Mechanical Properties upon Curing of Orthopaedic Composites

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Statement of Purpose: Orthopaedic composite cements are used in, and remain under study for, the application of percutaneous vertebroplasty (PVP). A concern in this minimally invasive surgical procedure is the length of time the patient must remain on the table before bearing weight on the implanted material. Typical PVP procedures last less than one hour and can be done under conscious sedation. Thus, the time post-surgery at which the patient can bear load becomes important. This abstract examines the mechanical strength during curing of orthopaedic composites used in PVP.

Methods: Compression pellets 6x12mm in size were molded of bone cement. These pellets were fabricated using steel molds and plates preheated to 37C in an electric oven to simulate body temperature. Cement was prepared according to the manufacturer's instructions. The molds were filled with prepared cement, clamped, and immediately inserted back into the oven for a predetermined time interval. Time points studied included 15 minutes, 90 minutes, 4 hours, and 24 hours. Pellets were removed from the mold and immediately tested in compression using an Instron 8516 servohydraulic test instrument. A minimum of five pellets for each time point were evaluated. Commercially available Simplex P® (Stryker, Kalamazoo, MI) was evaluated in addition to Cortoss® (Orthovita, Malvern, PA), an investigational device currently under clinical evaluation for PVP.

Results / Discussion: The results demonstrate that Cortoss has a maximum strength of 160 MPa within 15 minutes of application. The compressive strength of Cortoss is approximately four times that of Simplex P at 15 minutes. At this time point, Cortoss has reached 72% of full strength, while Simple P has reached 45.5% of full strength. Simplex P has a maximum strength at full cure of only 80 MPa. Cortoss reaches its maximum strength of 220 MPa within 24 hours, which is greater than the strength of intact cortical bone [1]. Furthermore, the yield strength of Cortoss is consistently higher than that of Simplex P, becoming much higher with additional curing time.

Another factor of clinical practice, though not measured here, that can affect the immediate and 24-hour post-surgical time period is the addition of opacifiers to PMMA. These additions are known to decrease mechanical properties. Cortoss does not necessitate these additions and is therefore not affected by them.

Conclusions: These results indicate that a patient receiving Cortoss in a percutaneous vertebroplasty may be able to bear weight at much earlier post-operative timepoints.

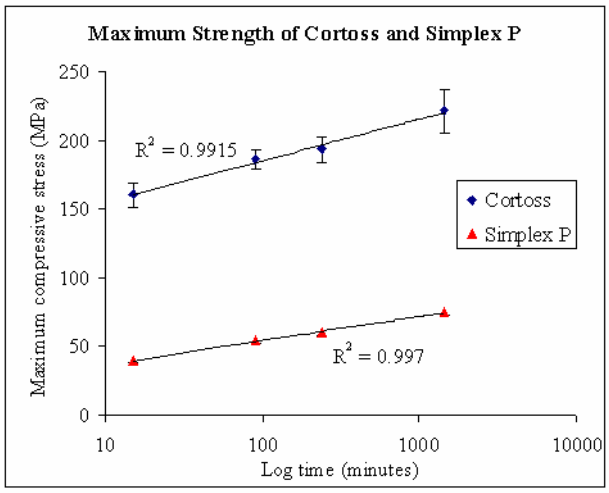

Figure 1. Maximum strength of Cortoss and Simplex P.

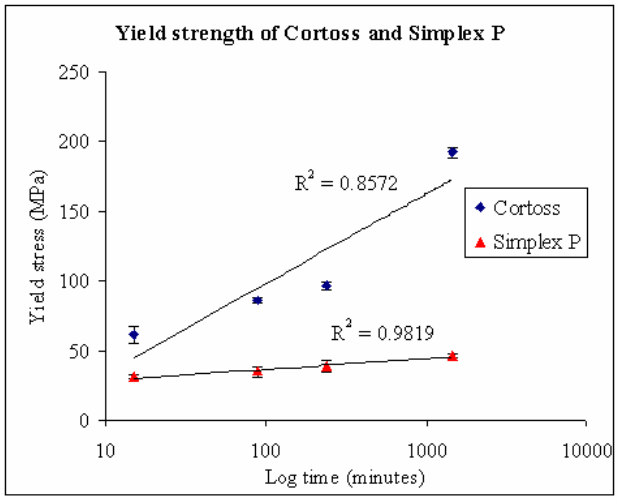

Figure 2. Yield strength of Cortoss and Simplex P.

References:

1) Martin RB et al. Skeletal Tissue Mechanics. New York: Springer-Verlag, 1998.