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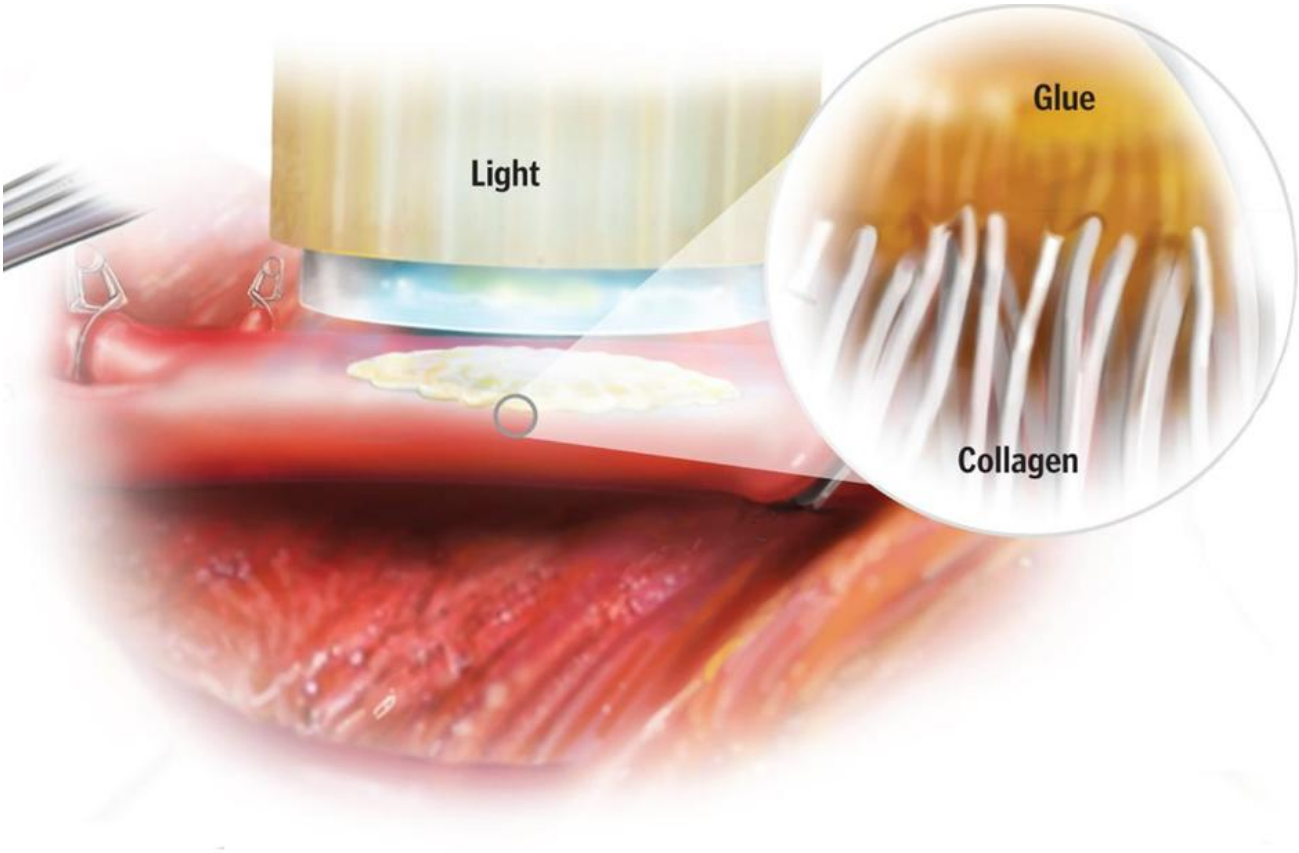
For heart surgery, a glue replaces needle and thread

By Karen Weintraub | GLOBE CORRESPONDENT JANUARY 09, 2014



ILLUSTRATIONS: RANDAL MCKENZIE/ MCKENZIE ILLUSTRATION

Glue and Light: Researchers at Brigham and Women's Hospital, Boston Children's Hospital, and MIT have developed a new type of elastic glue that cures after being exposed to light for 5 seconds.

