IMPROVED MECHANICAL PERFORMANCE OF A NEXT-GENERATION HYBRID BONE ADHESIVE

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Key Words: bone adhesive, biomedical materials, bioresorbable bone adhesive, bone repair, hybrid materials

Bioresorbable bone adhesives have potential to revolutionize the clinical treatment of the human skeletal system, ranging from the fixation and osseointegration of permanent implants to the direct healing and fusion of bones without permanent fixation hardware. Despite a clear 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. We have recently introduced a novel, bioinspired mineral-organic bone adhesive (Tetranite®) based on tetracalcium phosphate and phosphoserine that cures in minutes in an aqueous environment and provides high bone-to-bone adhesive strength.[1] This new hybrid, bioresorbable material was measured to be 10 times more adhesive to bone than bioresorbable calcium phosphate cement and 7.5 times more adhesive than non-resorbable PMMA bone cement, both of which are standard of care in the clinic today.
In this study, we further explore the mechanical performance of the bioresorbable bone adhesive and aim to achieve its improved fatigue behavior that would facilitate its widespread clinical use *in vivo*, where dynamic loading is prevalent.[2] Aside from several studies discussing the fatigue behavior of calcium phosphate bone cements, this is the first study exploring and improving the fatigue behavior of bioresorbable bone adhesives. For this purpose, we introduce polymeric materials into the bone adhesive – we reinforce it with PLGA polymer fibers and sutures as well as chitosan lactate aqueous solution. Apart from static mechanical testing and micro-CT analysis of different material formulations, we present a comprehensive study of the fatigue behavior of unreinforced and reinforced bone adhesive in compression at different conditions and point out the most promising formulations for further use in biomedical applications (Figure 1). The interplay between the different mineral-organic and polymer-ceramic components of the composite material leads to a significant improvement of the material's fatigue life under conditions mimicking the *in vivo* ones. Ultimately, the proposed functional composite formulations could aid in revolutionizing the procedures in which bone regeneration or fixation is critical for treatment and provide new design concepts for next generation biomedical materials with improved fatigue life.

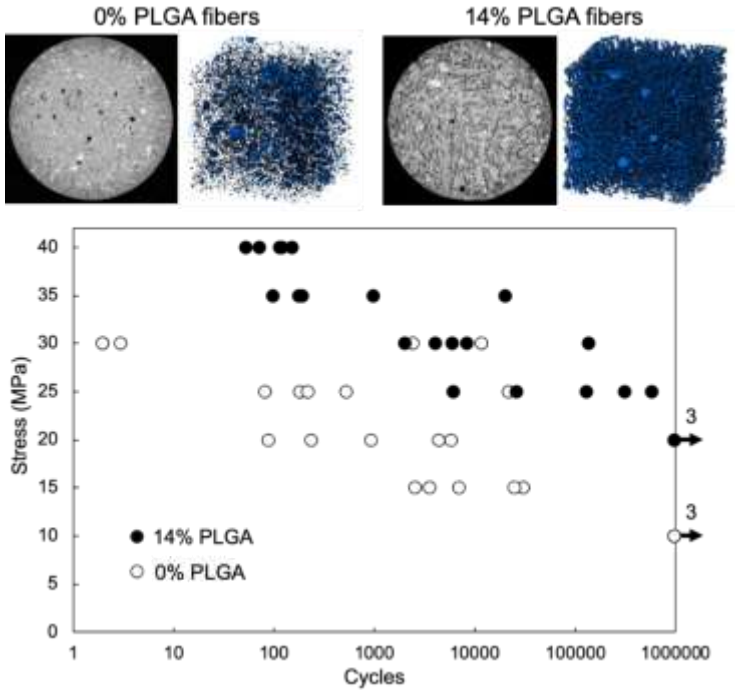

Figure 1 – Micro-CT images and compressive fatigue stress-life curves for the bone adhesive with 0% and 14% PLGA fibers

References

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