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## Making an Impact on Vertebral Compression Fractures

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## Clinical background

Spinal fractures account for approximately **1.4 million fractures per annum** worldwide [1]. Treatments for these injuries have evolved from simple bed rest through to the intricacy of modern **minimally invasive surgery**. **Balloon kyphoplasty** is one such treatment that uses a balloon to decompress collapsed vertebra, followed by injection of bone cement to stabilise the fracture (Figure 1). Recent research has correlated a **'halo'** feature on kyphoplasty patient x-rays with a **78% re-collapse rate** [2]. The present work documents a new method of mechanical analysis to investigate this issue and **explores alterations to current clinical practices to improve patient outcomes**.

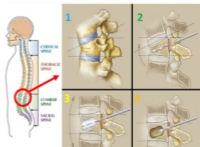


Figure 1, Balloon kyphoplasty treatment [3]

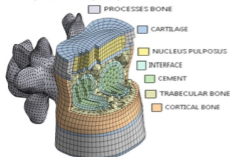


Figure 2, Model of kyphoplasty treatment

## Results

Figure 3 depicts the stress change for each of the components in the vertebra model due to the altered loading experienced during recovery from kyphoplasty. Results from the model indicate **increases in stress of 11% in the cement, up to 39% in the trabecular bone**. Detailed analysis also found that **altered loading of the interface region** was a contributory factor in causing height subsidence. This supports the clinical indications that the **'halo' effect** during kyphoplasty recovery can **substantially increase the risk of re-collapse at the treated level**.

### Change in stress during recovery from surgery

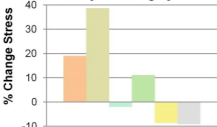


Figure 3, Change in stress of model components due to altered loading (colouring as per Fig. 2)

## Acknowledgements

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## Modelling

A validated computer model of a human spine was modified to replicate balloon kyphoplasty (Figure 2) in the first lumbar vertebra. The **first lumbar vertebra** was selected since it is the **most common site for spinal fractures**. A **mechanical model** of the kyphoplasty 'halo' was developed by modelling an **interface region** between the bone and injected cement regions. The **thickness** of this region was **derived from a mathematical model** based on the patient's bone properties and the level of bone compaction caused by the kyphoplasty balloon [4].

## Clinical Relevance

Results from the mechanical model indicate the incidence of vertebral **re-collapse could be reduced by improving the properties of the interface** between the bone and injected cement. Work is ongoing to achieve this improvement using an alternative surgical technique known as **'egg-shell' kyphoplasty** (Figure 4), which is hypothesised to enhance the long-term integrity of the treatment [5]. This alternative treatment offers surgeons a **new opportunity to improve patient outcomes with no additional equipment expense** and may even yield **savings** with lower incidence of hospital re-admissions.



Hypothesised that egg-shell technique improves structural interlock by forcing cement into bone using balloon

Figure 4, Egg-shell surgical technique [5]

## References

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