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MUSCULOSKELETAL INNOVATIONS

Tapered reduction of cement volume in the proximal vertebrae adjacent to the fused segment may translate into a decreased rate of Proximal Junctional Kyphosis (PJK) using Calcium phosphate cement - A biomechanical investigation

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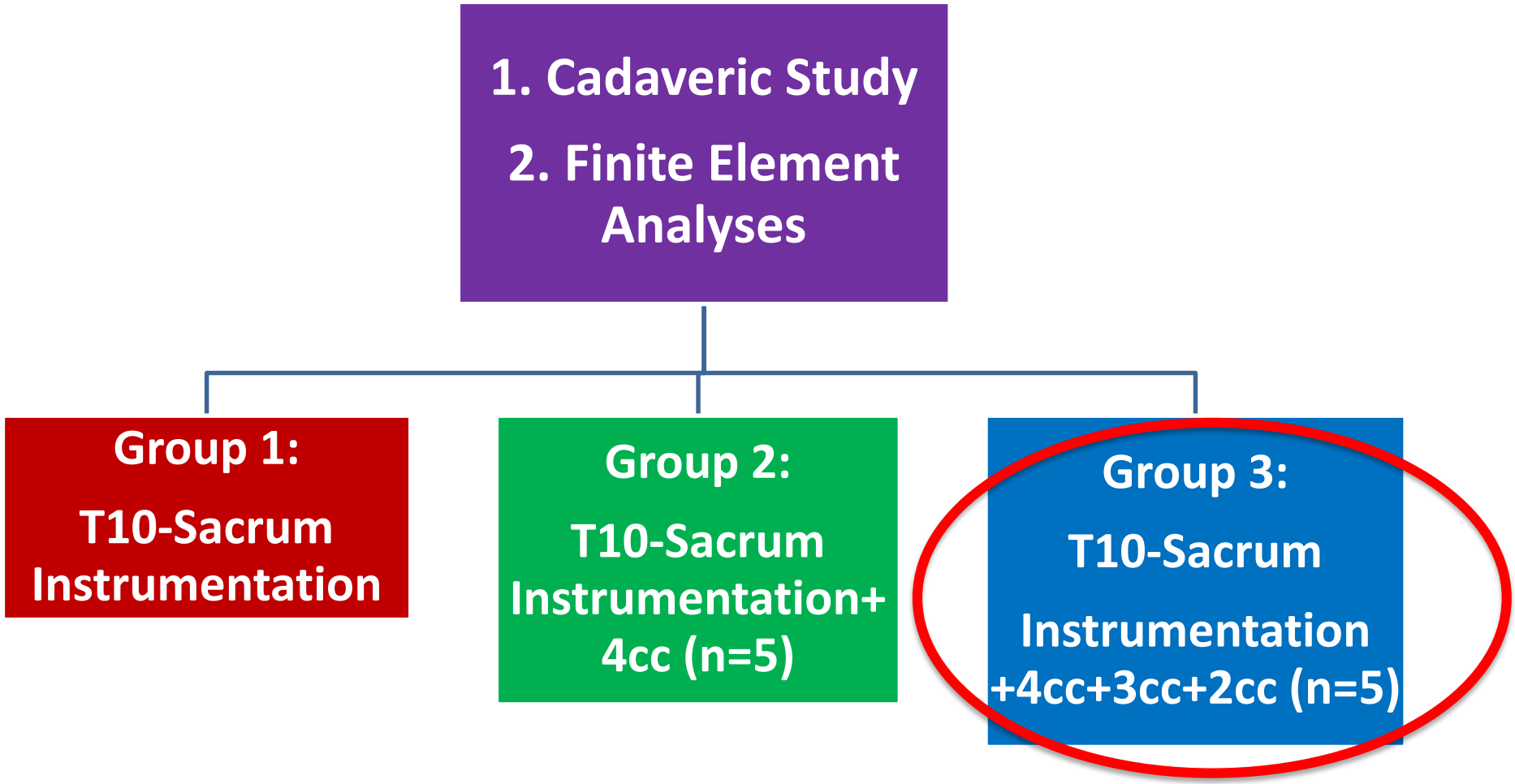
Introduction

- Proximal Junctional Kyphosis (PJK) is a condition in which the Cobb angle between the UIV and adjacent vertebrae above>10-20 degrees.
- Incidence of PJK is 5 to 46% post adult spinal deformity surgery.
- Vertebral compression fractures (VCF's) are one of the causes of PJK.
- Prophylactic vertebroplasty with the tapered bone cement dosage using PMMA showed reduced adjacent level fractures.
- PMMA has some disadvantages.
- A 5 year follow up clinical study by *Dr. Kebaish* demonstrated that prophylactic Vertebroplasty may minimize the risk for junctional failure in the early post operative period. However, it did not appear to decrease the incidence of PJK at 5 years.
- In this study , resorbable Calcium Phosphate cement will be used instead of PMMA which would give excellent outcome post operative and long term.

