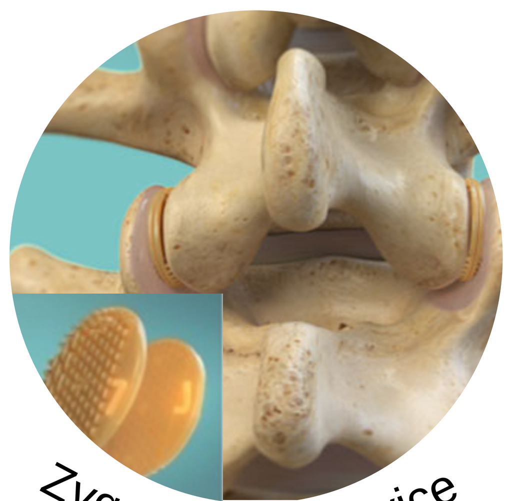
Aim: to design, manufacture and test (tribologically) a motion and tissue sparing facet joint device.



Zyre Facet Implant System



FENIX Resurfacing System

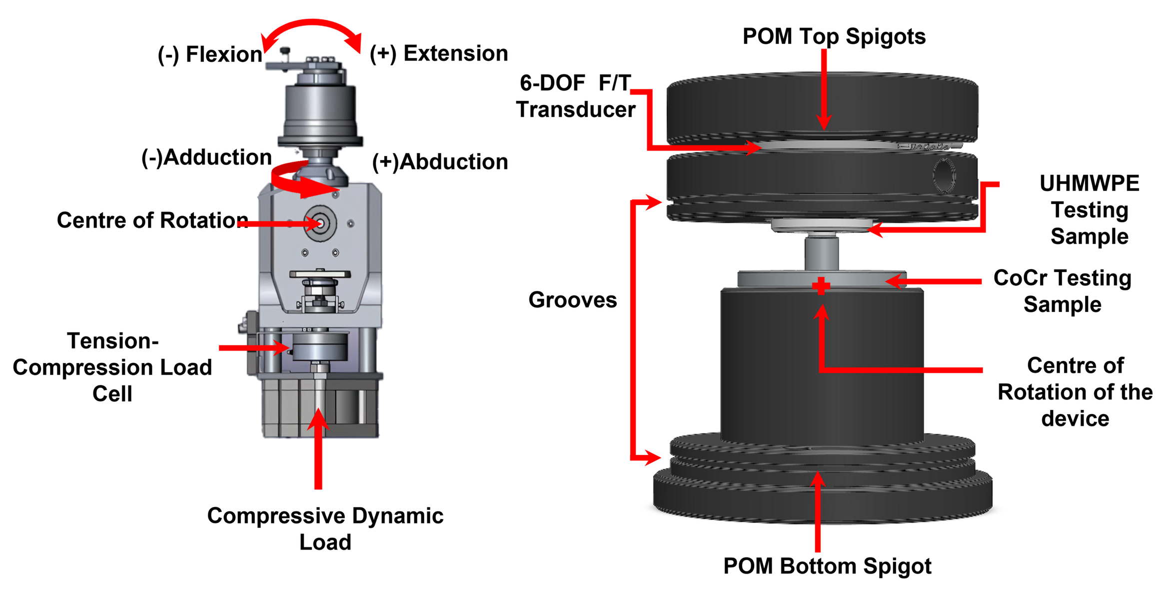


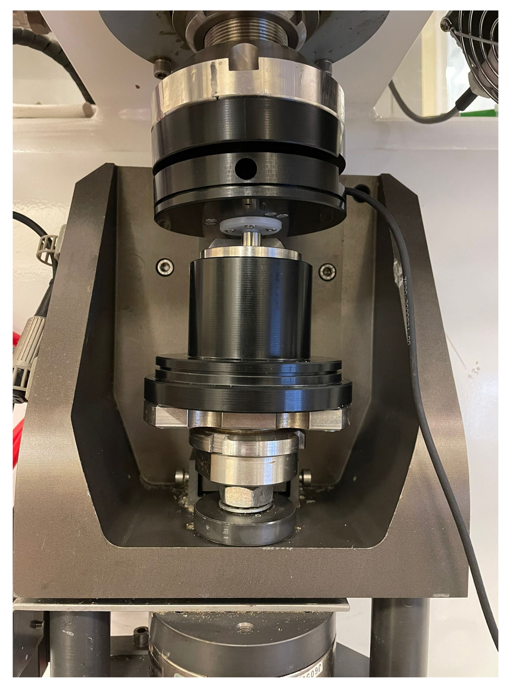
Zyga Glyder Device

Facet joint resurfacing devices focusing on lumbar spine

Design of a Facet Joint Resurfacing Bearings and its Tribological Testing Rig:

