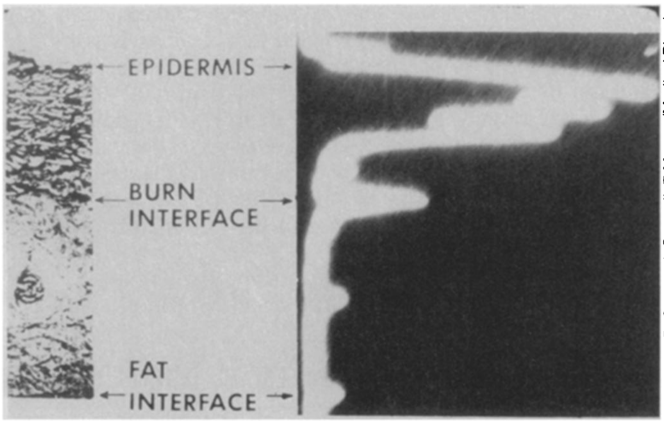
Ultrasound gives burns the third degree

When it comes to understanding burn injuries, David M. Heimbach of the University of Washington School of Medicine in Seattle likens scientists to alien creatures devising powerful telescopes with which to watch the human race. "We're still trying to decide what we're studying while we study it very intensely," he says. And, he says, in the race to heal a burn, doctors have "neither an endpoint nor signposts" indicating how deep the damage is or how much viable skin remains underneath, two of the main factors influencing treatment of the 75,000 burn victims hospitalized annually in the United States.

By using ultrasound to study basic properties of biological materials, researchers at the National Aeronautics and Space Administration's Langley Research Center in Hampton, Va., hope to take some of the guesswork out of burn diagnosis. As William T. Yost announced recently at a burn injury conference at the National Institutes of Health in Bethesda, Md., he and John H. Cantrell Jr. have linked ultrasonic differences between healthy and irreparably burned pig skin to differences between normal collagen and that denatured by heat.

According to Cantrell, an ultrasonic wave moves smoothly through burned skin until reaching the interface between dead and live tissue. At that point, and at the boundary between skin and subcutaneous fat, part of the wave gets reflected, providing a sonar image of burn depth and skin thickness. Cantrell began imaging skin using ultrasound with colleagues at Oak Ridge National Laboratory in Tennessee (SN: 6/10/78, p. 383). When they compared ultrasonic measurements of burned pig skin with histological slices of the same tissue, they found the sonar images to be accurate to within 5 percent in delineating tissue boundaries.



Comparison of a histological section of burned pig skin to its corresponding ultrasound image, showing a distinct boundary between live and thermally destroyed tissue. Scientists now attribute the ultrasonic blip at the burn interface to differences in collagen density.

In an effort to discover the cause of the acoustical difference between dead and live skin, Cantrell, by this time at NASA, developed a thermodynamic model describing the ultrasound measurements. With the help of Yost, he then compared this model to others describing the effects of heat on biological materials. As Yost announced last week, the researchers have now linked the acoustical difference to changes in collagen.

The most abundant protein in higher vertebrates, collagen consists of long linear molecules coiled into fibers. These fibers can interlock to form the flat sheets that serve as scaffolds in the dermal layer of the skin, which lies between the tough epidermis and subcutaneous fat. When exposed to heat, collagen undergoes a first-order phase transition, in which fibers uncoil and gelatinize. According to Cantrell, the abrupt change in density between gelled and coiled collagen gives rise to ultrasonic reflections at the border between dead and live skin.

Speaking after Yost at the burn conference, Heimbach described these findings as "very exciting," and stressed the need for an accurate diagnostic tool. Clinicians base treatment on their assessment of burn depth relative to skin thickness, which ranges from eyelid-thin to sole-of-the-foot-thick. To treat a full-thickness burn — one which destroys both layers of skin — a doctor must excise dead tissue, grafting donor skin in its place. Partial-thickness burns extend into the dermis. While some heal without surgery, others degenerate into full-thickness.

According to Heimbach, two burn surgeons at the University of Washington were asked to estimate whether 300 specific burns, left to their own devices, would heal in less or more than three weeks. The clinicians were right less than half the time. "We might as well ask the patient 'Do you think you'll heal or not?'" says Heimbach. "The ability to determine [burn depth] will be an inestimable help to the clinical surgeon."

Cantrell and Yost plan to start tests on humans within the next few months to determine if sonar images could provide the "signposts" necessary to aid diagnosis. Although the researchers took their data from studies on relatively thick pig skin, Cantrell expects ultrasound to yield comparable results on thinner human skin, "providing we get good enough resolution." And while scientists agree that collagen denaturation is a good indicator of thermal damage, no one knows if it represents the true burn depth, as skin cells may be more sensitive than collagen to heat. "We've established that ultrasound measures collagen denaturation," says Cantrell. "Now we need to establish if that's good enough to diagnose burn depth."

—S. Steinberg

Milrinone helps conquer heart failure

Milrinone, a powerful drug recently developed for long-term treatment of congestive heart failure, may provide the answer in the search for an oral substitute for the commonly prescribed but highly toxic digitalis, according to a recent study at Beth Israel Hospital in Boston.

"I am confident that if milrinone continues to show the effectiveness that we have seen in our study patients, it will replace digitalis as the first line of defense in the treatment of heart failure," says William Grossman, chief cardiologist at Beth Israel and a co-author of the study, which appeared in the Sept. 29 New England Journal of Medicine.

Congestive heart failure, currently affecting 2 million Americans, is usually the final manifestation of other heart ailments and results in the severe weakening of the heart muscle's ability to pump blood. Digitalis, derived from the foxglove plant, has been prescribed for failing hearts for two centuries; even the early Egyptians used it to treat dropsy (edema). But the usefulness of digitalis is limited by its toxicity— toxic and therapeutic doses are very close — and users suffer side effects such as nausea, shortness of breath and fever.

In their study involving 20 chronic cardiac patients, the researchers, headed by Donald Baim, found that milrinone helps strengthen the heart's contractile ability and works as a vasodilator, without significant side effects. "Patients who failed to improve with conventional medicines showed a very impressive response to milrinone," Baim says.

Edmund Ronnenblick, a cardiologist at Albert Einstein College of Medicine in New York City, is also studying milrinone's future as a cardiac drug. "Because it is less toxic than digitalis, it can be pushed farther and is therefore more potent," he says. "But I don't think it will replace digitalis. Rather, it will be used as an adjunct to digitalis and other cardiac drugs. Digitalis will remain an important drug in treating heart rhythm abnormalities and milrinone may even speed the heart up too much, we don't know yet. The point is that milrinone is an important addition to what is now inadequate treatment for heart failure."

—M. Wolfe