A Novel Implant for Partial Dynamic Stabilisation of the Cervical Spine from a Posterior Approach

Background

The conventional surgical treatment for neck pain caused by radiculopathy is fusion of the intervertebral joint after a decompression of the affected nerve root. However, fusion procedures are traumatic, costly, and cause pathological stress transfer to adjacent segments which may cause Adjacent Segment Degeneration\(^1\). Partial dynamic stabilisation, allows a controlled amount of intervertebral motion to prevent increased stress on the adjacent segments whilst still preventing neural recompression. There is currently no dynamic stabilisation device for the posterior stabilisation of the cervical spine.

Design

We aim to design a novel spinal implant to provide partial dynamic stabilisation in the C3 to T1 region from a posterior approach. The implant will be a single unit with a safe and technically simple insertion technique into the lateral masses. The implant uses a simple mechanism to allow adjustable intervertebral motion in situ.

Figure 1. Prototype design of the partial dynamic stabilisation implant

The implant will integrate expandable fasteners to increase fixation strength\(^2\) and allow for simpler implantation procedure using self awling tips. It is hoped that the novel features of the device may reduce the cost and complications of the procedure compared to traditional fusion and other competing surgeries.

Manufacturing

Prototypes of the cervical device are currently being manufactured from titanium using Selective Laser Melting (SLM) method at UWA. Prototypes of a lumbar spine design are being manufactured using conventional manufacturing techniques at Curtin.
Conclusion
Successful design of an implant for partial dynamic stabilisation of the cervical spine can potentially improve the quality of life of patients through less traumatic surgery and better long term outcomes. However, significant amount testing is required to satisfy all regulatory requirements for use in humans.

References

Finite Element Modelling
Finite element models will be constructed from CT scans of cadaveric human and porcine bone. Model parameters can be determined by calibrating results with destructive testing in porcine bone. The models will then be used to optimise design parameters.

Mechanical Testing
Prototypes will be manufactured based on the optimised design and mechanically tested to American Society for Testing and Materials (ASTM) standard using a Universal Testing Machine to ensure the device itself satisfies the static and fatigue strength requirements for clinical use.

Figure 2. i) Cadaveric cervical vertebrae ii) Coronal CT scan slice iii) lateral mass trabecular architecture iv) finite element model

Figure 3. i) expanding fastener pull-out test ii) screw pull-out test iii) sectioned expanding fastener sample iv) 3D printed bone test sample

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