

CHANGES IN BIOMECHANICAL PROPERTIES OF CHEMOTHERAPY BONE CEMENT AFTER A YEAR IN SALINE STORAGE

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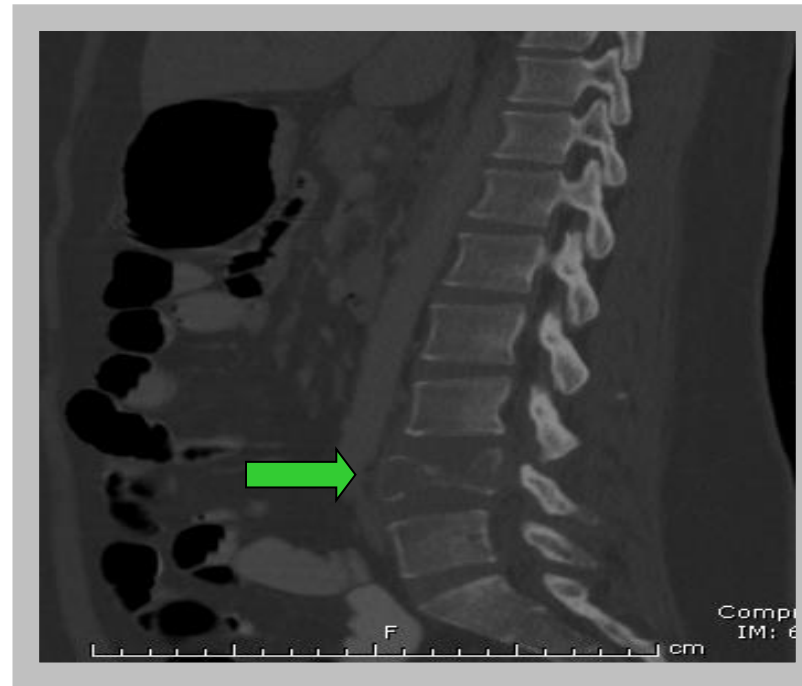
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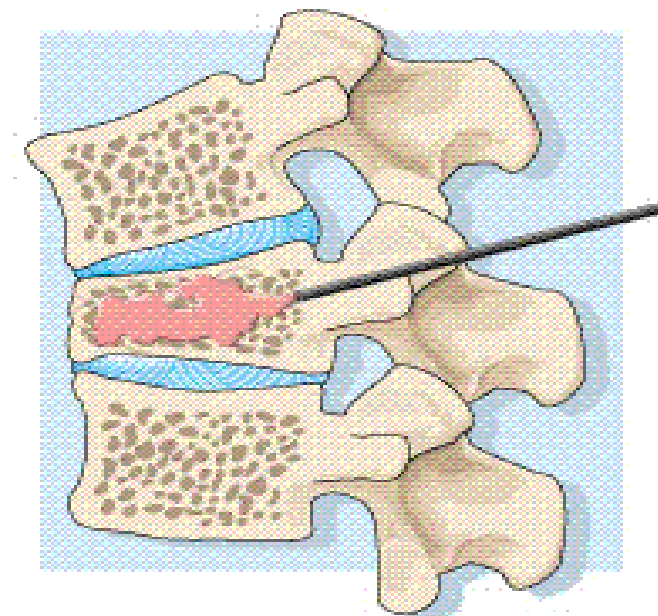
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INTRODUCTION

- Acrylic based bone cements are popular in orthopedic surgery due to the wide variety of uses and high degree of customization
- Bone cements are used to treat vertebral fractures due to osteoporosis and metastatic disease
- There is also utility for mixing chemotherapeutic agents with bone cement and using it as a local delivery system in vivo for bone cancer
- Elution profiles of bone cement can be modified by adding soluble fillers such as polyethylene glycol (PEG)
- Addition of PEG will increase elution time of chemotherapy agents, but it will also cause the mechanical properties of the cement to be changed
- Currently there isn't a reliable way for a surgeon to prepare a customized cement intraoperatively and predict its mechanical properties



