In the lab, engineer's novel liquid provides a solid fix for broken bones

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A bone-healing fluid that can be injected into breaks with a syringe shows such strong promise in lab testing, that it has been licensed from Brown by a Massachusetts biotech startup for further development.

Here's the vision: an elderly woman comes into the emergency room after a fall. She has broken her hip. The orthopaedic surgeon doesn't come with metal plates or screws or shiny titanium ball joints. Instead, she pulls out a syringe filled with a new kind of liquid that will solidify in seconds and injects into the break. Over time, new bone tissue will take its place, encouraged by natural growth factors embedded in the synthetic molecules of the material.

Although still early in its development, the liquid is real. In the Brown engineering lab of professor Thomas Webster it's called TBL, for the novel DNA-like "twin-base linker" molecules that give it seemingly ideal properties. The biotech company Audax Medical Inc., based in Littleton, Mass., announced on Dec. 7 an exclusive license of the technology from Brown. It brands the technology as Arxis and sees similar potential for repairing broken vertebrae.

"The reason we're excited about this material is because it gets us away from metals," Webster said. "Metals are not in us naturally and they can have a lot of problems with surrounding tissues."

In some of his work, Webster employs nanotechnology to try to bridge metals to bone better than traditional bone cement. But TBL is an entirely new material, co-developed with longtime colleague and chemist Hicham Fenniri at the University of Alberta. Fenniri synthesized the molecules, while Webster's research has focused on ensuring that TBL becomes viable material for medical use.

The molecules are artificial, but made from elements that are no strangers to the body: carbon, nitrogen, and oxygen. At room temperature their aggregate form is a liquid, but the material they form solidifies at body temperature. The molecules look like nanoscale tubes (billionths of a meter wide), and when they come together, it is in a spiraling ladder-shaped arrangement reminiscent of DNA or collagen. That natural structure makes it easy to integrate with bone tissue.

In the space within the nanotubes, the team, which includes graduate student Linlin Sun, has managed to stuff in various drugs including antibiotics, anti-inflammatory agents, and bone growth factors, which the tubes release over the course of months. Even better, different recipes of TBL, or Arxis, can be chemically tuned to become as hard as bone or as soft as cartilage, and can solidify in seconds or minutes, as needed. Once it is injected, nothing else is needed.

"We really like the fact that it doesn't need anything other than temperature to solidify," Webster said. Other compounds that people have developed require exposure to ultraviolet light and cannot therefore be injected through a tiny syringe hole. They require larger openings to be created.

For all of TBL's apparent benefits, they have only been demonstrated in cow bone fragments in incubators on the lab bench top, Webster said. TBL still needs to be proven in vivo and, ultimately, in human trials. Part of the agreement with Audax will include support to continue the material's clinical development. Audax research and development director Whitney Sharp, a Brown alumna (Sc.B., 2008; Sc.M., 2009), is now working with Webster's group.

"They see the future where hopefully we will get to the point where we won't be implanting these huge pieces of metal into people," Webster said. "Instead we'll be implanting things through a needle that could be used to heal a hip that's more natural."

Provided by Brown University

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