Objective

- To evaluate the effect of tapering dose of resorbable Calcium Phosphate cement on the adjacent segments in a spinel stabilized with long construct using cadaver model and FE analysis.

Project Outline



Cadaveric Study

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Methods

Specimen Preparation

1. DEXA Scan
2. Preparation of Specimen
3. Potting of Specimen

Surgical Procedure

1. Insertion of Pedicle Screws
2. Injection of Cement

Monitoring continuously using X rays to ensure the proper placement

Biomechanical Testing

1. Loading on the MTS Machine using U- Joint and applying the load at the rate of 5mm/min up to 50 mm

Evaluation

1. CT scans
2. Data obtained from MTS machine

X-Ray Images

Group 1-Instrumentation

Group 2-Instrumentation +4cc Group

Group 3-Instrumentation +4cc+3cc+2cc

Finite Element Analyses (FEA)

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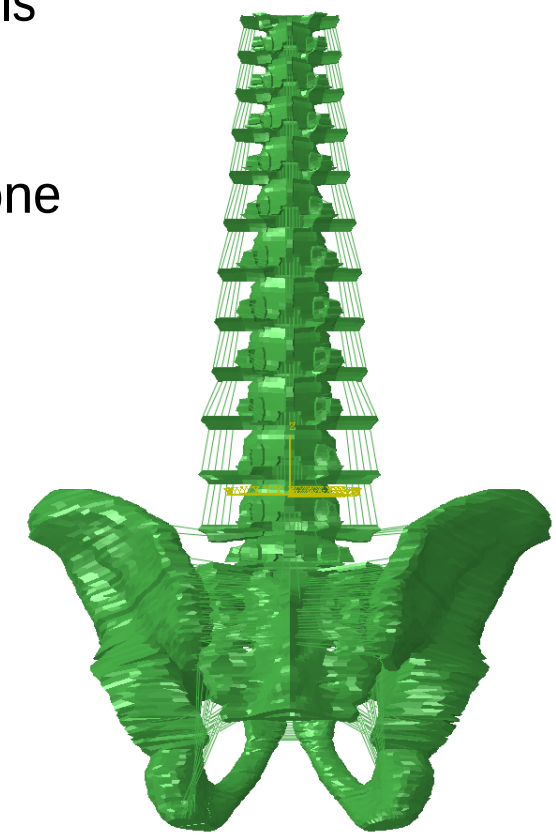
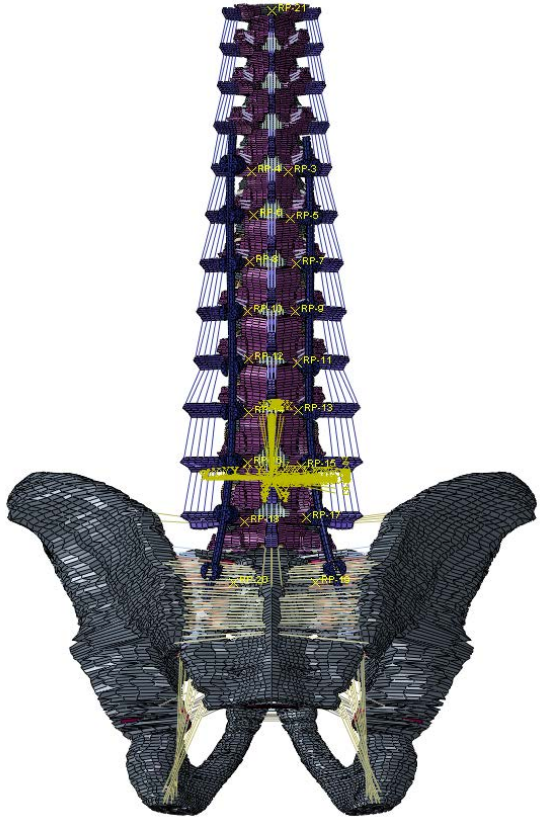
Two types of Models evaluated:

