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Reinforcement and Fatigue of a Bioinspired Mineral-Organic Bioresorbable Bone Adhesive

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Abstract

Bioresorbable bone adhesives may provide remarkable clinical solutions in areas ranging from fixation and osseointegration of permanent implants to the direct healing and fusion of bones without permanent fixation hardware. Mechanical properties of bone adhesives are critical for their successful application in vivo. Reinforcement of a tetracalcium phosphate-phosphoserine bone adhesive is investigated using three degradable reinforcement strategies: poly(lactic-co-glycolic) (PLGA) fibers, PLGA sutures, and chitosan lactate. All three approaches lead to higher compressive strengths of the material and better fatigue performance. Reinforcement with PLGA fibers and chitosan lactate results in a 100% probability of survival of samples at 20 MPa maximum compressive stress level, which is almost ten times higher compared to compressive loads observed in the intervertebral discs of the spine in vivo. High adhesive shear strength of 5.1 MPa is achieved for fiber-reinforced bone adhesive by tuning the surface architecture of titanium samples. Finally, biological and biomechanical performance of the fiber-reinforced adhesive is evaluated in a rabbit distal femur osteotomy model, showing the potential of the bone adhesive for clinical use.

Keywords: bioresorbable bone adhesives; bone adhesives; bone tissue engineering; fatigue; mechanical properties; rabbit osteotomy models.

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