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Bioinspired Mineral–Organic Bioresorbable Bone Adhesive

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Abstract

Bioresorbable bone adhesives have potential to revolutionize the clinical treatment of the human skeletal system, ranging from the fixation and osteointegration of permanent implants to the direct healing and fusion of bones without permanent fixation hardware. Despite an unmet need, there are currently no bone adhesives in clinical use that provide a strong enough bond to wet bone while possessing good osteointegration and bioresorbability. Inspired by the sandcastle worm that creates a protective tubular shell around its body using a proteinaceous adhesive, a novel bone adhesive is introduced, based on tetracalcium phosphate and phosphoserine, that cures in minutes in an aqueous environment and provides high bone-to-bone adhesive strength. The new material is measured to be 10 times more adhesive than bioresorbable calcium phosphate cement and 7.5 times more adhesive than non-resorbable poly(methyl methacrylate) bone cement, both of which are standard of care in the clinic today. The bone adhesive also demonstrates chemical adhesion to titanium approximately twice that of its adhesion to bone, unlocking the potential for adherence to metallic implants during surrounding bony incorporation. Finally, the bone adhesive is shown to demonstrate osteointegration and bioresorbability over a 52-week period in a critically sized distal femur defect in rabbits.

Conflict of Interest

The authors declare no conflict of interest.