Metastasis to L4 vertebra



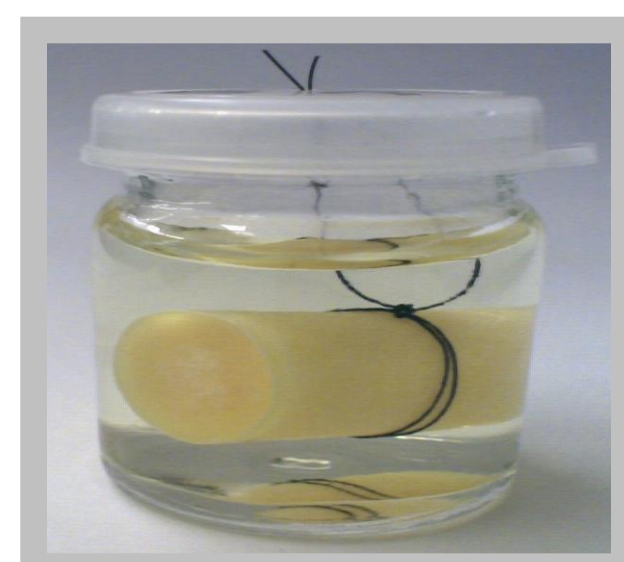
Vertebroplasty (injection of chemotherapy bone cement)

OBJECTIVES

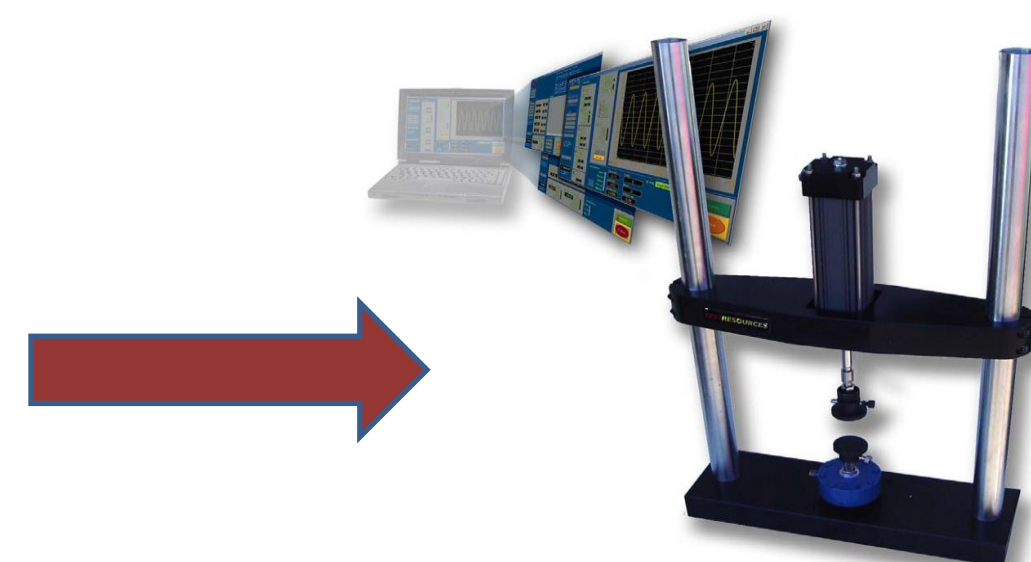
- Determine the change in mechanical properties of the cements after drug elution

METHODS

Confidence Ultra, Vertebroplastic (Depuy Spine, Inc), and Palacos cement (Zimmer Inc.) were used and mixed with varying amounts (0–50%) of PEG (MW 8,000) and chemotherapy agents (Methotrexate or doxorubicin). Cylindrical Bone cement specimens were placed in a saline solution for one year. After 1 year, the specimens (3 per group) were tested in compression at 1 mm/min until failure. Failure was established by watching the stress strain curve for the sample reach plastic deformation.



