Deterioration of Compressive Properties of Bone Cement due to Release of Multiple Antibiotics over Extended Time Periods

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Statement of Purpose: Antibiotic-loaded bone cement (ALBC) is often used for treating deep wound infections following Total Joint Replacements (TJR) [1-3]. Concerns have been raised about the deterioration of mechanical properties of bone cement as a result of using high doses of antibiotics [4]. Although we and others have previously examined the mechanical behavior of bone cement, only limited information is available on the mechanical properties of ALBC [5-9]. Although ALBC are being increasingly used, little information is available regarding the release of multiple antibiotics and its long term effects on the biomechanical properties of the bone cement. To address this gap in our knowledge, the **overall goal** of this project is to investigate the progressive change in the compressive properties of ALBC due to release of Tobramycin (T) and Gentamycin (G), at various concentrations and at various time points (0hr, 1hr, 3hr, 7hr, 24hr, 7d, 30d).

Methods: Preparation of Antibiotic Impregnated Bone Cement Batches: Simplex P® and the antibiotics were acquired from Stryker and Sigma (# T1783-500MG for T and # G3632-10G for G) respectively. Four batches of ALBC were prepared as follows: a) 0.5g G and 0.5g T to 40g of PMMA; b) 5g G and 5g T to 40g of PMMA; c) 10g G to 40g of PMMA and d) 10g T to 40g of PMMA. Samples of 6.0 mm diameter and height of 12.0 mm were fabricated in accordance with ASTM. **Porosity Evaluation:** All samples were hand mixed and evaluated using a Faxitron X-ray System. Specimens with bubbles >1mm were rejected. Three good samples were identified for each group. **Elution of antibiotics in PBS: S**pecimens were immersed in 2ml PBS in capped polypropylene vials and placed in a shaking incubator (Belly Button®). At the designated sampling times (mentioned before), specimens were recovered and air dried for compression testing and the elution solutions were stored at 4°C for later analysis. **Compression Testing:** Compression testing was performed using a materials testing machine (Instron model 5566; Instron Corp, Canton, Mass) fitted with a 20kN load cell. A test speed of 1.3mm/min was used.

Results: Figure 1 show typical load deformation behavior of various bone cement groups indicating an initial elastic behavior followed by large plastic deformation. There was a significant decrease in the compressive strength of the samples having the higher doses of antibiotics as compared to the control and the ones having the lowest dose. This may be due to compromised structural integrity of the samples having higher doses as a result of elusion of significant quantity of antibiotics. Duration of elution did not significantly change the compressive properties of the ALBC.

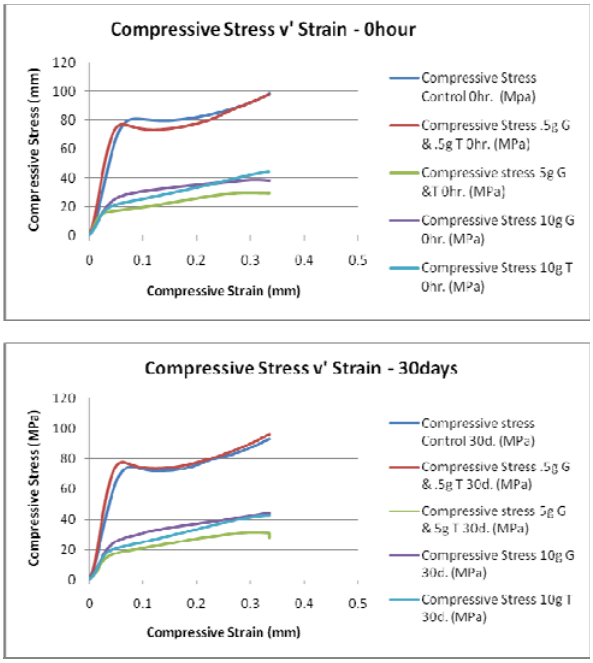

Figure 1 shows the compressive stress (MPa) for two different time periods, top: 0 hr and bottom : 30 days..

Conclusions and Discussion:
a) Amount of antibiotic incorporated to ALBC has a significant effect on their compressive properties and is more important than the duration of drug elution from the specimens**.**
b) Solubility of the drug in the vehicle and its density are important attributes that determine the compressive properties of the PMMA, post elution.

Future Directions:
Future studies will include tension and fatigue tests. Further tests could be performed with other antibiotics widely used in TJRs at increased doses and greated time periods to illustrate the corresponding effects on the biomechanical properties of ALBC. With only triplicate samples used per time period in this study, further tests with more samples would further validate the results.

References:
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