

VERTEBRAL AUGMENTATION WITH A NOVEL VESSEL-X BONE VOID FILLING CONTAINER SYSTEM AND BIOACTIVE BONE CEMENT —AN IN VITRO BIOMECHANICAL AND MORPHOLOGICAL STUDY

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INTRODUCTION

Vertebroplasty and kyphoplasty have good results in pain relief clinically, and strengthening effects experimentally. One of the shortcomings, however, is the risk of cement leakage. Vessel-X bone void filling container system (**Fig. 1**) is a novel bone expander and bone void filler combined instrument for vertebral augmentation.

The aim of this fresh cadaveric study was to compare Vessel-X system with kyphoplasty employing a bioactive bone cement (SrHAC) [1] to restore strength, stiffness and height in experimentally induced vertebral compressive fractures and to determine cement distribution morphologically.



Fig. 1: (a) Vessel-X container (b) expanded by bone cement and (c) schematic diagram in the vertebrae

METHODS

A total of 28 fresh-frozen vertebrae specimens were randomly divided into 4 groups viz: unipedicular and bipedicular Vessel-X (UVS and BVS), unipedicular and bipedicular kyphoplasty (UKS and BKS). After bone mineral density (BMD) was measured, simulated compressive fractures were experimentally created on each vertebra [2]. Kyphoplasty and Vessel-X with SrHAC were performed in specimens under C-arm fluoroscopy guidance (**Fig. 2**). Mechanical recompression testing was carried out to measure the augmented effects. Morphological observations of initial, fractured and augmented vertebrae were performed to present the cement distribution and vertebral height restoration.

RESULTS AND DISCUSSION

There was no significant difference in BMD, initial strength and stiffness in all the groups. Cement volumes for Vessel-X and kyphoplasty groups were 3.26 ± 0.06 ml and 3.07 ± 0.05 ml with unipedicular injection and 5.97 ± 0.07 ml and 5.81 ± 0.36 ml with bipedicular injection, respectively. The difference in cement volume between Vessel-X and kyphoplasty either with unipedicular or bipedicular was not statistically significant. The height restoration ranged from 88.5% to 96.4% in all groups.

Radiographs of Vessel-X showed that the distribution of SrHAC cement in UVS and BVS groups were completely intact within the vertebral body. The expanded configuration of the Vessel-X container was relatively homogenous with a balloon or long ellipse shapers (**Fig. 2**). After cross-section, we found that the Vessel-X container expanded well in the vertebral body and the mesh layer

enwrapped the bone cement really well with almost no cement leakage.

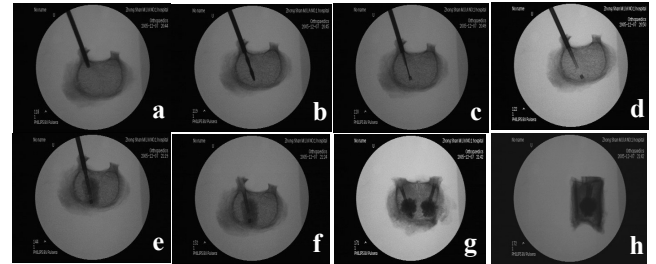


Fig. 2: The procedures of Vessel-X cement injection performed under C-arm fluoroscopy monitoring

The augmented compressive strength with unipedicular and bipedicular injections reached 3600N and 4300N, respectively (**Fig. 3A**), which increased significantly compared to initial. The unipedicularly injection, employing either Vessel-X or kyphoplasty provided similar strength restoration effects to that of bipedicular. In stiffness restoration, either with unipedicular or bipedicular injection, Vessel-X was comparable to kyphoplasty. Meanwhile, stiffness with bipedicular injection was significantly higher than that of unipedicular injection (**Fig. 3B**). This may be due to the doubled cement volume and the more symmetrical cement distribution with bipedicular injection.

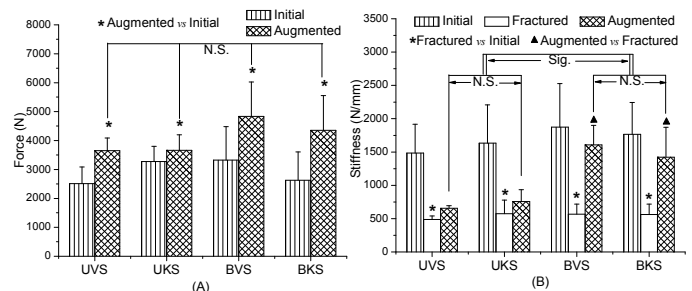


Fig. 3: Compressive strength and stiffness in each group

CONCLUSIONS

Vessel-X was comparable to kyphoplasty in fractured vertebrae mechanical properties and height restoration. The Vessel-X instrument showed considerably less cement leakage and better cement distribution in the vertebrae body. Therefore, it could be a leakage controllable technique in percutaneous vertebral augmentation.

REFERENCES

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