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Minimising Subsidence in Total Disc Replacement using Cement Reinforcement: A Dynamic Study

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Disclosures

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National Osteoporosis Society

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Introduction

- Total disc replacement (TDR) is used to treat degenerative disc disease (DDD).[1]
- Currently, elderly patients are excluded due to poor bone quality to reduce subsidence.[2]
- However, clinical evidence suggests that TDR can be successful in the over 60s.[3]
- Use of vertebral body (VB) cement augmentation may prevent subsidence.[4]
- The aim of the study was to investigate the effect of cement augmentation on TDR device subsidence in a dynamic environment.

[1] Blumenthal et al. (2005); [2] David (2007); [3] Bertagnoli et al. (2006); [4] Yoder et al. (2010)

Materials and Methods

- Twenty-four two vertebra motion segments were harvested from ten human spines (T11-L5).
- Two designs of TDR device were implanted – spiked and keel fixations (Fig. 1).
- Four groups were defined:
    1. Control – Implanted with spiked TDR and no cement augmentation.
    2. Single – Implanted with spiked TDR with cement augmentation of lower VB.
    3. Double – Implanted with spiked TDR with cement augmentation of both VBs.
    4. Keel – Implanted with keel TDR with cement augmentation of both VBs.

Fig. 1: TDR designs.

Materials and Methods

- PMMA cement was delivered via an anterior bilateral approach with a 20% target fill.
- All specimens underwent dynamic compression at 1 Hz for 24 hours.
- Loading regimes were specimen specific based on BMD and endplate area.
- Subsidence was calculated from pre- and post-loading micro-CT scans.

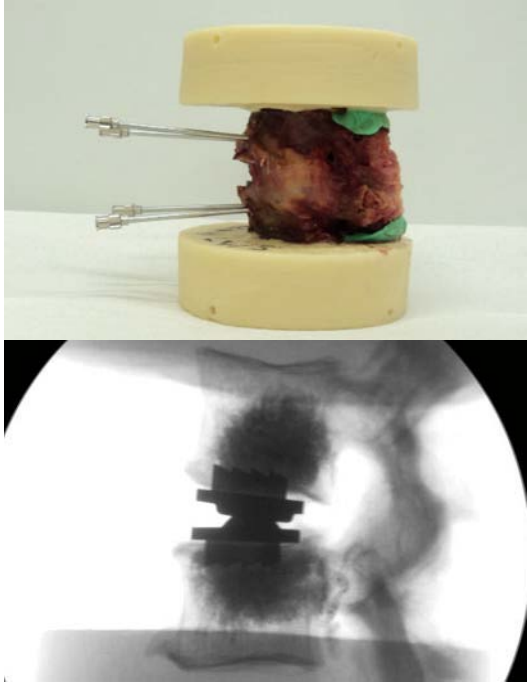

Fig. 2: Cement approach and placement for a double level augmented specimen.

Results

Inferior VB

- Subsidence was greatest in the control group (Fig. 3).
- Control group was significantly different to the single group ($p = .043$) and marginally different to the double ($p = .123$) and keel ($p = .113$) groups.

Superior VB

- Subsidence was greatest in the single group (Fig. 3).
- Significantly different to the double group ($p = .044$) and marginal to the control ($p = .085$) and keel ($p = .064$) groups.

- No difference between spiked and keel TDR fixations.

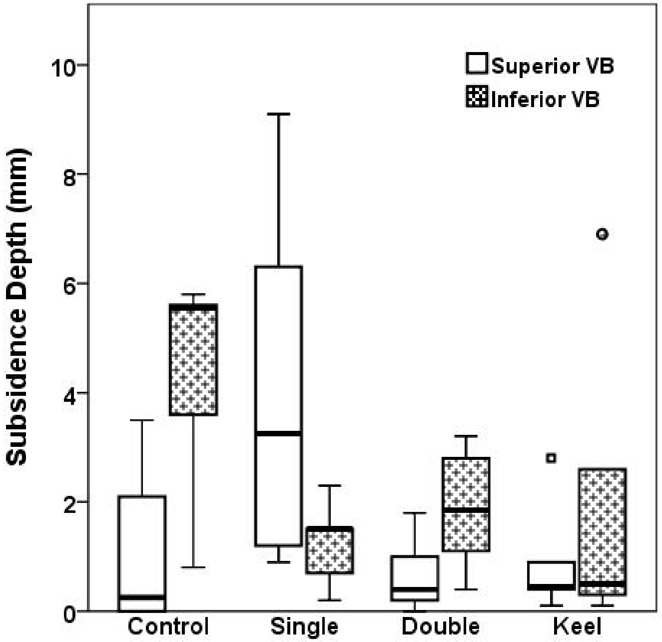

Fig. 3: Boxplot displaying subsidence magnitude across the four groups.

Results

- Device tilting in the coronal plane was reduced following cement augmentation (Fig.4).
- Cement had a limited effect in the sagittal plane.
- Subsidence angle was not significantly different from zero in any of the groups.
- No statistical difference between spiked and keel TDRs.

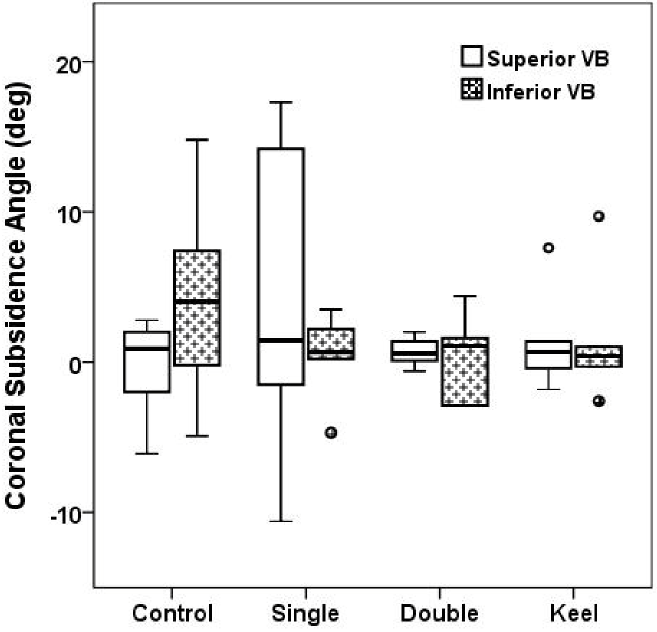

Fig. 3: Boxplot displaying subsidence angle in the coronal plane across the four groups.

Discussion

- Without the presence of cement, subsidence was greatest in the superior endplate of the lower VB.
- This is supported by literature stating superior endplates to be weakest[1] and more prone to fracture.[2]
- Subsidence was significantly reduced in the lower VB following single level augmentation.
- However, this promoted increased subsidence in the upper VB in terms of both mean and variability.
- Double level augmentation provided equal subsidence resistance and improved stability to both endplates.
- TDR fixation between spiked and keel designs did not affect subsidence.

[1] Grant et al. (2001); [2] Zhao et al. (2009)

Conclusions

- Cement augmentation significantly reduced TDR device subsidence.
- Inter-vertebra cement placement plays a crucial role.
- No difference in subsidence behaviour was observed between spiked and keel designs in augmented vertebrae.