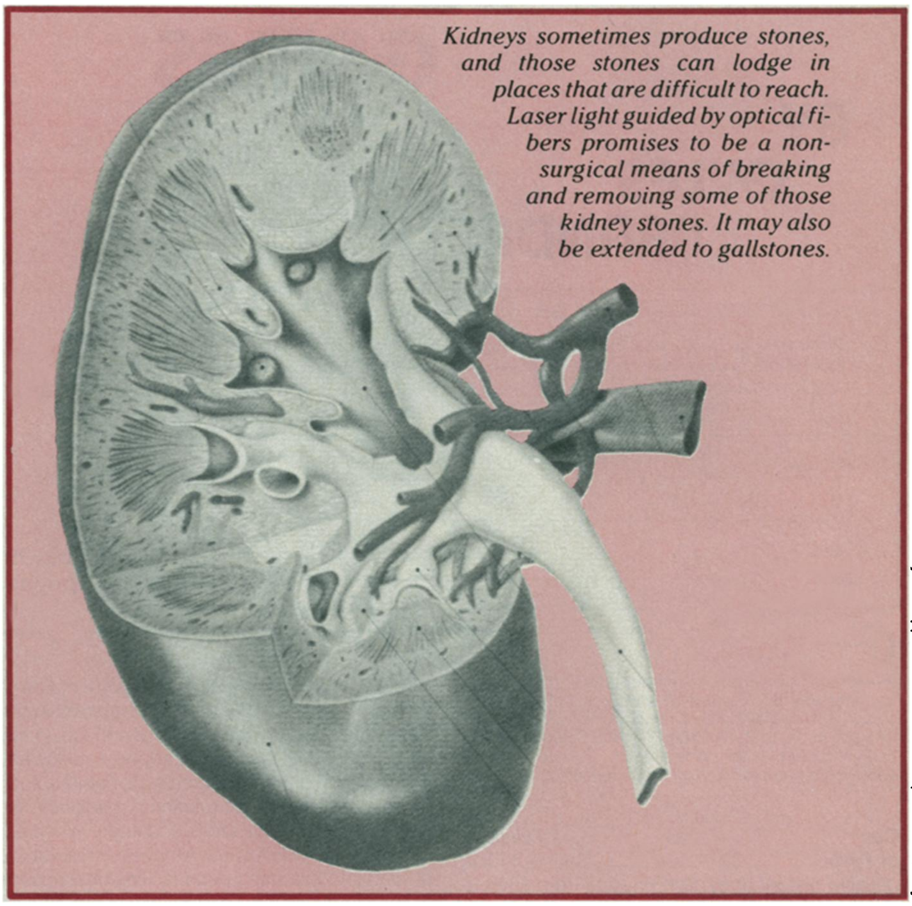
Plasma Physics Breaks Stones

It may be the first application of plasma physics to medicine

By DIETRICK E. THOMSEN



Kidneys sometimes produce stones, and those stones can lodge in places that are difficult to reach. Laser light guided by optical fibers promises to be a nonsurgical means of breaking and removing some of those kidney stones. It may also be extended to gallstones.

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Cutting for stones is one of the oldest of surgical procedures; the operation goes back centuries. Today kidney stones account for about 350,000 U.S. hospital admissions a year, according to Thomas F. Deutsch of Massachusetts General Hospital in Boston. But not all of these people are cut. When conditions are favorable, therapists will use noninvasive options — methods of breaking up the stones inside the body and removing them by natural elimination or other means that don't involve cutting.

One recently developed option is treatment in a device called a lithotripter, which generates sound waves to crush the stones. Worldwide, about 100,000 patients a year undergo this treatment. The sound-wave approach has its limitations, however. Now a technique that uses laser light is about to enter clinical use, offering several potential advantages over the lithotripter.

Clinical studies in which laser light successfully treated 76 out of 77 patients with kidney stones have recently ended at Massachusetts General, Deutsch reported at the recent Conference on Lasers and Electro-Optics held in San Francisco. (Deutsch spoke on behalf of Richard Rox Anderson and coauthors Norman S. Nishioka, Stephen P. Dretler and John A. Parrish of Harvard Medical School in Boston.) The method's proponents expect that it will eventually take its place as an alternate, noninvasive therapy that will be less expensive and less cumbersome than the lithotripter and will be able to treat patients the lithotripter cannot. The pelvic bones block the sound waves, so the lithotripter is useful only for stones lying above the waist, Deutsch says. A lithotripter can represent $1.7 million in capital cost, he adds, and a single treatment with it can run up to $3,500.

Laboratory studies have shown that laser light will also shatter gallstones, and so it may also become a clinical treatment for gallstones that come to rest in the common bile duct. For stones in the gallbladder itself, excision would still be the preferred treatment, Deutsch says, but in the common bile duct the stones are difficult to get to, and it is hard to get a good view of them with an endoscope. Under these conditions the laser method could be an attractive alternative. Stones in the common bile duct are far less prevalent than kidney stones, affecting fewer than 10,000 persons a year, he says. Clinical studies on gallstones are still in the future.

What seems to be happening here could be called an application of plasma physics to medicine. In the laboratory experiments the stones were held in little wire baskets. (These baskets are also used therapeutically: On the end of a catheter they can grasp and crush a stone.) The experimenters put an optical fiber into contact with the stone and send the laser light through the fiber, just as if they were treating a patient.

In these experiments, whenever a pulse of light hit a stone, there was a sparklike flash. The experimenters wanted to know what this flash was and whether it was necessary to the destruction of the stone, so they studied the spectrum of the flash. It was not a blackbody spectrum but a line spectrum, Deutsch says. The line spectrum indicated that something more than simple heating was taking place.

The experimenters believe that the light vaporized and ionized a small part of the surface of the stone, producing an ionized gas, a plasma. The plasma absorbed energy from the light and so expanded. Expansion of the plasma, they believe, generated an acoustic wave that shattered the stone.

The work on kidney stones was begun by a London urologist, Graham Watson, who experimented at first on pigs. Watson came to the United States to work as a visitor at Massachusetts General, and after the Food and Drug Administration gave permission for human trials, he treated 34 patients this way. Later, Dretler, a hospital staff member, treated 43 more. In all but one of the patients, the shattered stones were passed in urine or removed with the basket. □