How Does Your Cement Fare?

Article by Gabriela Voskerician, PhD

Dr. Marc Bohner and his colleagues at the RMS Foundation (Bettlach, SWITZERLAND) have brought their innovation into the hands of orthopedic surgeons, and in the process developed one or two novel mechanisms of materials synthesis. Our Journal recently accepted for publication from this group the manuscript entitled: “Design of an inorganic dual-paste apatite cement using cation exchange,” which is now published online and available for 30-day free access for all readers, and will also appear in print as part of the February 2015 issue.

Dr. Bohner and his colleagues initiated their research on dual-paste cements in 2009. This work represents the achievement of five years of conceptual design, proof of concept assessment, failed formulations, and finally the development of an aqueous α-tricalcium phosphate (α-TCP) paste with a stability of 1 year.

The authors presented a thoroughly logical development-implementation-validation tour-de-force that left me wanting to know more.

The goal of the work was two-fold. The authors aimed to develop a stable α-TCP achieved through the addition of cations such as Mg. Then, the authors investigated the potential for re-activation of the formulation (in situ re-set as a cement) through the design of a dual-paste system. Here, the research group showed that traditional methods, such as phosphate ions or hydroxyapatite powder lead to no or limited re-activation. Therefore, a novel approach to re-activation was proposed and tested, involving the use of Ca ions.

Following the extensive conceptual design-implementation-validation provided in the manuscript, my mind fast-forwarded to the user tangible value, specifically: the most appropriate method of paste delivery, comparative cement setting time, adhesiveness, and applicability in specific orthopedic procedures. The authors helped address my concerns, which I share here with our community.

To start off, I wondered if one year was a sufficiently long stability time point for the product performance. α-TCP is traditionally provided in the form of an injectable. For this purpose, a component of this group’s ongoing work currently focuses on assessing the stability of the aqueous α-TCP beyond current stability. Issues of sedimentation over time, possible aqueous leakage leading to drying and plugging of the syringe tip, represent real obstacles that Dr. Bohner and colleagues are investigating.

Additionally, I was concerned when the authors reported in-situ cement setting times longer than the setting time of currently used cements. I could not see the orthopedic surgeon taking a “coffee break” or “meditating” while the cement is setting, only then to complete the procedure. I wonder how the hospital would bill for that... The group reports that ongoing work is aiming to bring the cement setting time in line with currently used products (10-15 minutes or even less), an effort supported by initial successful experimental outcomes.

A related component to cement setting time is the extent of comparative in-situ adhesiveness between the reported dual-paste cement and predicates, which the authors do not address. This concern becomes exponentially significant with cements that have a long setting time. If the group manages to lock the cement setting time at the current goal of 5-10 minutes, it is expected that the in-situ adhesiveness would be comparable to that of current products. Development of an extension product that contains a hydrogel in the formulation is also considered to enhance adhesiveness. Products such as Hydroset (Stryker) and chronOS Inject (DePuy-Synthes, J&J) have successfully taken this approach, with the recognized sterilization protocol complications of needing to autoclave the product replacing the mainstream sterilization technique of gamma-irradiation.

Finally, the question of surgical procedure applicability came to mind. Such aqueous α-TCP cements and the associated mode of delivery depend on two critical needs. There is a growing trend towards prophylactic procedures in the stabilization of the broken osteoporotic vertebrae (vertebroplasty). Current cements are excessively brittle, an undesirable property in addressing the need. However, aqueous α-TCP cements could be ideal in performing vertebroplasty due to their paste nature. Another interesting application of the aqueous...
α-TCP cements is expected to be in reinforcing the cannulated screws placed in the osteoporotic bone of patients. With a rapidly aging population and over 200 million screws annually implanted worldwide, the aqueous α-TCP cements are expected to make a difference in the quality of care and quality of life for many patients.

In spite of the authors’ flagrant deviation from the current manuscript section structure, which temporarily affected my blood pressure, I found this work engaging, an excellent example of translational research while using basic science in its innovation, and thorough in its evaluative design and data reporting.

I would like to thank Dr. Bohner and his colleagues for kindly agreeing to offer his research group’s vision on α-TCP cements beyond the confines of the published scientific work.

To our readers: I am looking forward to your comments that can be sent to gabriela.voskerician@case.edu using the heading “Editors’ Choice”. We hope to develop this feature into a dynamic forum think-tank.