In vitro cement mold stored in saline



Electromechanical testing machine

RESULTS

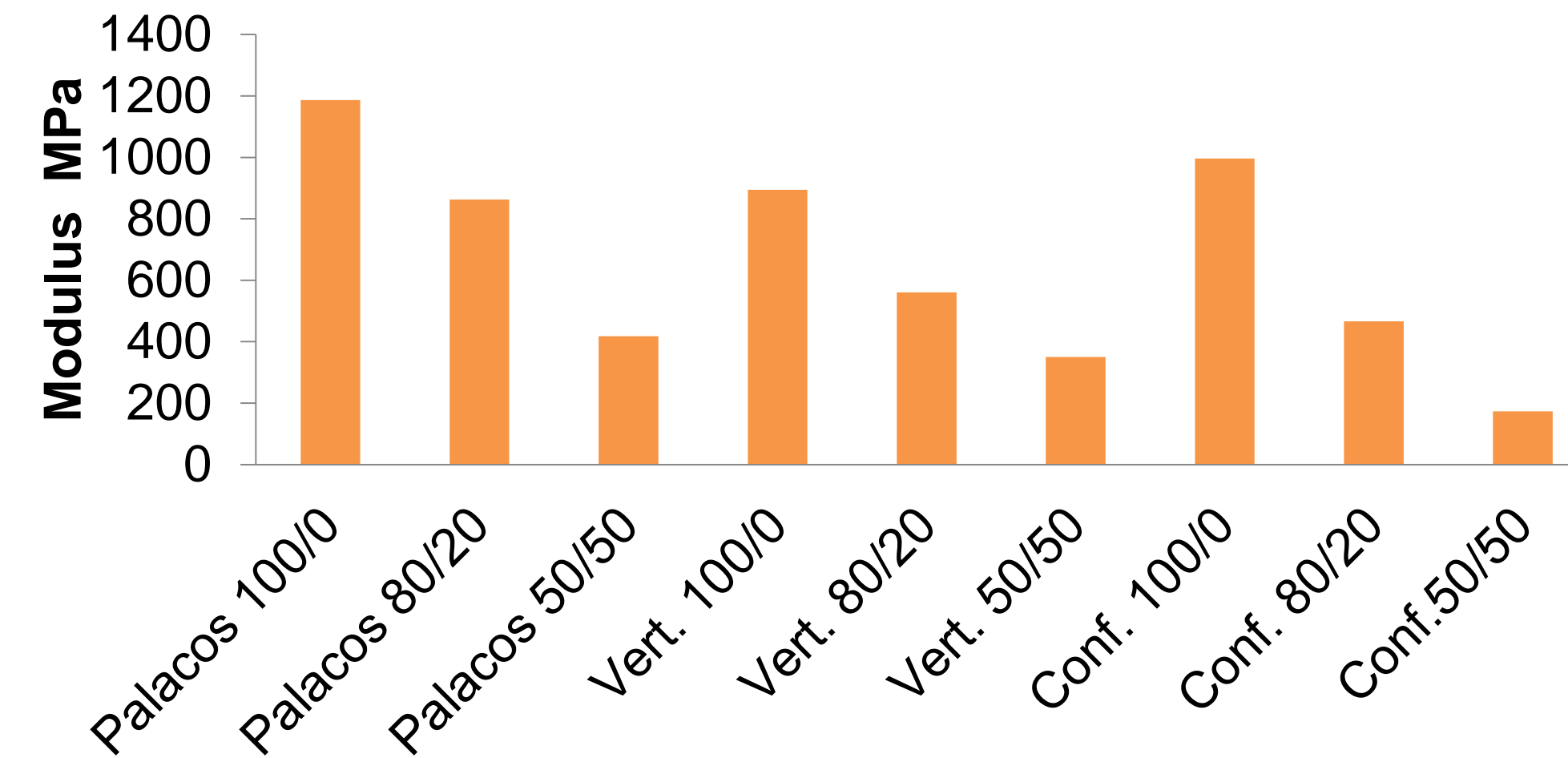


Figure 1: Modulus of Bone Cement Samples

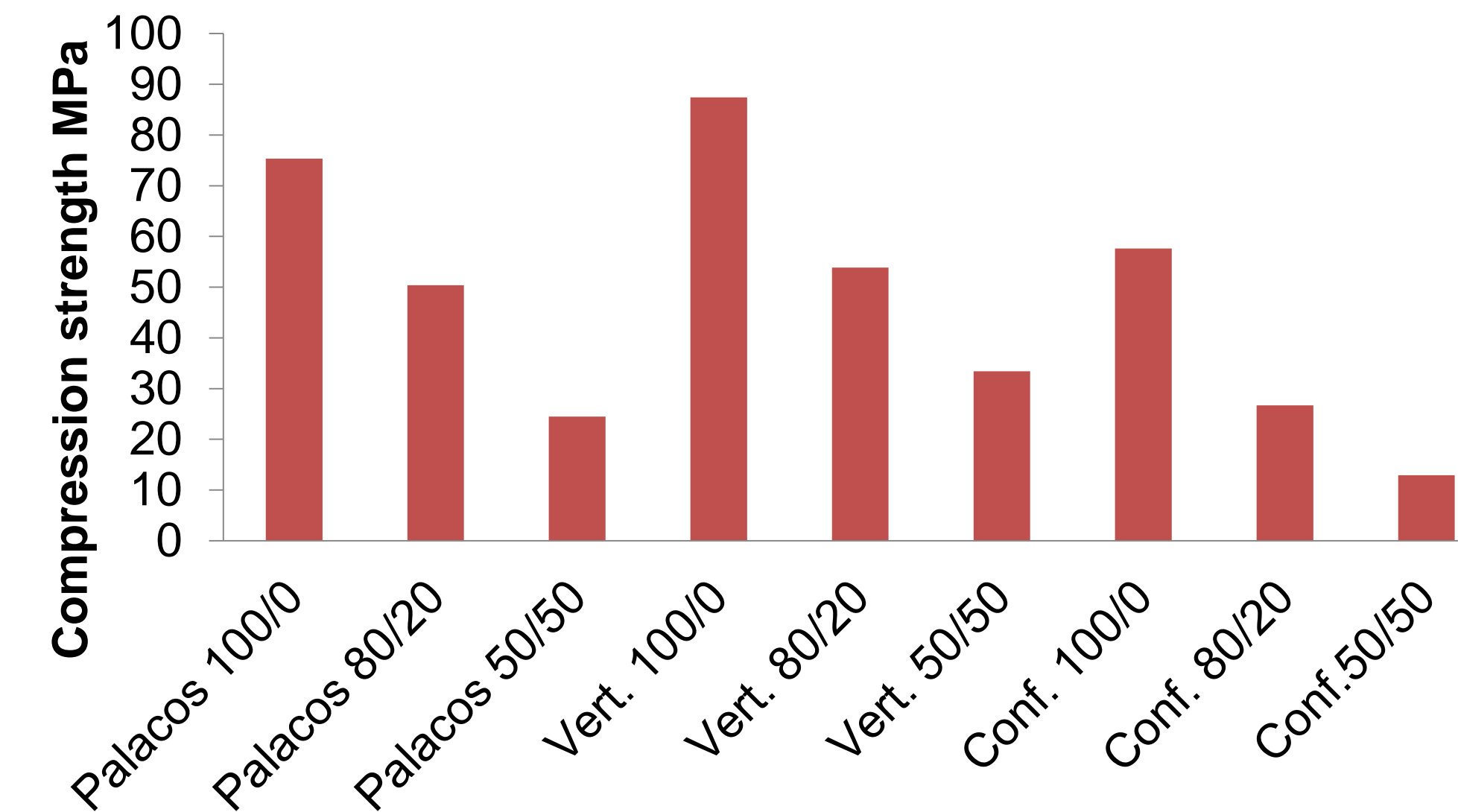


Figure 2: Compression Strength of Bone Cement Samples

	Modulus MPa	Compression Strength MPa	Retained Modulus	Retained Strength
Palacos 100/0	1186.91	75.32		
Palacos 80/20	862.76	50.39	73%	67%
Palacos 50/50	418.29	24.47	35%	32%
Vert 100/0	894.43	87.41		
Vert 80/20	560.49	53.88	63%	62%
Vert 50/50	350.38	33.42	39%	38%
Conf 100/0	996.61	57.62		
Conf 80/20	466.65	26.69	47%	46%
Conf 50/50	173.50	12.91	17%	22%

Table 1. Mechanical Properties of Bone Cement Samples

DISCUSSION

- Palacos and Vertebroplastic retained their properties better than Confidence
- Increasing the amount of soluble filler resulted in a decreased modulus and compression strength (Figures 1&2) in all three bone cement samples as expected
- Despite elution in a liquid medium for one year the cements retained adequate modulus of elasticity and compression strength
- Other than knowing that the addition of soluble fillers will lower mechanical properties, it is difficult to know the exact combination of cement and filler to make a material with the desired mechanical properties for the patient
- The best was to guarantee the appropriate properties, and drug elution profile of a bone cement would be for a company to provide a commercially available product with known mechanical properties

CONCLUSION

When using bone cements clinically it is important to remember that combining soluble fillers enhances drug elution at the expense of mechanical properties.

Additionally, the mechanical properties of different commercially available bone cements behave differently with similar percentages of soluble filler and drug added. This shows the difficulty in predicting in vivo changes in mechanical properties of bone cement intraoperatively.

Many surgeons prepare the bone cement/chemotherapy mixtures intraoperatively, however our experiments show the difficulty in predicting the exact behavior of this new combination as far as mechanical properties are concerned. This elucidates the need for well characterized bone cement optimized for chemotherapy drug delivery.

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