- Normal Bone
- Osteoporotic Bone

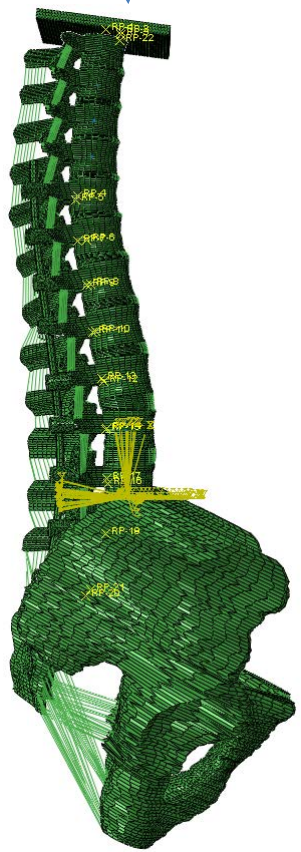
Axial load applied perpendicular to the end plate of T6 Vertebra and 10 mm anterior of its center



Validated FE Model
T6-Pelvis



Validated FE Model
T6-Pelvis Instrumented



Methods

Material Properties

- The standard validated material properties were used in the development of the FE model. For simulating osteoporotic model, the value of Young's modulus was changed from E=100 (Normal) to E=34 (Osteoporotic).

Cement	Modulus of Elasticity (MPa)	Poisson's Ratio
PMMA	2200	0.41
CaP	691	0.15

Boundary Conditions

- The pelvis is fixed in all planes.

Constraints

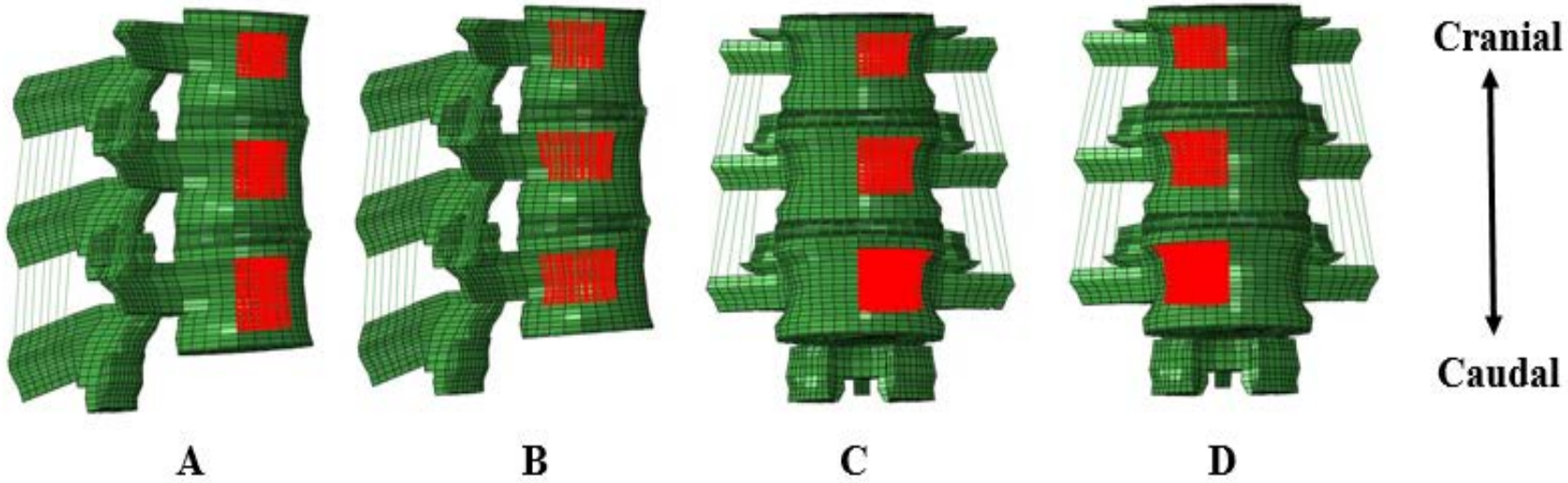
- Coupling between screw head & rod, bone & bush and Metal fixture and upper end plate of T6 vertebra.
- Tie between screw shaft and bush.

Loading

- Load is applied perpendicular to the end plate of T6 vertebra and 10 mm anterior to its center until the failure is observed.

Parametric Analyses

1. Simulation of degenerated discs
2. Changing positions of tapered dose of cement



Cement positions- (A) Anterior, (B) Center, (C) Lateral Left, (D) Lateral Right

Timeline

- Developed protocol and procuring specimens.
- Currently working on FE simulations.
- Finish pilot testing – January 31, 2018
- Finish collecting all data –April 31, 2018
- Data Analyses , publications (abstracts and manuscripts) and report – July, 31, 2018

Acknowledgement

- Thanks CDMI and IAB.