Design of CoCr and UHMWPE Friction Testing Samples





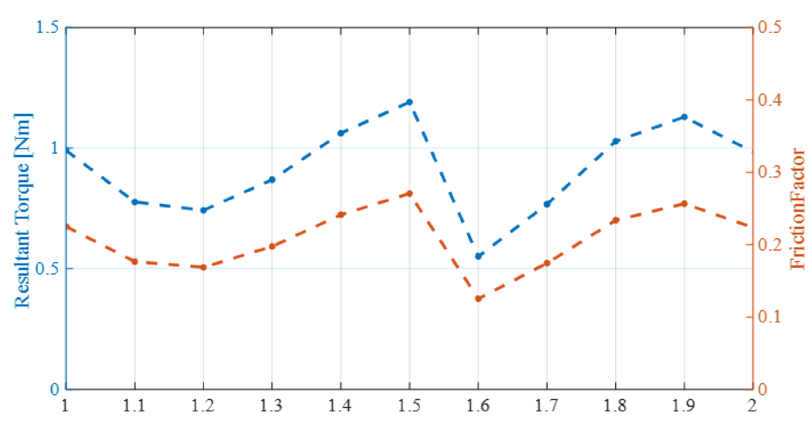
Spigot Design to Attach Samples to the Simulator

Conclusion:

1. A novel facet joint replacement design tailored for the C5-6 level for tribological testing purposes was produced.
2. The advantages of such motion preserving device design:
   - Maintains option for Total Facet Joint Replacement and fusion surgery,
   - A minimally invasive facet restoration implant.
3. The hip simulator was reconfigured to be used as an FJ simulator.
4. A novel validation rig was designed and manufactured.

Limitations:

- Implant dislocation may occur that requires reoperation
- Lack of clinical data (biomechanics)
- The sensitivity of the hip simulator's load cell



$$\tau_{resultant} = \sqrt{\tau_x{}^2 + \tau_y{}^2 + \tau_z{}^2}$$

The friction factor was then computed by dividing the overall frictional torque by the applied compressive load and the head radius:

$$Friction\ Factor = \frac{\tau_{resultant}}{rx\ Fz}$$

F/E ±7.5°

Dry (No lubricant)

100 cycles were recorded after 250 cycles

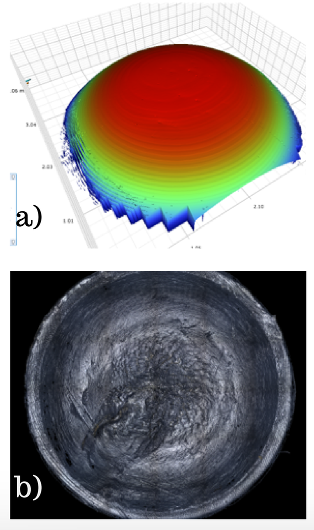
Axial Loading 400 N

Stainless Steel-UHMWPE/dry

Data Analysis

Future Work:

1. The wear and friction relationship will be explored for CoCr/UHMWPE facet joint resurfacing system under static and dynamic loading conditions.
2. The effect of wear-resistant coatings on reducing friction and wear in orthopaedic implants will be investigated.
3. Particle size distribution analysis will be done for the generated wear debris



Pre-Experiment Surface Images of a) CoCr b) UHMWPE samples

References:

1. Côté, P., J.D. Cassidy, and L. Carroll, The Saskatchewan Health and Back Pain Survey. The prevalence of neck pain and related disability in Saskatchewan adults. Spine (Phila Pa 1976), 1998. 23(15): p. 1689-98.
2. O'Leary, S.A., et al., Facet Joints of the Spine: Structure-Function Relationships, Problems and Treatments, and the Potential for Regeneration. Annu Rev Biomed Eng, 2018. 20: p. 145-170.
3. Spinal Implants & Devices Market Size, Share & Trends Analysis Report By Product (Fusion Devices, Spinal Biologics), By Technology, By Surgery Type, By Procedure Type, And Segment Forecasts, 2018 - 2024.)

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