Comparative Handling, Intrusion and Antibiotic Elution Characteristics of a New, High Viscosity Bone Cement

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Introduction:

Operational efficiencies are receiving greater interest by surgeons and hospital administration. High viscosity (HV) bone cements usually provide a shorter dough time than medium viscosity cements, which may result in surgical efficiencies by allowing surgeons to handle and apply the cement to implants earlier. Some reports indicate that high viscosity cements have poorer intrusion compared to medium viscosity cements.[1,2] The depth of intrusion of the bone cement into the cancellous bone has been shown to increase the strength of the bone-cement interface.[3,4] A recent study by Bishop found that pull-out force of tibial base plates from post-mortem tibia increased with an increase of cement penetration,[5] providing a direct suggestion for improved fixation of the tibial tray. Antibiotic elution is another important property for acrylic bone cement. The purpose of this study was to investigate the handling properties, intrusion, antibiotic elution, and mechanical properties of HV bone cement options.

Materials and Methods:

The new formulation (bone cement A) contains 40g polymethyl methacrylate(PMMA) powder and 20ml MMA liquid. Its pre-blended antibiotic version contains 0.8g Gentamicin (0.5g active) (bone cement A+G). Palacos R bone cement (bone cement B) and its antibiotic version with Gentamicin (bone cement B+G) were tested in this study for comparison. Dough and setting times were determined following the ASTM F451-08 and ISO5833 standard method but performed at 18.5° C (65 °F) and 50% relative humidity, which is more clinically relevant. The depth of intrusion (n=16), compression strength (n=6) and bending strength/modulus (n=5) were determined following the standard method described in ASTM F451-08 and ISO5833. A modified Kirby-Bauer technique was utilized where staphylococcus epidermidis was used to detect eluent Gentamicin concentrations per USP Standards (n=54).[6] The student T test was used to test for statistical differences.

Results and Discussion:

Dough and set times of bone cement A (dough time 1.6 min; setting time 15.6min) were comparable to the times of the bone cement B (dough time 2.2min; setting time 15.4min). The average depths of intrusion were 7.5±1.9mm and 4.8±1.6mm for bone cements A and B, respectively (Figure 1). Both exceeded ISO minimum requirement for acrylic bone cement, but the depth of intrusion of bone cement A was significantly larger than that of the cement B (p<0.05). Bone cement A+G also demonstrated statistically higher (p<0.005) cumulative Gentamicin elution than bone cement B+G for a period of 24 hours (Figure 2). Compressive strength and bending strength/modulus of bone cement A and bone cement A+G exceeded ASTM/ISO requirements for acrylic bone cement (Table 1).

Conclusion:

Under the conditions of this study, it was demonstrated that bone cement A formulation significantly improved the depth of intrusion without prolonging dough time of the cement. The cumulative Gentamicin elution from bone cement A+G was also higher than that from bone cement B+G for up to 48hrs. The unique properties of bone cement A may help provide surgeons with the rapid dough time of HV bone cement without compromising depth of intrusion and initial antibiotic elution. Clinical results will be needed to validate these findings.

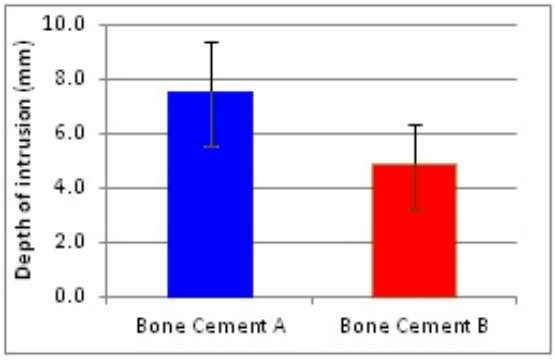

Figure1. Depth of Intrusion

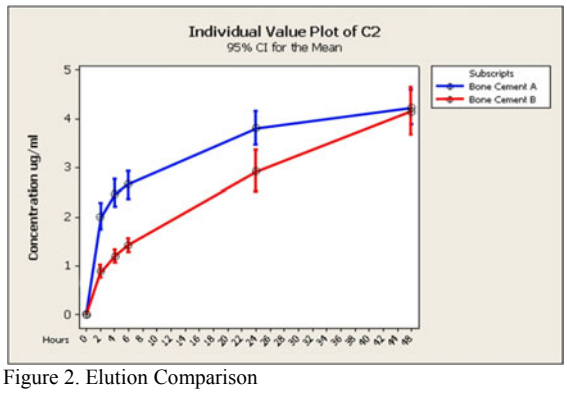

Figure 2. Elution Comparison

	Bone Cement A (MPa)	Bone Cement A+G (MPa)	ASTM & ISO
Bending Strength	63.8 ± 1.4 (n=5)	65.2 ± 0.56 (n=5)	>50
Bending Modulus	2459.9 ± 78.3 (n=5)	2479.1 ± 45.6 (n=5)	>1800
Compressive Strength	114.7 ± 2.6 (n=6)	110.2 ± 2.6 (n=6)	>70

Table 1. Compressive Strength and Bending Strength/Modulus

References:

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