When Dr. Pedro del Nido operates on an infant's or small child's heart, he closes the surgical cuts the old-fashioned way: with needle and thread.

As tried and true as it is, sewing a patch onto a child's heart is difficult and risky: It has to be done fast, and in a small area; the needle has to pierce healthy tissue but avoid the cluster of cells that operate as the heart's natural pacemaker.

Frustrated by these limitations, del Nido, head of the cardiac surgery department at Boston Children's Hospital, and medical researchers in Boston have come up with a replacement that, conceptually at least, is as simple as needle and thread: glue.

This surgical glue is nontoxic, biodegradable, and fast-drying even in the presence of blood, forming a bond that is strong enough to close a hole on a beating heart. The glue is the invention of Jeffrey Karp, a bioengineer at Brigham and Women's Hospital, and MIT super scientist Robert S. Langer, who nearly four years ago took up del Nido's challenge to find a safer way to close surgical cuts.

The pair have formed a company, Gecko Biomedical Co., to develop the glue into a product that can be tested in people. On Wednesday they and del Nido published a paper in Science Translational Medicine showing that the glue works in the harsh conditions of a surgical site.

Though adhesives have long been used in treating wounds, none has proved to work well in edge-of-life situations such as heart surgery or sealing blood vessels. Current glues are either too toxic or too fast-acting, work only in the absence of blood, or are not strong enough to hold moving tissue together.

The Gecko glue appears to solve those problems and is already being hailed by others in the industry as a significant advance.

"This group has really addressed the challenges that have prevented adhesives from becoming a mainstay in hospitals: working in a wet environment and working on moving tissues," said Jennifer Elisseeff, a professor and director of the Translational Tissue Engineering Center at Johns Hopkins University in Baltimore.

Indeed, del Nido said the number of other potential uses for the surgical glue is "quite long," and could include making repairs to the gastrointestinal tract, as a substitute for surgical staples, and in trauma situations.

The continued use of stitches has kept the medical industry from making surgery less invasive, said Michael Longacre, a professor of surgery, biomaterials, and bioengineering at Stanford University; just getting a surgeon's hands to the operating site to sew in a patch, for example, requires a relatively large incision.

“It excites me that technology is being developed that will help us meet an unmet need: How do we do this safely, through a less invasive approach,” said Longacre, who also serves as codirector of Stanford’s Institute for Stem Cell Biology for Regenerative Medicine.

Karp said he, del Nido, and Langer developed the glue out of another polymer they had been working with for some time, which has been proven safe and easy to manufacture. A combination of glycerol and sebacic acid, the sealant is squirted onto a surgical patch, placed in position, and then gently heated with a small light for a few seconds to form a bond that is solid, strong, and flexible. It can even take hold on a beating heart, which would allow del Nido and his peers to patch a heart without the need for a bypass machine.

Importantly, the viscous glue infiltrates the tissue, like fingers interlocking with each other.

Karp said the glue biodegrades slowly over weeks or months, allowing the tissue to heal itself.

Also an associate professor at Harvard Medical School, Karp is making a name for himself with his nature-inspired inventions. He is developing a painless needle modeled on the quill of a porcupine and adhesive bandages inspired by the sticky feet of a gecko.

For the heart glue, Karp said, he took ideas from the secretions of slugs, spiders, and mites, which are liquid, sticky, and not washed away by water.

“We thought this would be useful to consider in the context of a new adhesive that could attach within the presence of blood,” said Karp, who is chairman of Gecko Biomedical’s scientific and clinical advisory board.

The company said in December it had raised $11 million to advance the surgical glue. So far the glue has been tested only on lab animals, Gecko next must scale up production of the material, and subject it to a large-scale test on animals before trying it on humans.

“Provided we can scale the material and insure consistency, we should be able to bring this to the clinic in a short time frame,” said Karp, explaining that the process is less arduous for a medical product like the glue than for a drug. The company, which is based in Paris, will pursue approval in Europe before the United States, he said.

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