



Polyurethanes help to seal wounds effectively

Cut and paste

Surgical incisions, lacerations and other cuts are generally repaired with needle and thread. In many cases the stitches have to be removed once the wound has healed, leaving an unsightly scar. Depending on the degree of injury, conventional wound adhesives quickly reach their limits. Now Bayer MaterialScience research scientists are working on a new solution: they hope to achieve better wound healing of even deep wounds or injuries to organs with a new medical adhesive technology.

They say that every child has a guardian angel. Nevertheless, most children at some time or other fall down in the school yard or at the playground, when inline skating or cycling, and come home with a bleeding wound. The question facing parents in such situations is: does it require stitches? Young children in particular are terrified by the thought of the needle and having the stitches removed once the cut has healed. To avoid this, research scientists at Bayer MaterialScience are working on an alternative method of closing wounds – medical adhesives. Sticking skin injuries or surgical inci-

sions together instead of sewing has a number of advantages for the patient: there are no sharp needles involved – either for injecting the local anesthetic or for sewing – and also there are no stitches which have to be removed later. The thin adhesive film dissolves gradually, leaving a barely visible scar. Also, once dry, the adhesive film is impermeable to germs, which means that there is less likelihood of bacterial infection. So all in all, adhesives could help in their own small way to reduce the cost of health care.

“Conventional adhesives do not yet satisfy all the medical requirements,”

says Dr. Thomas Muehlberger, Associate Professor and Head of the Plastic Surgery Department at the Red Cross Hospital in Berlin-Westend. “Although they are very stable, the cyanoacrylates used at present are only suitable for superficial cuts and are not approved for deeper wounds or organs.” However, thanks to an innovative polyurethane adhesive from Bayer MaterialScience, surgeons could have a more effective alternative at their disposal in just a few years’ time. A project team headed by Dr. Heike Heckroth has succeeded in developing an adhesive system that is extremely easy to use, has outstanding

Adhesives instead of stitches: Dr. Heike Heckroth (photo, center) and her team have developed a novel adhesive that could soon render needle and thread superfluous after surgery. The transparent, polyurethane-based adhesive with the consistency of honey (photo, right) firmly seals wound edges together within five minutes and forms a bond that is stronger than the individual tissue fibers themselves.



adhesive properties and excellent skin compatibility.

Heckroth and chemical technician Gerd Vermehren from Medical Coatings, Adhesives & Specialties at Bayer MaterialScience are working together on new adhesives that will seal the edges of the wound quickly and hold them together reliably throughout the healing process while at the same time being sufficiently elastic to prevent the wound from bursting open again. No simple task, as Heckroth explains: "In addition to proteins, skin and other organic tissues contain both water and fat. Sticking these together is extremely difficult."

The chemist started off with a polyurethane system whose suitability for use in waterborne wound gels had already been investigated. The polymer consists of long carbon chains with a reactive end which forms a stable network on exposure to moisture. The problem is that it is a very slow process. In order to speed things up, Heckroth and her colleague began looking for a second component. After investigating various options, they finally found a compound that cures the polymer quickly and at the same time forms a highly effective adhesive that works even on a wet substrate. In other words, it reacts quickly enough to prevent the surgeon from having to wait too long, while still leaving sufficient time for minor adjustments.

The polyurethane itself has also been improved. The Bayer materials

experts synthesized and tested over 200 variants of the polymer in the laboratory. As there is no standard process for surgical adhesives, they developed a new method analogous to those used for materials testing. First they stick two strips of muscle tissue together. The exact quantity of clear plastic, which has the consistency of honey, is then applied on the tissue in a thin layer. Finally, the one-centimeter-wide and one-centimeter-thick strips are overlapped and stuck together.

Firmly sealed wounds within five minutes

It takes a mere five minutes for the adhesive to cure and the two strips to form a firm bond. The system is placed in a tension tester so that the scientists can measure the force required to tear either the tissue or the pasted seam. First the tissue stretches without anything happening, but then a tear occurs – however well above the actual join. In other words, the polyurethane adhesive has better tensile strength than the tissue fibers and at the same time remains flexible and elastic.

Toxicity tests on the new tissue adhesive likewise give grounds for optimism. "The material is extremely biocompatible and has exhibited no mutagenic or irritant effects in tests to date," says Heckroth, "and the healing process is not impaired either." This was confirmed in trials carried out by Muehlberger. In his cell cultures he found

that the main cells responsible for wound healing – keratinocytes, fibroblasts and melanocytes – do not avoid the adhesive, but actually grow along it. "So even the healing of internal wounds should not be hampered. After all, only a very thin layer is needed to hold the tissue together," comments the surgeon. Initial in vivo trials – i.e. trials carried out on a living organism – underpin this result.

Heckroth and her colleagues are currently preparing further trials with the medical adhesive with a view to testing their polyurethane compound not just on external wounds but also on internal organs following surgery. After that, clinical tests will follow. If the plastic comes through all the test phases successfully, doctors will have to resort to needle and thread less often in a few years and patients will be left with less noticeable scars on their skin. Health centers and hospitals will keep small syringes of the adhesive at the ready so that doctors will be able to reassure anxious patients of all ages with the words: "No stitches, we're going to stick you together."

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A summary of a study on this topic can be found under the heading "Tissue adhesives".