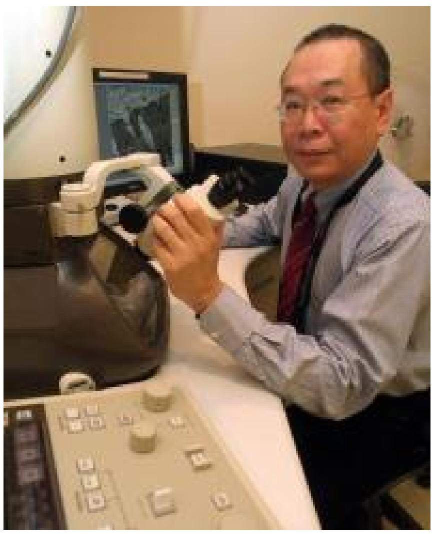
Nanotechnology may increase longevity of dental fillings

July 1 2009



Dr. Franklin Tay, associate professor of endodontics in the Medical College of Georgia School of Dentistry, is studying a new nanotechnology technique to extend the longevity of tooth-colored fillings. Credit: Medical College of Georgia

Tooth-colored fillings may be more attractive than silver ones, but the bonds between the white filling and the tooth quickly age and degrade. A Medical College of Georgia researcher hopes a new nanotechnology technique will extend the fillings' longevity.

"Dentin adhesives bond well initially, but then the hybrid layer between the adhesive and the dentin begins to break down in as little as one year," says Dr. Franklin Tay, associate professor of endodontics in the MCG School of Dentistry. "When that happens, the restoration will eventually fail and come off the tooth."

Half of all tooth-colored restorations, which are made of composite resin, fail within 10 years, and about 60 percent of all operative dentistry involves replacing them, according to research in the *Journal of the American Dental Association*.

"Our adhesives are not as good as we thought they were, and that causes problems for the bonds," Dr. Tay says.

To make a bond, a dentist etches away some of the dentin's minerals with phosphoric acid to expose a network of collagen, known as the hybrid layer. Acid-etching is like priming a wall before it's painted; it prepares the tooth for application of an adhesive to the hybrid layer so that the resin can latch on to the collagen network. Unfortunately, the imperfect adhesives leave spaces inside the collagen that are not properly infiltrated with resin, leading to the bonds' failure.

Dr. Tay is trying to prevent the aging and degradation of resin-dentin bonding by feeding minerals back into the collagen network. With a two year, $252,497 grant from the National Institute of Dental & Craniofacial Research, he will investigate guided tissue remineralization, a new nanotechnology process of growing extremely small, mineral-rich crystals and guiding them into the demineralized gaps between collagen fibers.

His idea came from examining how crystals form in nature. "Eggshells and abalone [sea snail] shells are very strong and intriguing," Dr. Tay says. "We're trying to mimic nature, and we're learning a lot from observing how small animals make their shells."

The crystals, called hydroxyapatite, bond when proteins and minerals interact. Dr. Tay will use calcium phosphate, a mineral that's the primary component of dentin, enamel and bone, and two protein analogs also found in dentin so he can mimic nature while controlling the size of each crystal.

Crystal size is the real challenge, Dr. Tay says. Most crystals are grown from one small crystal into a larger, homogeneous one that is far too big to penetrate the spaces within the collagen network. Instead, Dr. Tay will fit the crystal into the space it needs to fill. "When crystals are formed, they don't have a definite shape, so they are easily guided into the nooks and crannies of the collagen matrix," he says.

In theory, the crystals should lock the minerals into the hybrid layer and prevent it from degrading. If Dr. Tay's concept of guided tissue remineralization works, he will create a delivery system to apply the crystals to the hybrid layer after the acid-etching process.

"Instead of dentists replacing the teeth with failed bonds, we're hoping that using these crystals during the bond-making process will provide the strength to save the bonds," Dr. Tay says. "Our end goal is that this material will repair a cavity on its own so that dentists don't have to fill the tooth."

Source: Medical College of Georgia

Citation: Nanotechnology may increase longevity of dental fillings (2009, July 1) retrieved 10 April 2024 from https://phys.org/news/2009-07-nanotechnology-longevity-dental.html

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